



NATIONAL INFECTION PREVENTION AND CONTROL TRAINING

PARTICIPANT MANUAL

OCTOBER 2019

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ACRONYMS

AD	Auto-Disposable
AIDS	Acquired Immuno Deficiency Syndrome
AMR	Antimicrobial Resistance
ARV	Anti Retroviral
BSI	Body Substance Isolation
CHG	Chlorohexidine Gluconate
CDC	Center for Disease Control
d4T	Stavudine
EFV	Efavirenez
FMOH	Federal Ministry of Health
GMT	Good Microbial Technique
HAI	Healthcare Associated Infections
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HCWM	Health care waste management
HICPAC	Healthcare Infection Control Practices Advisory Committee
HIV	Human Immuno Deficiency Virus
HLD	High Level Disinfection
IPC	Infection prevention and Control
LASA	Look-Alike Sound Alike
MMIS	Making Medical Injection Safe
MVA	Manual Vacuum Aspiration
NVP	Nevirapine
OR	Operating Room
PEP	Post Exposure Prophylaxis
PPE	Personal Protective Equipment
PPP	Power point presentation
PPT	Power point
PS	Patient safety

SIGN	Safe Injection Global Network
SSI	Surgical Site Infection
TB	Tuberculosis
TDS	Training Demonstration Segments
TTI	Transfusion transmissible infections
UP	Universal precaution
VIIPC	Visualization In Participatory Programmes
UV	Ultra Violet
VNRDs	Voluntary non-remunerated donors
WHO	World Health Organization

HOW TO USE THE IPC TRAINING RESOURCE PACKAGE

The IPC resource package

This Infection prevention and Control training package is designed to develop or strengthens the capacity of healthcare providers to protect themselves, their patients/clients and the community from healthcare acquired infections (HCAIs).

This IPC training resource Package includes the following components:

- Infection Prevention and Control Reference Manual for Service Providers and Managers in Healthcare Facilities of Ethiopia
 - Infection Prevention and Control handbook for Trainers-Facilitator guide
 - Infection Prevention and Control handbook for participant- Participant guide
- Video presentations

Participants are also encouraged to read the Ethiopian Hospital Transformation Implementation Guidelines

Purpose of the IPC Training guide

This guide is prepared to help trainers in providing an effective training on Infection Prevention and Control (IPC). The guide will serve as a reminder of how to facilitate each activity and also provide with detail notes on each topic.

How the guide is organized

The facilitator guide is developed in a user-friendly, flexible format using adult learning principles. Participatory approaches and techniques are used throughout the activities to help participant acquire the required knowledge, attitudes, and skills. The training activities encourage the participant to see, analyze and share their practice and experiences on Infection Prevention and Control (IPC). This training Resource Package can be used in a variety of ways depending on the healthcare facility's needs assessment, participant' needs and background, program objectives and goals, time availability, and trainer's capacity.

The facilitator guide's organization and materials offer the following options for its implementation:

Group-Based Training:

A basic **8-day** Infection Prevention and Control (IPC) comprehensive (Volume1 and volume2) training for healthcare workers is presented in the course overview, detailed schedule, and outline provided. The two volumes and chapter under each volume are organized/ grouped based on their need where to apply, flow of action and rational sequence.

The 8-days IPC training covers a total 31 chapters (14 under volume-1 and 17 under volume-2). It is recommended that the trainer follow the sequence of chapters in the schedule and outline. Each chapter is presented in an interactive and user friendly format. Power point presentation slides are also provided for each chapter separately. However, in situations where the use of power point presentation is not possible, trainers should use flipchart as an alternative.

On-the-Job Training:

A sequential (complete or partial) modular approach for healthcare providers with a structure depending on participant' needs. In this case the trainer will need to adapt the schedule and outline according to the specific needs and a volume or Chapters selected, using the schedules and outlines provided for the 8-day group-based course as an example. The methodology may also change depending on the number of participants attending the training activity, time allocated for each chapter, and materials available. Regardless of the format used, however, it is important to maintain the basic principles of competency-based training and strengthen knowledge and skills to enhance transfer of learning and change the attitude of trainees. The trainer should plan in advance with the facility supervisor/Managers and participants on the objectives of the IPC training, methodology to be used, including the evaluation process, materials (e.g., reference manual, videos, IPC supplies (Soap, alcohol-based hand-rub, PPE, and etc.) to be used, and the schedule of the knowledge and practical sessions. The trainer can also set up the IPC skill-stations related to the topic being covered and allow the participants to practice as their schedules allow. The trainer should then have time available to work with participants individually or in pairs to assess and qualify their skills.

OVERVIEW OF THE TRAINING

Training Design

This training course is designed for healthcare Professionals. Training emphasizes, **changes in attitude** and **learning by doing**, not just knowing, and it uses **competency-based evaluation** of performance.

Pre-training questionnaire will be used to determine participants individual and group knowledge on IPC, the healthcare facilities' needs/gaps in IPC are identified in advance or throughout the training using IPC a needs matrix operational action plan, the practical sessions focus on using simple IPC practices that minimize costs, progress of learning is assessed using checklist and each participant performance is assessed by an IPC trainer using competency-based skills checklists.

Successful completion of the training is based on mastery of both the content and skill components, as well as satisfactory overall performance of the recommended IPC practices.

Evaluation

This IPC training is designed to produce healthcare workers at all levels qualified to use recommended basic IPC principles and practices for primary and hospital care services. Volume two is more applicable for hospitals that provide comprehensive and different specialty services.

Qualification is a statement by the training organization that the participant has met the requirements of the training in knowledge and skills. Qualification does **not** imply certification. Personnel can be certified only by an authorized organization or agency. Qualification is based on the participant's achievement in two areas:

- **Knowledge**—A score of at least 85% on the post training Questionnaire (Annex 2)
- **Skills**—satisfactory performance of recommended selected IPC practices during a skill-station. Responsibility for the participant's becoming qualified is shared among the participant and the trainer. Both participants and trainers can keep track of their progress on the selected IPC skills using the **Participant Monitoring Sheet**.

The evaluation methods used in the training are described briefly below:

- **Post training Test.** This knowledge assessment will be given at the time in the training when all subject areas have been presented. A score of 85% or more correct indicates knowledge based mastery of the material presented in the reference manual. For any participant scoring less than 85% on their first attempt, the IPC trainer should review the results with the participant individually and provide guidance on using the reference manual and participant manual to learn the required information. Participant scoring less than 85% can retake the Post Course Test Questionnaire at any time during the remainder of the course, after they have had time to study the selected areas of the reference manual.
- **Infection Prevention and Control Checklists (Skill-station checklists).** The IPC trainer will use selected skill-station checklists to assess each participant as the participant performs IPC activities/practices in the simulated clinical setting. In determining whether the participant is qualified, the trainer(s) will observe and rate the participant's performance for each step of the skill or activity. The participant must be rated to the minimum "satisfactory" in each skill or activity to be evaluated as qualified.

Within 3 to 6 months of qualification, it is recommended that participant be followed up at their facility by an IPC trainer, their supervisor who attended previously the same training package using the same IPC checklists or WHO's IPC performance standards. Follow up is crucial to maximize the transfer of learning and improve job performance, which is the main goal of a learning intervention. During the follow-up, the trainer or supervisor should provide direct feedback to the participant and review the implementation of the action plan with the participant, supervisor, and co-workers.

This review provides the opportunity to identify and discuss progress to date as well as any start up issues or constraints to service delivery (e.g., lack of instruments, supplies, support staff, IPC policies, etc.). Equally important, it provides feedback on the training and its appropriateness to local conditions. Without this type of feedback, training easily can become routine, stagnant, and irrelevant to service delivery need.

COURSE SYLLABUS FOR 8-DAYS BASIC IPC TRAINING FOR HEALTHCARE PROFESSIONALS

Training Description

The 8-day basic IPC training is designed to provide to all levels of healthcare workers the basic infection prevention and Patent Safety knowledge and skills they need to use recommended IPC principles and practices in primary health care and hospital settings with limited resources.

Goal of Basic IPC training

- To make healthcare facilities a safer places.

Training Objective

- To influence in a positive way the attitudes of the participant toward the benefits of using appropriate IPC principles and practices
- To provide the participant with training in simple, inexpensive IPC practices and processes
- To provide the participant with the knowledge and skills needed to implement and/or improve IPC principles and practices in her/his home facility

Participant Learning Objectives

The learning objectives of the 8-day training course is presented in the “Volume-1 for the basic IPC (for 4 days) and Volume-2 for IPC for specialty hospitals (for 4 days) infection prevention and Control course outline”

Training/Learning Methods

- Brainstorming
- Game
- Gallery walk
- Group discussions
- Buzz groups

- Individual and group exercises
- Role plays and skill stations
- Videotapes and discussion
- Illustrative lectures
- Simulation
- Individual reflection
- Demonstrations
- Observation site/ facility visits

Learning Materials

- This guide for facilitator/ trainers is designed to be used with the following materials:
 - Infection Prevention and Control Reference Manual for Service Providers and Managers in Healthcare Facilities of Ethiopia
 - IPC Participant Guide
 - Training videotapes: Infection Prevention Guidelines for Healthcare Facilities with Limited Resources: Overview and Practical Training Demonstration Segments and Safe Practices in the Operating Room

Participant Selection Criteria

Participant of the training are health professionals working at various levels in the healthcare system of the country

Methods of Evaluation

Participant

- Pre- and Post-training Questionnaires
- Infection Prevention and Control skill-station Checklists (to be completed by trainer)

The trainer/facilitator

- Training Evaluation (to be completed by each participant)

Number of Hours

- 64 hours (8-day course)

Suggested Training Composition

- 20–30 participant
- 3-4 IPC trainers
- 1 Training Coordinator

BASIC 8-DAYS INFECTION PREVENTION AND CONTROL TRAINING

SCHEDULE

GENERAL INFECTION PRVNETION AND CONTROL,VOLUME1			
Time	Chapter	Topic	Facilitator/Co-facilitator
DAY ONE			
8:30-8:50		Registration	
08:50–10:45		<ul style="list-style-type: none"> • Welcome and introduction (20 min) • Participant expectations (10 min) • Review course materials (5 min) • Group Norm (10 min) • Pre-test(35min) • Training overview(15min) 	
10:45-11:00		TEA BREAK	
11:00-12:30	1	Chapter 1: Introduction to Infection Prevention and Control. (90min)	1hour- 30 minutes
12:30-1:30		LUNCH	
1:30- 2:00	2	Chapter 2: Basic Microbiology (New)	1 hour
		Chapter 3: Standard and Transmission Based Precautions (1:00 min)	1 hour
2:45-3:30	3	Chapter 4: Hand Hygiene (45min)	2 hours
3:30-3:45		TEA BREAK	
3:45-5:00	3	Chapte4: Hand Hygiene(Cont'd) (75min)	
5:00-5:10		Daily course evaluation	
DAY TWO			
8:30-8:45		Daily recap and warm up	
08:45-10:45	4	Chapter 5:PPE (120 minutes)	2 Hours
10:45-11:00		TEA BREAK	
11:00-12:30	5	Chapter 6: Sharp and Injection Safety (1:30 hour)	(2:30
12:30-2:00		LUNCH	
2:00-3:45	5	Chapter 6: Sharp and Injection Safety (1:00hr) continued	
3:45-4:00		TEA BREAK	

4:00-5:25	6	Chapter 7: Decontamination and reprocessing of medical devices (1: 25 hour)	3:15
5:25-5:30		Daily course evaluation	

DAY THREE

8:30-8:40		Daily recap and warm up	
08:40-10:30	7	Chapter 7: Decontamination and reprocessing of medical devices (1:50 hour)	
10:30-10:45		TEA BREAK	
10:45-11:30	8	Chapter 8: Processing reusable textiles and laundry services (50 Minutes)	50 Minutes
11:30-12:30	9	Chapter 9: Environmental Cleaning in Healthcare Facility (1 hour)	1 hour
12:30-1:30		LUNCH	
1:30-3:30	10	Chapter 10: Health care waste Management (2:00 hour)	2 hours
3:30-3:45		TEA BREAK	
3:45-4:30	11	Chapter 11: food and water safety (45 minutes)	45 Minutes
4:30-5:25	12	Chapter 12 :Facility design and patient flow (55 Minutes)	55 minutes
5:25-5:30		Daily Course evaluation	

DAY FOUR

8:30-8:35		Daily recap and warm up	
8:35-10:35	13	Chapter 13: IPC aspects of occupational health in health care settings (2hr)	2 Hours
10:35-10:50		TEA BREAK	
10:50-11:35	14	Chapter 14: client education in IPC (45 minutes)	45 Minutes
11:35-12:30		Orientation for field visit	
12:30-1:30		LUNCH	
1:30-3:30		Facility visit	
3:45-4:00		TEA BREAK	
4:00-5:15		Presentation and feed back	
5:15-5:30		Daily course evaluation and closing	

VOLUME 2: ADVANCED AND SPECIAL IPC			
Time	Chapters	Topic	Facilitator/Co-facilitator
DAY FIVE			
8:30-8:50		Daily Recap and Warm up	
	1	Prevention of AMR	
08:50 – 9:50		Chapter 1: Rational Use of Antibiotics (1 Hour)	
9:50- 10:45	1	Chapter 2: Antibiotic Stewardship Programs (55 Minutes)	
10:45-11:00		TEA BREAK	
	2	Prevention of Common Healthcare Associated Infections	
11:00-12:30	2	Chapter 1: Prevention of Surgical Site Infection (SSI) (1 Hour-25 Minutes)	
12:30-1:30		LUNCH	
1:30- 2:45	2	Chapter 2: Preventing Catheter-Associated Urinary Tract Infections (CAUTIS) (1 Hour -15 Minutes)	
2:45-3:30	2	Chapter 3: Preventing Intravascular Catheter-Associated Bloodstream Infections (1 Hour-15 Minutes)	
3:30-3:45		TEA BREAK	
3:45-4:15	2	Chapter 3: Preventing Intravascular Catheter-Associated Bloodstream Infections (Cont'd)	
4:15-5:15		Chapter 4: Health Care Associated Pneumonia (Including Ventilator Associated Pneumonia) (2 Hours)	
5:15-5:30		Daily Course evaluation	
DAY SIX			
8:30-8:45		Daily recap and warm up	
08:45 – 9:45	2	Health Care Associated Pneumonia (Cont'd)	
9:45- 10:45	2	Chapter 5: Preventing Health Care-Associated Infectious Diarrhoea(1 Hour)	
10:45-11:00		TEA BREAK	
	3	Basic Surveillance and Biostatistics of Healthcare Acquired Infection (HAI)	
11:00-12:00	3	Chapter 1: Introduction to Surveillance of Healthcare-Associated Infections (1 hour)	
12:00-12:30	3	Chapter 2: Basic Epidemiology and Statistics for Infection Prevention and Control (1 Hour)	

12:30-2:00		LUNCH	
2:00-2:30	3	Chapter 2: Basic Epidemiology and Statistics for Infection Prevention and Control (Cont'd)	
	4	Infection Prevention and Control in Special Setting	
2:30-3:45	4	Chapter 1: Infection Prevention and Control in The Operation Room and Safe Surgery (1 Hour -30 Minutes)	
3:45-4:00		TEA BREAK	
4:00-4:15	4	Infection Prevention and Control (Cont'd)	
4:15-5:15	4	Chapter 2: Infection Prevention and Control (IPC) In Intensive (Critical) Care Unit (ICU) (1 Hour)	
5:15-5:30		Daily course evaluation	
DAY SEVEN			
8:30-8:40		Daily recap and warm up	
08:40-9:40	4	Chapter 3: Infection Prevention and Control (IPC) In Clinical Laboratory Services (1 hour)	
9:40-10:30		Chapter 4: Infection Prevention and Control (IPC) In Blood Bank and Transfusion Services (50 Minutes)	
10:30-10:45		TEA BREAK	
10:45-12:05	4	Chapter 5: Infection Prevention and Control (IPC) In Maternal and New-Born Unit (1 Hour- 20 Minutes)	
12:05-12:30	4	Chapter 9: Infection Prevention and Control (IPC) In Mortuary and Handling of Human Remains (30 Minutes)	
12:30-1:30		LUNCH	
	5	Infection Prevention and Control Program Management and Governance	
1:30-2:50	5	Chapter 1: Principles of Public Health Emergency Preparedness and Outbreak Management for Health Care Facilities (1 Hour- 20 Minutes)	
2:50-4:10	5	Chapter 2: Managing Infection Prevention and Control Program (1 Hour- 20 Minutes)	
4:30-4:45		TEA BREAK	
4:45-5:15	5	General Discussion and Facility Visit Arrangement	
5:15-5:30		Daily Course evaluation	
DAY EIGHT			
8:30-3:00		Daily recap and warm up	
3:00- 12:30		Conduct Local Facility Visit	
12:30-1:30		LUNCH	

1:30-3:30		Presentation and feed -back on Facility Visit	
3:30-3:45		TEA BREAK	
3:45-4:00		Daily course evaluation	
4:00-4:35		Post-Test and closing	

VOLUME 1 : GENERAL INFECTION PREVENTION AND CONTROL PRACTICES

- **Chapter 1:** Introduction to IPC
- **Chapter 2:** Basic Microbiology for IPC
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CHAPTER 1: INTRODUCTION TO INFECTION PREVENTION AND CONTROL (IPC)

Chapter Objective

The objective of this chapter is to enable healthcare professionals understand how infections are transmitted in healthcare facilities and identify the associated risks to healthcare workers, patients/clients as well as the community at large.

Learning objectives

By the end of this chapter, participants will be able to:

- Define infection prevention and control
- Describe the goal of IPC programs
- Explain the WHO's core components for Infection prevention and control
- Explain the disease transmission cycle and measures to halt the spread of disease at health care delivery setting
- Understand what HAI's are
- Describe the role of standard precaution and transmission based precautions in preventing Healthcare Acquired Infections

Chapter Content

- 1.1. Overview
- 1.2. Goal of Infection Prevention and control
- 1.3. WHO Core Components of Infection Prevention and Control
- 1.4. Infection Chain / Cycle
- 1.5. Breaking the Chain of Infection
- 1.6. Healthcare associated infections
- 1.7. Overview of standard and transmission based precautions

1.1. Overview

Infection Prevention and Control is essential for delivery of safe and quality healthcare services. Healthcare workers have a critical role to play in the prevention and control of infection at all levels of care and the nature of their work increases their chances of acquiring or transmitting infectious agents.

Health care-associated infections are the most frequent adverse events in health care delivery systems worldwide.

They are a major cause of preventable diseases, deaths, and higher health care costs. Application of evidence-based IPC practices at all healthcare settings is the key in preventing health care associated infections.

1.2. Goal of Infection Prevention and Control (IPC)

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

1.3. WHO Core components of Infection prevention and control (IPC)

To improve the desire outcome of the implementation infection prevention and control and ultimately to improve quality of care, WHO recommends the following core components

Table 1-1: WHO's Eight Core Components for Infection Prevention and Control (IPC)

Serial No.	Component	Recommendation
1	IPC programmes	An appropriate IPC programme with a dedicated, trained team should be in place in each acute health care facility for the purpose of preventing HAI and combating AMR through IPC good practices. Stand-alone, active national IPC programmes with clearly defined objectives, functions and activities for the purpose of preventing HAI and combating AMR through IPC good practices should be established. National IPC programmes should be linked to other relevant national programmes and professional organizations.
2	Evidence-based	Evidence-based guidelines should be developed and implemented for the purpose of reducing HAI and AMR.

	guidelines	Education and training of the relevant health care workers on guideline recommendations and monitoring of adherence with guideline recommendations should be undertaken to achieve successful implementation.
3	Education and training	<p>At the facility level, IPC education should be in place for all health care workers by utilizing team and task based strategies that are participatory and include bedside and simulation training to reduce the risk of HAI and AMR.</p> <p>The national IPC programme should support education and training of the health workforce as one of its core functions.</p>
4	Health care-associated infection (HAI) surveillance	<p>Facility-based HAI surveillance should be performed to guide IPC interventions and detect outbreaks, including AMR surveillance with timely feedback of results to health care workers and stakeholders and through national networks.</p> <p>National HAI surveillance programmes and networks that include mechanisms for timely data feedback and with the potential to be used for benchmarking purposes should be established to reduce HAI and AMR.</p>
5	Multimodal strategies	<p>At the facility level, IPC activities should be implemented using multimodal strategies to improve practices and reduce HAI and AMR.</p> <p>National IPC programmes should coordinate and facilitate the implementation of IPC activities through multimodal strategies at the national or sub-national level.</p>
6	Monitoring and audit of IPC practices and feedback	<p>Regular monitoring/audit and timely feedback of health care practices should be undertaken according to IPC standards to prevent and control HAIs and AMR at the health care facility level. Feed-back should be provided to all audited persons and relevant staff.</p> <p>A national IPC monitoring and evaluation programme should be established to assess the extent to which standards are being met and activities are being performed according to the programme's goals and objectives. Hand hygiene monitoring with feedback should be considered as a key performance indicator at national level.</p>
7	Workload, staffing and bed occupancy	<p>In order to reduce the risk of HAI and the spread of AMR, the following should be addressed:</p> <p>(1) Bed occupancy should not exceed the standard capacity of the facility;</p>

	(for facility level)	(2) Health care worker staffing levels should be adequately assigned according to patient workload.
8	Built environment, materials and equipment for IPC (for facility level)	<p>At the facility level, patient care activities should be undertaken in a clean and/or hygienic environment that facilitates practices related to the prevention and control of HAI, as well as AMR, including all elements around the WASH infrastructure and services and the availability of appropriate IPC materials and equipment.</p> <p>At the facility level, materials and equipment to perform appropriate hand hygiene should be readily available at the point of care.</p>

From World Health Organization (2016). *Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level*. World Health Organization

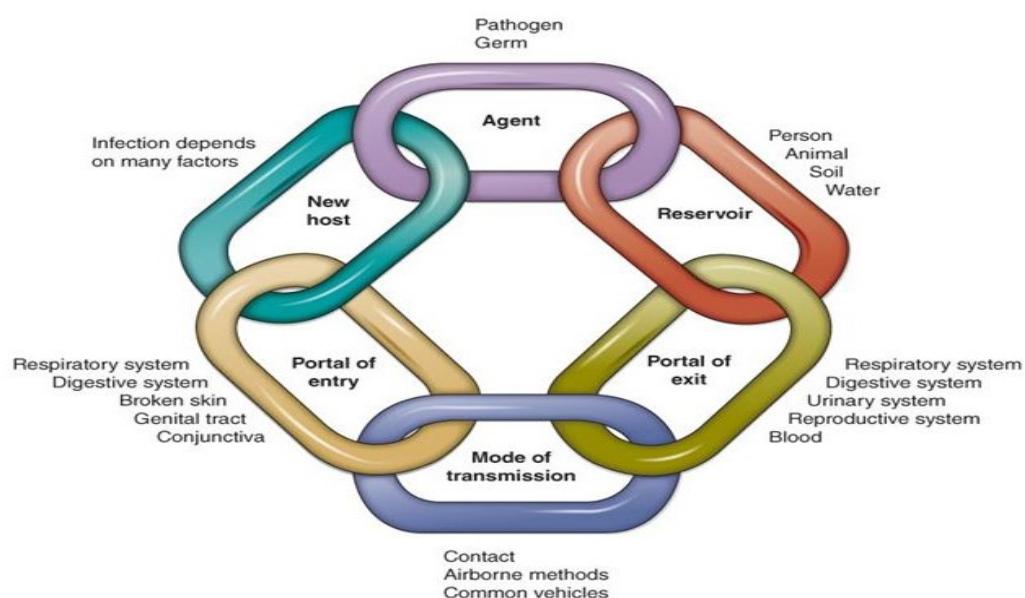
1.4. The infection chain/cycle

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

Health workers have a responsibility to prevent and control infections, including Healthcare Associated Infections (HAIs), however it is essential to understand the how infections spread, to apply appropriate preventive measures.

- For infectious agents to successfully survive and spread certain factors or conditions must be present; these are illustrated as the components or elements of the Chain of Infection.
- If any of the links or components of the chain is absent or removed, an infection cannot occur, this interruption of the “chain” is commonly referred to as “breaking the chain of infection”.

These concepts are illustrated below.



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Figure 1-1: The Infection Chain

Key Elements of the Chain Infection

The following elements are required in sequential order, for an infection to occur and spread as shown by the Chain of Infection illustration;

- 1. Infectious Agent-** These are disease-causing organisms including bacteria, virus, fungus, parasites etc.
- 2. Reservoir:** Reservoir of an agent is the habitat in which an infectious agent normally lives, grows, and multiplies. Reservoirs include humans, animals, and the environment. The reservoir may or may not be the source from which an agent is transferred to a host. For example, the reservoir of *Clostridium botulinum* is soil, but the source of most botulism

infections is improperly canned food containing *C. botulinum* spores. Many of the common infectious diseases have human reservoirs. Diseases which are transmitted from person to person without intermediaries include the sexually transmitted diseases, measles, mumps, streptococcal infection, most respiratory pathogens, and many others. Smallpox was eradicated after the last human case was identified and isolated because humans were the only reservoir for the smallpox virus. Two types of human reservoir exist:

- **Persons with symptomatic illness**
- **Carriers:** Persons who are not experiencing symptoms of an infection but are capable of transmitting the pathogen to others. The different types of carriers are;
 - **Asymptomatic or passive carriers:** Those who have never been ill from the infection
 - **Incubatory carriers;** Those who are in the incubation period of the disease
 - **Convalescent carriers:** Those who have recovered from the infection
 - **Chronic carriers;** Those which remain as reservoirs for the disease causing agents for as long as years after they had the infection,

3. Portal of Exit - This is a gateway through which the agent leaves the host or reservoir. However, the agent must have the right environment for its survival until it gets an entry to infect another person/animal. For example, the bacteria that cause tuberculosis can survive in sputum for weeks, but fortunately could be killed by sunlight within few hours.

4. Mode of Transmission - an agent which exists and develops in its natural reservoir can be transmitted in numerous ways to a susceptible host and get portal of entry. These modes of transmission are classified as:

- **Direct Transmission** - refers to an immediate transfer of the agent from a reservoir to a susceptible host through direct contact or droplet.
- **Direct Contact** - occurs through kissing, skin-to-skin contact, and sexual intercourse.
- **Droplet Spread** - refers to a spray of a relatively large, short-range germ laden aerosols produced by sneezing and/or coughing (or even talking) of infected people. Droplet Spread is classified as direct because transmission is by direct spray over a few feet, before the droplets fall to the ground.

- **Indirect Transmission** - an agent is carried from a reservoir to the susceptible host by suspended air particles or by animate (vector) or inanimate (vehicle) intermediaries.
 - Airborne
 - Vehicle-borne
 - Vector borne
 - Mechanical
 - Biologic

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

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

For example:

- The following figure illustrates the steps in the transmission of hepatitis B virus (HBV) and human immunodeficiency virus (HIV) from infected persons (e.g. a family planning client or pregnant woman attending an antenatal clinic) or patients getting treated in healthcare institutions.
- This spread of infection from viruses occurs when the staffs (physician, nurse or cleaning personnel) are exposed to the blood or body fluids of an infected person (e.g. needle stick injury).

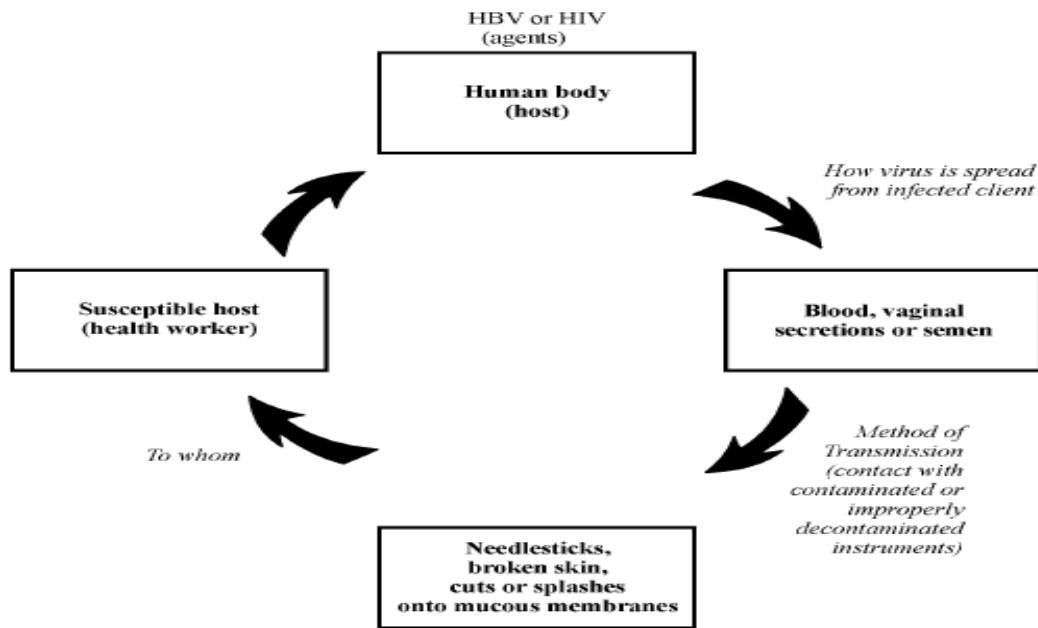


Figure 1-2: Transmissions of HBV and HIV from Patients to Healthcare Workers

1.5. Breaking the Chain of Infection

Understanding the Chain of Infection or Transmission Cycle of specific infectious diseases is important, if healthcare workers are to:

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

Preventing the spread of infectious agents or proper infection prevention and control practice requires breaking the chain of infection by removing one or more of the conditions necessary for transmission of the diseases from the host, reservoir to the susceptible host through practices which;

- Reduce the number of microorganisms present (e.g. hand washing, cleaning of instruments)
- Kill, inhibit or inactivate microorganisms (e.g. hand washing with a waterless alcohol preparation, decontamination of patient care items);

- Create barriers to prevent infectious agents from spreading (e.g. wearing gloves or personal protective equipment); or
- Reduce or eliminate risky practices (e.g. by using hands-free technique in the operation room, using gloves and disposable syringes etc.)
- Make sure that people, especially healthcare workers, are immune or vaccinated

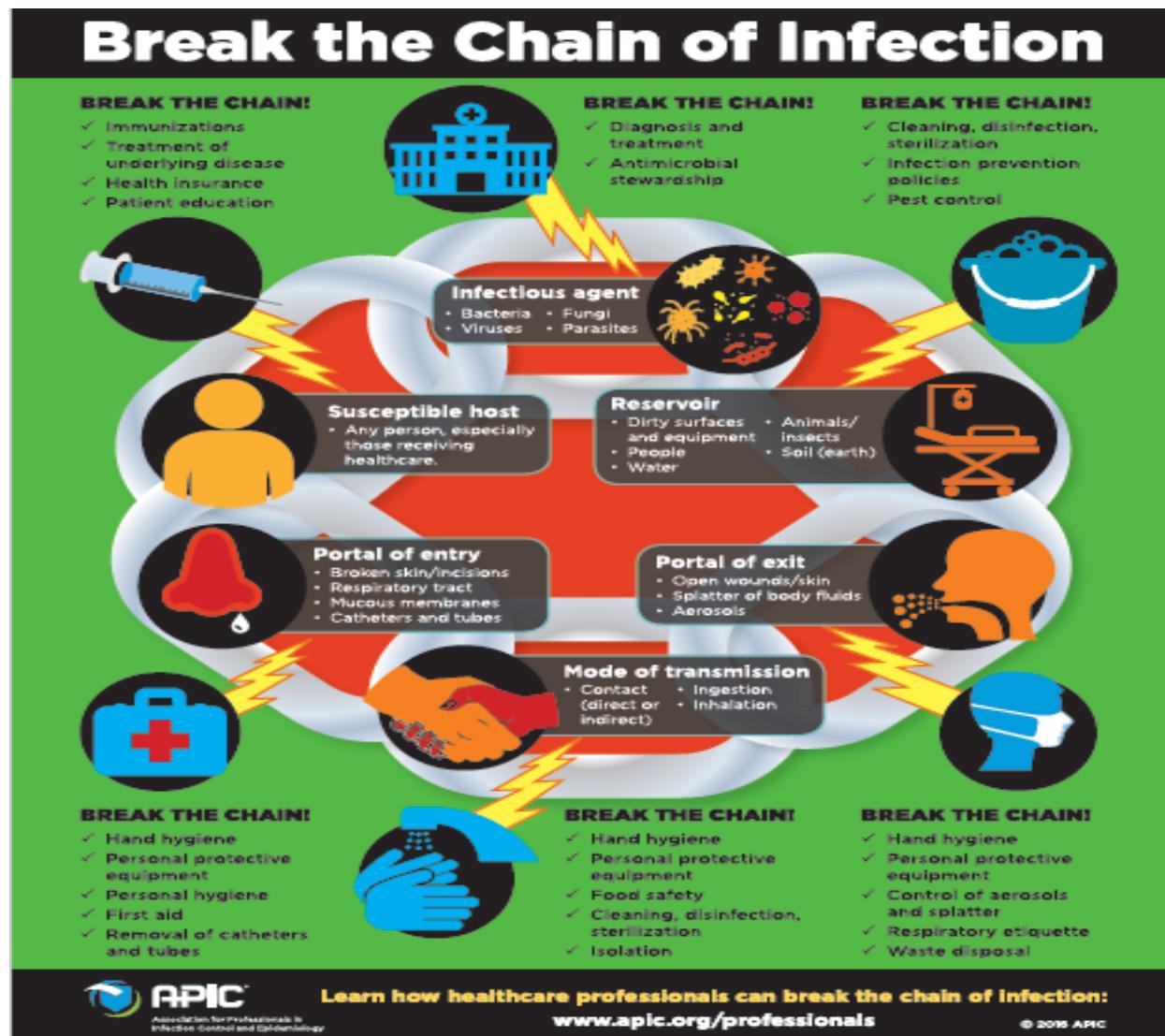


Figure 1-3: Breaking the Chain of Infection

Note: Failure to apply infection prevention and control measures in healthcare settings can increase the risk for **Healthcare Associated Infections**.

1.6. Health Care Associated Infections

- Healthcare Associated Infection (HAI) was previously known as Hospital Acquired Infection and Nosocomial Infection. An infection is called “healthcare-associated” if it is acquired during the course of healthcare intervention for other conditions, regardless of where the interventions are provided. OR
- Infections acquired while a patient is under hospital (or any other health facility) care which are not present or incubating at time of admission. It is a time related criterion which refers to Infections occurring more than 48 hours after admission. This situation, therefore, is inclusive of infections acquired in the hospital but appeared after discharge and occupational infections among the staff of the facility as well.

HAIs may also occur;

- up to 48 hours after the episode of care
- up to 3 days after discharge
- up to 30 days after an operation
- up to 1 year after an operation with an implant

Note: that patients and healthcare workers are at risk of acquiring HAIs.

- HAIs may be endogenous (from self) where the infectious agents is from patient like the normal flora which causes disease as a result of gaining access into another part of the body where it is not normally found Example organism from the colon entering the urinary tract and causing Urinary Tract Infection.
- HAIs may also be exogenous (from others or cross infection). This involves acquiring infection from an external source; for example a patient or health worker, through contaminated hands, or contaminated patient care items or the environment.
- Some of the most common HAIs are; Urinary Tract Infections, Blood Stream Infections, Surgical Site Infections and Pneumonia
- Infection prevention practices are crucial for reducing the risk for any type of HAI with application of an understanding of the chain of infection or transmission cycle. Two sets of practices for Infection prevention are; Standard Precautions and Transmission-Based Precautions.

1.7. Overview of standard and transmission based precautions

Infection prevention and control practices include standard and transmission-based Precautions.

- **Standard Precautions:** These practices are designed for use in caring for all people—both clients and patients attending healthcare facilities (first level precautions). These apply to blood, all body fluids, secretions and excretions (except sweat), non-intact skin and mucous membranes. Since no one really knows what organisms do clients or patients have, it is necessary that standard precautions be used all the time.
- **Transmission-Based Precautions:** The second level precaution is intended for use in patients known or highly suspected of being infected or colonized with pathogens transmitted by:
 - Air (tuberculosis, chicken pox, measles, etc)
 - Droplet (flu, mumps and rubella); or
 - Contact (hepatitis A or E and other enteric pathogens, herpes simplex and skin or eye infections).

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

In all cases (whether they are being used alone or in combination), Transmission-Based Precautions must be used in conjunction with the Standard Precautions.

Summary

In summary, the goal of infection prevention and control is to make health care facilities a safe place. The Core components of Infection Prevention and Control as defined by WHO form an integral part of this guideline. Understanding each step of infection chain or cycle is a one step forward in prevention and control of HAI's. Always Apply Standard Precaution and Transmission based precaution as appropriate. Infection prevention and patient safety activates are every body's responsibility. And each and every one of us, have a responsibility to implement IPC activates in our health care facilities.

CHAPTER 2: BASIC MICROBIOLOGY FOR IPC

Chapter Objective

The objective of this chapter is to enable healthcare workers understand basic microbiology for infection prevention and control.



Learning objectives

By the end of this chapter, participants will be able to:

- Describe the Basic features of microorganisms
- Identify the Classifications and identification of microorganisms
- Recognize how the microorganisms cause disease
- Explain Specimen collection and transport
- Identify common techniques for identifying microorganisms
- Describe the characteristics of microorganisms of interest for infection prevention and control

Chapter content

- 2.1. Overview
- 2.2. Basic features of microorganisms
- 2.3. Classification and identification of microorganisms
- 2.4. How microbes cause disease
- 2.5. Specimen collection and transport
- 2.6. Common techniques for identifying microorganisms
- 2.7. Characteristics of microorganisms of interest for infection prevention and control (IPC)

2.1. Overview

A basic knowledge of the microscopic organisms that commonly cause infections and the methods used by the clinical laboratory to identify and examine them is important in the day-to-day work of the IPC team. Team members who are knowledgeable about microorganisms can more effectively convince health care workers (HCWs) of the need for basic IPC strategies such as hand hygiene, Standard Precautions, Transmission-Based Precautions, cleaning, and disinfection. Also, knowing about the features and behavior of the microorganisms that are causing infections in a health care facility, in particular health care-associated infections (HAIs), can help the IPC team choose the most effective prevention strategy.

2.2. Basic Features of Microorganisms

The basic features that microorganisms of medical interest share can help hospital staff, patients, and families understand the importance of IPC. These features include:

- **Microscopic size:** Microorganisms can be seen only with a microscope.
- **Rapid rate of reproduction:** If conditions are favorable, microorganisms can multiply quickly.
- **Tendency to spread from one place to another:** Microorganisms can spread through air currents, people's hands, or equipment.
- **Ability to resist eradication:** Some microorganisms can survive harsh conditions (heat, cold, dryness, and chemicals).

2.3. Classification and Identification of Microorganisms

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

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

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

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

BACTERIA

Bacteria are single-cell organisms (see Figure 1-1) with a well-defined cell wall that maintains the shape of the cell and protects an underlying structure called the plasma membrane, which surrounds and encloses the contents of the cell including:

- Cytoplasm, which contains the other cell contents
- Ribosomes, which produce proteins for cell function
- Genetic material, which is composed of a bacterial chromosome made of double-stranded DNA that is essential for cell function and replication.

Some bacteria also have plasmids, which contain other DNA molecules that are not necessary for cell replication and that carry genes for antibiotic resistance and production of toxins and enzymes. Some bacteria also have appendages on the outside of the cell that help the cell move (flagella) or help the cell attach to surfaces or other cells (fimbriae and pili). (APIC 2014b)

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

Significance

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

Laboratory methods of identification

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

Morphology (forms and structure) of bacteria cells is used to identify and classify different groups of bacteria. Given the small size of these microorganisms, they can be viewed and recognized only under a microscope, based on their size, shape, and how they are grouped together. (see Reference Manual)

Staining of the cell walls with different dyes is also used to identify and classify bacteria (see Reference Manual volume, chapter2). Gram stain is widely used in clinical laboratories to differentiate bacteria into two groups, gram positive and gram negative. Nearly all clinically relevant bacteria fall into one of these two groups based on whether or not their cell walls retain Gram stain.

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

Gram-negative bacteria include Enterobacteriaceae (e.g., *Escherichia coli*, *Klebsiella* spp., *Serratia* spp.) that commonly cause serious infections, particularly when medical devices are used (such as urinary catheters and IV lines), and are often resistant to antibiotics and colonize patients in hospitals.

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

- Oxygen requirements
- Fermentation of carbohydrates
- Presence of specific enzymes

VIRUSES

Viruses are microorganisms that are smaller than bacteria and consist of genetic material, which can be either DNA or RNA, surrounded by a protein coat and, in some viruses, by a membranous envelope. Viruses do not have many of the cell structures found in bacteria and fungi and are able to multiply only within the living cells of a host (see chapter 2 of Volume 1 IPC Reference Manual). They attach to receptors on the host cell (such as a respiratory tract cell), enter the cell, and use the cell to replicate. The offspring are then released from the host cell.

Viruses are classified based on:

- The type of substance that makes up their central core—DNA (e.g., herpesvirus, cytomegalovirus) or RNA (e.g., HIV, measles, Ebola, SARS, hepatitis C, and polio)
- The number of strands in the core—double-stranded (e.g., rotavirus) or single-stranded
- The presence or absence of a membrane-like envelope surrounding them—enveloped (herpesvirus, chicken pox virus, influenza viruses, and Ebola virus) and non-enveloped viruses (adenovirus, poliovirus) (APIC 2014b)

Significance:

- Many viruses can be transmitted in the health care environment and often cause HAIs and outbreaks. Bloodborne viruses, such as HIV and hepatitis B and C, can be spread from patient to patient during transfusions, dialysis, injections, and endoscopy. Viruses such as influenza and respiratory syncytial virus (RSV) can be spread from patient to patient by respiratory fluid droplets during crowding or sharing of respiratory equipment, or on contaminated hands.
- The presence or absence of a virus envelope has significance for cleaning and disinfection. Enveloped viruses (e.g., herpes, HIV, Ebola) are easier to kill with disinfectants than non-enveloped viruses (e.g., norovirus, rotavirus, adenovirus, and poliovirus). Cleaning products should be evaluated for their ability to kill both enveloped and non-enveloped viruses. (Rutala *et al.*, 2008).

Laboratory methods of identification

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

- Enzyme-linked immunosorbent assay (ELISA) for detecting antibodies against HIV, RSV, rotavirus, and hepatitis B
- Polymerase chain reaction (PCR) for DNA and RNA detection of HIV, HPV, and many others viruses
- Papanicolaou (Pap) smears for the effect of human papillomavirus on squamous cells lining the cervix(APIC 2014b)

FUNGI

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

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

Significance

While fungi can cause infection in humans (e.g., *Candida albicans*), most are opportunistic pathogens that cause infections (which can be severe) in those who are on extended antibiotic treatment or are immunosuppressed (*C. albicans*, *Aspergillus* spp., *Cryptococcus neoformans*, *Cryptosporidium*). A species of yeast, *Candida auris*, with a propensity to spread in hospitals and resistant to multiple antifungals, is emerging globally.

Laboratory methods of identification

Like bacteria, fungi can also form colonies. Fungi are mainly identified using direct examination under the microscope of physical characteristics of the mold, such as shape, color, staining, and

the root-like structures; they are also identified through culture and non-culture tests. (APIC 2014b)

PARASITES

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

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

Common parasitic infections

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

Significance

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

Laboratory methods of identification

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

2.4. Microbial Pathogenesis- How Microbes Cause Disease

Normal Flora/Commensal Microbiota

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

Colonization

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

Infection

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

Sources of Microorganisms

HAIs can be categorized according to the source of the microorganisms that cause them.

Bacteria can come from:

- **The patient (endogenous):** Organisms from the individual's own body (normal flora or colonization) can cause infection when the immune system is compromised, other body defenses are interrupted (via a wound or medical device), or antibiotic therapy causes overgrowth of some microorganisms (such as yeast in the gastrointestinal and reproductive tracts).
- **Another person (exogenous cross-infection):** Organisms that cause infection can come from a source outside of the individual.
- **The health care environment:** Organisms causing infection can come from the hospital environment where they live permanently or transiently

2.5. Specimen collection and transport

When an infection is suspected, specimens are usually obtained to help identify the location and cause in order to guide diagnosis and treatment. For the clinical microbiological laboratory to correctly identify microorganisms, specimens must be correctly collected, transported to the laboratory, and processed. Incorrect specimen collection and transport can result in:

- No growth when microorganisms were actually present, which can occur when antibiotics are started before the specimen was collected, the wrong container was used so microorganisms died before arriving at the laboratory, poor collection techniques were used so microorganisms were not collected, or transport was delayed and microorganisms died before they arrived at the laboratory.
- Growth of the wrong organisms, which can occur when poor collection techniques allow contamination of the sample, such as in a blood culture contaminated from skin, or when delayed transport or incorrect storage allows overgrowth of unimportant microorganisms, such as for a stool sample.

Incorrect results can lead to inappropriate patient management, erroneous surveillance results, and the wrong choice of IPC strategies.

The IPC team should be aware of optimal specimen collection techniques and teach them to all HCWs who collect specimens (see Reference Manual). In addition, the microbiology laboratory should provide information on specific procedures for collection and transport of specimens. HCWs collecting the specimens should be competent in these procedures.

2.6. Common Techniques for Identifying Microorganism

There are a variety of diagnostic tests available to microbiology laboratories. IPC staff are encouraged to become familiar with those commonly used at their facility. Brief descriptions of some microbiological methods are given below. For further details, consult your clinical laboratory staff and review relevant guidelines. Visiting the microbiological laboratory to observe these tests can be very informative for IPC staff who are not familiar with laboratory methods.

- **Direct examination of wet-mount** is used for specimens such as sputum, body fluid aspirates, stool, vaginal fluids, and urine sediments. The specimens are prepared for direct examination by being placed directly on the slide with sterile saline.
- **Smears** are prepared by spreading samples on a slide and fixing them with heat or chemicals. This process will kill the organisms so they are safe to handle. Once the sample is fixed on the slides, it is easy to stain.
- **Staining** methods are used to classify bacteria. Staining makes microorganisms stand out from the background so they can be identified under the microscope. Gram stains and acid-fast stains are most commonly used:
- **Gram stain:** The sample is fixed on the slide and is washed with crystal violet/iodine dye to stain the bacteria. The slide is then washed with alcohol. If the microbes retain the purple color, the sample is gram positive.
- **Acid-fast stain:** Acid-fast bacteria, for example *Mycobacterium tuberculosis*, *Nocardia* spp., and *Actinomyces* spp., have a particular cell wall structure that does not lose color from stain (crystal violet or any such dye) when rinsed in a solution of acid and alcohol. (APIC 2014b).
- **Plating and culture** are used to grow bacteria and yeast. The specimen is added to a culture medium that contains necessary nutrients and then incubated at a specific temperature to allow the bacteria to grow ([see on Reference Manual](#)).
- **Antimicrobial susceptibility testing (AST):** Some microorganisms can survive despite being exposed to specific antimicrobial drugs that should kill them (have developed resistance). AST was developed to determine which antimicrobial would be most successful in treating a specific infection.
- An **antibiogram** is a collection of data from antimicrobial susceptibilities of local bacterial isolates over a specific period of time, summarizing the percentage of individual bacterial pathogens susceptible to different antimicrobial agents.

- **Immunology/serologic testing:** The human body recognizes microorganisms as foreign bodies or antigens and the immune system produces antibodies to neutralize them. These antibodies are specific for each microorganism.
- **Molecular diagnostic methods:** Molecular methods, generally available at large centers or reference laboratories, use sequences in DNA, RNA, or proteins to test for specific organisms.

2.7. Characteristics of Organisms Commonly Associated with Health Care-Associated Infections

The IPC team should know that microorganisms have characteristics that enable them to survive and/or easily spread in health care environments. These characteristics include:

- **Are able to survive on the hands of HCWs**, environmental surfaces, and medical equipment when IPC practices such as hand hygiene, cleaning, disinfection, and sterilization are suboptimal.
- **Can survive dryness, heat, and disinfectants** and so can cause infections in patients and HCWs in health care facilities despite IPC methods such as hand hygiene, cleaning, disinfection, and sterilization.
- **Live in blood and body fluids** even though they cannot survive for long in the health care environment. Innated with blood or body fluids—even minute amounts
- **Thrive in damp areas**, and thus the drains, sinks, and equipment that use water (such as humidifiers, patient warmers, and respiratory equipment) can harbor these organisms.
- **Colonize patients and staff**, allowing the microorganisms to survive in the health care environment and pass from person to person, causing an infection if immune defenses become suboptimal, such as after surgery or when medical devices are in place.
- **Are small in size** and able to remain suspended in the air and be transmitted short distances through the air in respiratory droplets, particularly when propelled by coughing or sneezing, and therefore can cause transmission.

- Are very small in size and so able to float long distances on air currents if the ventilation of the facility is not protective of staff and patients.
- Are resistant to antimicrobials examples include MRSA, VRE, and CRE

Gram-Negative Bacteria

Health care-associated infections caused by gram-negative bacteria include pneumonia, bloodstream infections, wound or surgical site infections, and meningitis. Gram-negative bacteria are often resistant to antibiotics. This group, which includes *Klebsiella* spp., *Acinetobacter* spp., *Pseudomonas aeruginosa*, and *E. coli*, among many others, is found in damp areas and is transmitted via unwashed hands of HCWs, water sources, and inadequately cleaned medical equipment.

Gram-Positive Bacteria

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

Potential Microbial Agents of Bioterrorism

Bacteria, viruses, and toxins could all be potentially used as agents of bioterrorism. Likelihood of a bioterror event is highest in areas with large, dense populations (such as cities) and those in areas with ongoing or potential conflict.

Role of the Clinical Laboratory in Infection Prevention and Control

The clinical laboratory primarily functions to identify and analyze samples for clinical care. However, collaboration between the laboratory and IPC team members can greatly enhance the effectiveness of IPC programs by increasing the capacity to identify, investigate, and contain infectious diseases in a timely fashion and thus improve patient safety at the facility. The following are specific examples of how the IPC team can collaborate with the clinical microbiology laboratory:

- Surveillance
- Outbreak identification and investigation

- Environmental sampling
- Reporting

Summary

Microorganisms that IPC staff may encounter in health care facilities include bacteria, fungi, parasites, and viruses. Each has different characteristics, methods of identification, and significance. Correct collection and transportation of specimens is important to ensure accurate results. After arrival at the laboratory, specimens undergo various processes to identify the microorganism of interest. The IPC team should have a basic understanding of these processes. Collaboration with the clinical laboratory can increase the IPC team's capacity to identify, investigate, and contain infectious diseases.

CHAPTER 3: STANDARD AND TRANSMISSION BASED PRECAUTIONS

Chapter Objective

The objective of this chapter is to enable healthcare workers understand the role of standard precautions and transmission based precautions in preventing infection for health service providers as well as patients.



Learning objectives

By the end of this chapter, participants will be able to:

- Define what standard precaution and transmission based precautions
- List the principles of standard precaution
- List components of standard precaution
- Describe the role of Empiric/syndromic use of transmission in prevention of HAI's
- List the components of transmission based precaution
- Elucidate the recommended precautions for each route of infection transmission during out break

Chapter Content

- 3.1. Overview
- 3.2. Standard Precautions
- 3.3. Transmission based precaution

3.1. Overview

The guideline issued by the CDC in 1996 involves two level approaches, namely standard precaution and transmission precaution.

Standard Precautions combine the major features of universal precaution and body substance isolation. The basic concept in the implementation of Standard Precautions is the maintenance

of a physical, mechanical, or chemical barrier between microorganisms, the environment, and an individual, thus breaking the disease transmission cycle.

The rationale is that, for transmission to occur within the health care setting, all elements in the disease transmission cycle must be present [see chapter 1, Disease Transmission Cycle].

3.2. Standard Precaution

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

Example of barriers

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

- Standard Precaution is first level precautions.
- The aim of standard precautions is to reduce the risk of transmitting micro microorganisms from known or unknown source infection (e.g. respiratory droplet, contaminated object) within health care settings.
- Applying Standard Precaution while providing patient care is based on the anticipated interaction HCW will have with blood, body fluid or potential pathogen exposure from patients. They provide a rationale for appropriate utilization of limited IPC resources.

Key Principles of Standard Precaution

- Consider every client and patient as potentially infectious or susceptible to infection.
- Apply to all patients and clients attending health care facility
- Apply to all blood, body fluid, secretion, excretion (except sweat), mucous membrane and no intact skin.

Key Components of Standard Precautions

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

Key Components of standard precaution includes:

- **Hand Hygiene** – involves HCWs cleaning their hands before, after, and at specific moments during patient care and when performing health care tasks. Hand hygiene is the single most important intervention for preventing transmission of infections (e.g., person to person or contaminated object to person). It must be performed consistently at the recommended moment during patient care using soap and water or alcohol-based hand rub (ABHR) and with a technique that effectively removes microorganisms from hands. [For detailed information see CHAPTER 4: HAND HYGIENE].
- **Use of PPE** – relies on an HCW's assessment of the likely risk of contact with potentially infectious materials during each task. The appropriate PPE should be chosen by the HCW according to the assessed risk. The risk is not based on the appearance, characteristics, or diagnosis of the patient, but rather the potential for the HCW coming into contact with blood, body fluids, non-intact skin, mucous membranes, or items that have been in contact with these. The risk may be re-assessed during the task (e.g., if the patient starts vomiting) and PPE added as needed. PPE may include the following depending on the assessed risk. [For detailed information see Chapter 5, Personal Protective Equipment].
- **Safe injection practices** – are those that do not harm the patient, do not expose the HCW to any risks, provided by skilled person, using appropriate injection equipment and do not result in waste that is dangerous for the community. [For detailed information see Chapter 6, Sharp and Injection Safety].
- **Environmental Cleaning** – of noncritical care equipment, instruments, devices, and environmental surfaces. Clean patient care equipment between each use on patients to prevent cross-contamination between patients. [For detailed information see Chapter 10, Environmental Cleaning].

- **Instrument Processing** – processing instruments and other items (before reuse) so as to reduce the transmission of infection during clinical procedures following the correct steps. [For detailed information see Chapter 8, Decontamination and Reprocessing of Medical Devices].
- **Processing textile and Laundry** – in a manner that:
 - Removes pathogens from the textiles and protects cleaned textiles from reintroduction of pathogens.
 - Reduces risk for transfer of pathogens to HCWs, other patients, and the environment. [For detailed information see Chapter 9, Processing reusable textile and laundry].
- **Healthcare waste management** – is a key issue to control and reduce HAIs in healthcare facilities (HCF) and to ensure that the environment is well protected. Healthcare Waste Management (HCWM) should be part of the overall management system of a HCF and reflect the quality of the services provided by the facilities. [For detailed information see Chapter 12, Healthcare Waste Management].

3.3. Transmission Based Precaution

- Although the spread of infectious disease in hospitals has been recognized for many years, understanding on how to prevent these infections and implementing the successful remedial policies and practices have so far been not easy.
- Isolation guidelines involve a two level approach: Standard Precautions, which apply to all clients and patients attending healthcare facilities on the one hand, and Transmission-Based Precautions which apply primarily to hospitalized patients on the other (Garner & HICPAC, 1996).
- Actually, either approach is too interlinked to be used in separation. Thus, the relatively specific approach-transmission-based precautions must be used in conjunction with the Standard Precautions.
- **Transmission-Based Precautions:** designed to reduce the risk of transmitting infections that are spread wholly or partly by airborne, droplet, or contact routes between hospitalized patients and health providers

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

Key Components of Transmission based Precaution

- Airborne
- Droplet
- Contact

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

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

Airborne Precaution

Airborne Precautions prevent transmission of infectious agents that remain infectious over long distances (particles which are 5 μ m or less in size and can remain in the air for several hours and be widely dispersed). This transmission can occur either through airborne droplet nuclei or dust particles containing the infectious microorganisms, which can be produced by coughing, sneezing, talking, or by procedures (e.g., bronchoscopy or suctioning). Special air handling and

ventilation are needed to ensure prevention of airborne transmission of infectious agents. Airborne particles do not land on and contaminate surfaces. These precautions are effective in preventing infections like Mycobacterium tuberculosis, Chicken pox and measles. They are recommended for patients with either known or suspected infections that could be transmitted by airborne route. The precautions include:

Patient Placement

- Patients should be placed in airborne infection isolation room (AIIR). An AIIR is a single-patient room that is equipped with special air handling and ventilation capacity (i.e. a facility which could create negative pressure relative to the surrounding area, 12 air exchanges per hour for new construction and renovation and 6 air exchanges per hour for existing facilities, air exhausted directly to the outside, etc). In a setting where resources are limited, the air in the room should be exhausted to the outside using a fan or other filtration system keeping the door closed all the time.
- If private room not available, place patients in a room with patient having active infection with the same disease, but with no other infection (cohorting).
- The staff on duty should check all visitors for susceptibility before allowing them to visit.
- Limit movements in and out of the room to HCWs caring for the patient.

Note: In areas where TB is prevalent, it is important to devise a mechanism to quickly assess patients with suspected TB and put them under airborne precautions including

Respiratory hygiene and cough etiquette

To prevent the spread of respiratory secretions via droplets expelled from the respiratory tract onto the hands and surfaces. This includes:

- Cover the mouth and nose when coughing and sneezing and dispose of used tissues in the nearest waste container.
- Perform hand hygiene after contact with respiratory secretions and contaminated objects.
- Maintain an appropriate distance from and between symptomatic patients, at least 1 meter (3 feet).

- Identify persons with symptoms suggestive of acute respiratory illness and teach them to use a surgical mask and practice cough etiquette.

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

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

The elements of Respiratory Hygiene/Cough Etiquette generally include

- Education of healthcare facility staff, patients, and visitors;
- Posted signs, in language(s) appropriate to the population served, with instructions to patients and accompanying family members or friends
- Source control measures (e.g. covering the mouth/nose with a tissue when coughing and prompt disposal of used tissues, using surgical masks on the coughing person when tolerated and appropriate);
- Hygiene of the hand after contact with respiratory secretions; and spatial separation, ideally >3 feet (one meter), of persons with respiratory infections in common waiting areas when possible.
- Restrict susceptible HCWs from entering the room of patients known or suspected to have measles, chicken pox, disseminated zoster, or smallpox if Other, immune HCWs are available

Use of PPE

- Wear a particulate respirator such as a fit-tested N95, and conduct a seal check before entering the patient's room (or at least a surgical mask if respirator not available).

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

Patient Transport

- Limit transport of patient to essential reasons only, for example, diagnostic tests or therapeutic procedures that cannot be performed in the room. If the patient needs to leave the room for a test or procedure:
- Alert the department or facility where the patient is being transported so they can prepare to receive a patient on Transmission-Based Precautions.
- Use PPE appropriately
- Ensure that patients on Droplet or Airborne Precautions wear a surgical mask while outside of the patient room;
- Cover wounds with appropriate dressings
- Clean and disinfect the wheelchair or coach after transportation.
- Remove PPE and perform hand hygiene once the patient has been transported.

Droplet Precaution

These precautions reduce the risks of transmission of pathogens spread wholly or partly by droplets larger than $5\mu\text{m}$ in size (e.g. *Bordatella pertussis*, *H. influenza* & *N. Meningitidis*, *M. pneumonia*, *flu*, *mumps*, and *rubella* viruses). Other conditions include Diphtheria, Pertussis, Pneumonic Plague and *S. pharyngitis*.

These remain in the air briefly and can travel about 1 meter (3 feet) or less. Droplet transmission requires close proximity or contact between the source and the susceptible host. Droplets may also land on surfaces and then be transferred by contact transmission.

Patient placement

- Private room, door may be left open. Patients should wear a surgical mask in waiting rooms and when outside of the patient room.
- If private room is not available, place the patient in a room with patient having active infection with the same disease, not with other infection.
- If neither option is available, maintain over 1 meter (3 feet) spatial separation between patient beds and use of a physical barrier, such as a curtain or divider, are especially important to prevent transmission by droplets.
- Limit transport of patient to essential purposes only and notify area receiving patients

Respiratory hygiene and cough etiquette

To prevent the spread of respiratory secretions via droplets expelled from the respiratory tract onto the hands and surfaces. This includes:

- Cover the mouth and nose when coughing and sneezing and dispose of used tissues in the nearest waste container.
- Perform hand hygiene after contact with respiratory secretions and contaminated objects.
- Maintain an appropriate distance from and between symptomatic patients, at least 1 meter (3 feet).
- Identify persons with symptoms suggestive of acute respiratory illness and teach them to use a surgical mask and practice cough etiquette.
- For elements of cough etiquette see air bone precaution on is chapter

Use of PPE

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

Cleaning

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

Contact Precautions

- Contact is a common way that germs spread in health care facilities. Organisms that require Contact Precautions include cholera, varicella-zoster (shingles); neonatal or mucocutaneous herpes simplex virus; enterovirus meningitis; patients infected or colonized with enteric pathogens, hemorrhagic fever viruses, multidrug-resistant organisms such as carbapenem-resistant Enterobacteriaceae (CRE); and C. difficile.

Patient Placement

- Isolate patients who require Contact Precautions in a single room, if possible.
- The door may be left open in this case.
- If private room is not available, place the patient in a room with patient having active infection with the same microorganism, not with other infections (cohorting).
- In multi-patient rooms, more than one meter (3 feet) spatial separation between patient beds is advised to reduce the opportunities for inadvertent sharing of items between the infected/colonized patient and other patients.

Use of PPE

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

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

Hand washing

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

Patient Transport

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

Patient care equipment

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

Cleaning

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

Empiric/ Syndromic Use of Transmission Based Precaution

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

Summary

To protect HCWs, patients, and visitors from acquiring infections during health care facility visits, ensure compliance with:

- Standard Precautions for all patients at all times and apply
- Transmission-Based Precautions to all patients with potential or confirmed infections that are transmitted via contact, droplet, and airborne routes.

Standard Precautions, including hand hygiene, are the cornerstone of IPC. They provide the first line of defense in the prevention of transmission of pathogens in health care facilities.

Transmission-Based Precautions, including their empiric use, are designed to provide additional protection and reduce the risk of transmissions via airborne, droplet, and contact routes among hospitalized patients and HCWs.

CHAPTER 4: HAND HYGIENE

Chapter objective

The objective of this chapter is to enable participants understand hand hygiene techniques.



Learning objectives

By the end of this module, participants will be able to:

- Explain the importance of hand hygiene
- Describe when to perform hand hygiene—the World Health Organization's (WHO's) “5 Moments for Hand Hygiene”
- Demonstrate proper technique for washing hands with soap and water
- Explain proper technique for use of alcohol-based handrub
- Discuss issues and considerations related to hand hygiene
- Describe monitoring of hand hygiene
- Explain WHO's strategy for improving hand hygiene programs

Chapter content

- 4.1. Overview
- 4.2. When to perform hand hygiene
- 4.3. Hand hygiene methods
- 4.4. Issues and considerations related to hand hygiene
- 4.5. Monitoring hand hygiene

4.1. Overview

Hand hygiene is the single most important measure to prevent transmission of infection and is the cornerstone of infection prevention and control (IPC). Proper hand hygiene can prevent transmission of microorganisms and decrease the frequency of HAIs.

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

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

4.2. When to Perform Hand Hygiene (Hand Hygiene Opportunities)

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

Other opportunities for hand hygiene

- Immediately on arrival and before departure from work (the health facility).
- Immediately after touching contaminated instruments or articles.
- Before putting on gloves and after removing them
- Whenever the hands become visibly soiled after nasal blowing or following a covered sneeze
- Before touching the face (eyes, nose or mouth)
- Before and after cleaning the environment
- Before and after preparing food
- Before eating and drinking or serving food
- After visiting the toilet.

Hand Hygiene for Patients and Patient Care-takers and Visitors

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

4.3. Hand Hygiene Methods

Hand washing with Soap and Water

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

The cleansing activity of hand washing is achieved by both friction and the detergent properties of the soap. Plain soap has minimal antimicrobial properties, but assists with the mechanical removal of debris and loosely adherent microbes, while the mechanical action removes some bacteria from hands. Time is also an important factor—hand washing for 30 seconds has been shown to remove 10 times the amount of bacteria as hand washing for 15 seconds. The entire hand washing procedure, if completed properly, as described step by step in Figure 1-2, should take 40–60 seconds. (CDC 2002; WHO 2009a)

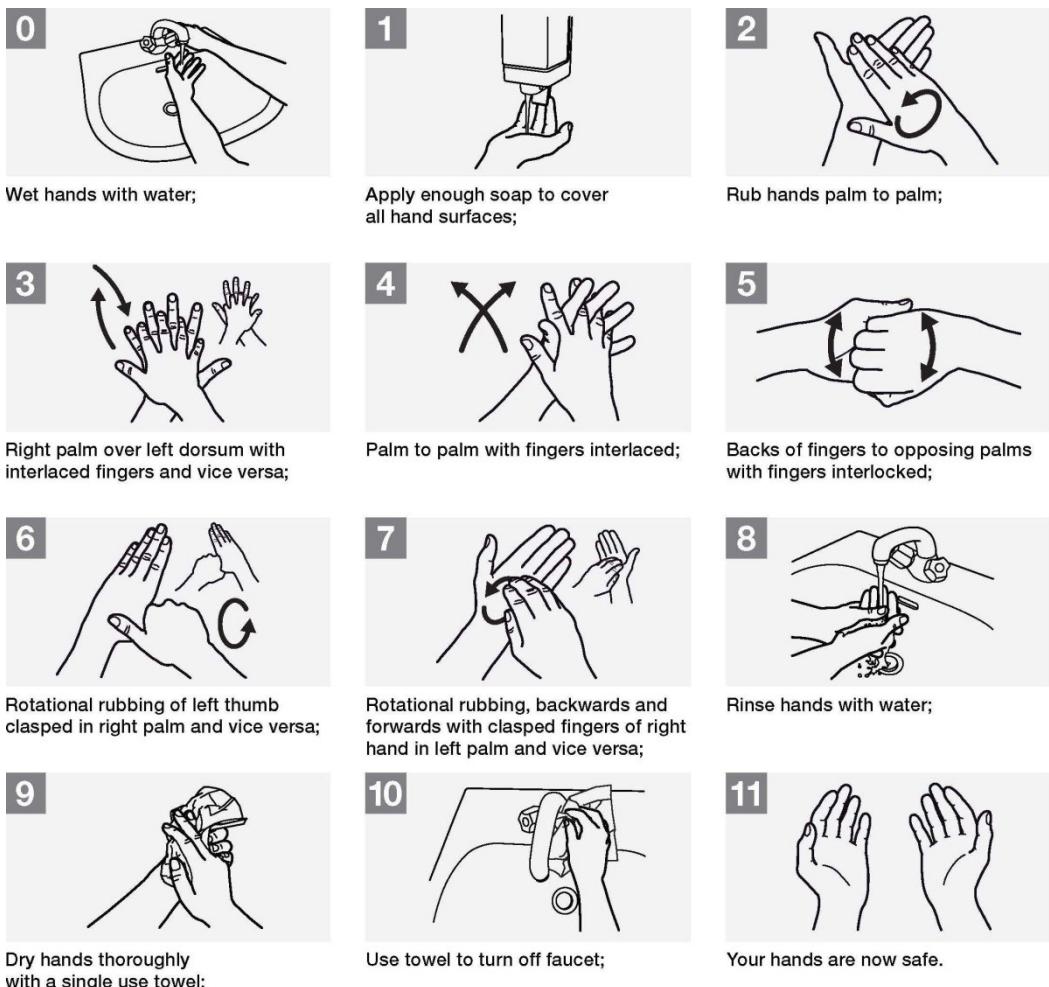


Figure 4-1: The Steps for Routine Hand washing (How to Properly Wash Your Hands)

Reprinted from: "How to Handwash," © World Health Organization (2009). http://www.who.int/gpsc/5may/How_To_HandWash_Poster.pdf. Accessed May 6, 2016.

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

1. If hands are visibly soiled or contaminated with blood or body fluids
2. After using the toilet
3. Before eating
4. To remove the buildup of emollients (e.g., glycerol) on hands after repeated use of ABHR

5. In outbreaks of *C. difficile*, but not in health care settings with only a few cases of *C. difficile*. (Cohen et al. 2010; Siegel et al. 2007) *C. difficile* is a bacterial infection that causes severe diarrhea and is common in some settings.

- Avoiding contamination of hands during hand washing
- Avoid bar soaps when possible because they can become contaminated, leading to colonization of microorganisms on hands. There is some evidence, however, that the actual hazard of transmitting microorganisms through hand washing with previously used bar soaps is negligible. If bar soap is used, provide small bars and use soap racks that drain the water after use. (WHO 2009a)
- Filter and/or treat water if a health care facility's water is suspected of being contaminated; this will make the water microbiologically safer.
- Use running water for hand hygiene. In settings where no running water is available, water "flowing" from a pre-filled container with a tap is preferable to still-standing water in a basin. Use a container with a tap that can be turned off preferably with the back of the elbow (when hands are lathered) and turned on again with the back of the elbow for rinsing. As a last resort, use a bucket with a lid or a pitcher and a mug to draw water from the bucket, with the help of an assistant, if available. (WHO 2009a)
- Dry hands properly because wet hands can more readily acquire and spread microorganisms. Paper towels or single-use clean cloths/towels are an option. Make sure that towels are not used multiple times or by multiple individuals because shared towels quickly become contaminated.

Alcohol-Based Hand Rub (ABHR)

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

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

To be effective, approximately 3–5 mL (i.e., 1 teaspoon) of ABHR should be used. The ideal volume of ABHR to apply to the hands varies according to different formulations of the product and hand size (refer to manufacturer’s instructions for use). ABHR should be used, following the steps shown in Figure 1-3, for approximately 20–30 seconds or until the solution has fully dried. Since ABHR does not remove soil or organic matter, if hands are visibly soiled or contaminated with blood or body fluids, wash hands with soap and water. To reduce the buildup of emollients on hands after repeated use of ABHR, washing hands with soap and water after every 5–10 applications of ABHR is recommended.

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



Figure 4-2: WHO Recommendation on How to Perform Hand Hygiene with ABHR

Reprinted from: “How to handrub,” © World Health Organization (2009). http://www.who.int/gpsc/5may/How_To_HandRub_Poster.pdf. Accessed May 6, 2016.

Producing alcohol-based hand rub

An effective ABHR solution is inexpensive and simple to make, even in limited-resource settings. WHO provides procedures for making ABHR in health care facility pharmacies (see Box 4-1: Alcohol-Based Hand Rub Formulation).

Box 4-1: Alcohol-Based Hand Rub Formulation

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

Pour into a 1,000-mL graduated flask:

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

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

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

Pour into a 1,000-mL graduated flask:

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

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

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

Adapted from: WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge. Clean Care Is Safer Care, page 49. © World Health Organization (2009).

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

Antiseptic Soaps

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

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

4.2.1. Surgical Hand Scrub

The purpose of the surgical hand scrub is to mechanically remove soil, dirt, debris, and transient flora microorganisms and to reduce resident flora before and for the duration of the surgery. The goal is to prevent wound contamination by microorganisms from the hands and arms of the surgical team members (see Module 7, Chapter 2, Use of Antiseptics in Health Care Facilities, for more details).

4.4. Issues and Considerations Related to Hand Hygiene

Glove Use

While the effectiveness of gloves in preventing contamination of HCWs' hands has been confirmed, gloves do not provide complete protection against hand contamination. Contamination may occur as a result of small, undetected holes in gloves, as well as during glove removal. Thus, wearing gloves does not replace the need for proper hand hygiene. Hand hygiene should always be performed before putting on and after removing gloves (See reference manual Volume 1, Chapter 4: Personal Protective Equipment, for details of correct glove use). (CDC 2002; WHO 2002)

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

Every effort must be made to reinforce the message that gloves do not replace the use of hand hygiene and that when gloves are required, they should be used in addition to hand hygiene (see SECTION 1CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S, for more information on glove use).

Hand Lotions and Hand Creams

In an effort to minimize hand hygiene-related contact dermatitis (a skin rash caused by irritation from a substance such as soap due to frequent hand hygiene), hand lotions, creams, barrier creams, and moisturizing skin care products are recommended. Hand lotions and creams often contain humectants (substances that help retain moisture) and various fats and oils. These humectants can increase hydration and replace altered or depleted skin lipids that can serve as a barrier to microorganisms on normal skin. Several studies have shown that regular use (i.e., at least twice per day) of such products can help prevent and treat contact dermatitis. There is also biologic evidence that emollients (e.g., glycerol and sorbitol) contained in ABHR, with or without antiseptics, may decrease cross-contamination because they reduce shedding of bacteria from skin for up to 4 hours. These products are absorbed into the superficial layers of the epidermis and are designed to form a protective layer that is not removed by standard handwashing. (Boyce et al. 2002; McCormick et al. 2000; WHO 2009a)

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

Resistance to Topical Antiseptic Agents

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

Lesions and Skin Breaks

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

Religious and Cultural Considerations

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

Fingernails

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

Artificial nails

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

Nail polish

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

Jewelry

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

In summary healthcare workers should adhere to the following to ensure effective hand hygiene practices;

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

Hand Care

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

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

Note the following recommendations for hand care to prevent irritation due to frequent hand hygiene (based on WHO (2009) hand care recommendations);

- Develop a regular routine of using a protective hand cream or lotion, at least daily
- Do not routinely wash hands with soap and water immediately before or after using an alcohol-based hand rub
- After hand rubbing or hand washing, let your hands dry completely before putting on gloves
- Use alcohol based hand rubs with emollients rather than detergent based soaps
- Select efficacious products with the least potential for irritation
- Avoid unnecessary prolonged glove use
- Dry hands completely after washing and prior to gloving
- Avoid rough paper towels; pat rather than rub dry
- Don't use soaps, detergents, or aqueous creams or lotions containing **sodium lauryl sulfate**
- When skin is damaged or frequent hand washing is required, a mild soap (without antiseptic agent) should be used to remove soil and debris.
- In high-risk areas such as the operating room, neonatal ICU or transplant units, hand scrub protocols that use soft brushes or sponges for a shorter time (at least two minutes) should replace harsh scrubbing by hard brushes for 6 to 10 minutes.

4.5. Monitoring Hand Hygiene

The WHO Guidelines on Hand Hygiene in Health Care encourage providers in all health care settings to evaluate, improve, and monitor the reliability of hand hygiene practices with the aim of changing the behavior of HCWs. Optimizing hand hygiene compliance at the 5 recommended moments for hand hygiene increases patient safety. (WHO 2009a; WHO 2009e)

Hand hygiene compliance can be monitored both directly and indirectly (see Table 4-1: Hand Hygiene Observation Methods) (WHO 2009a). Each method of monitoring hand hygiene has its own advantages and disadvantages (see Table 4-2: Advantages and Disadvantages of Various Hand Hygiene Monitoring Approaches). The direct observation of hand hygiene compliance by a

validated observer¹, however, is considered the “gold standard” in hand hygiene monitoring. It is often valuable to utilize more than one method of monitoring at the same time. (The Joint Commission 2009; WHO 2009a)

Table 4-1: Hand Hygiene Observation Methods

Direct Methods of Hand Hygiene Observation	Indirect Methods of Hand Hygiene Observation
Direct observation	Monitoring consumption of products (soap or ABHR)
Patient assessment	Automated monitoring of use of sinks or ABHR dispensers

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

For detail information see from references manual in (chapter 3)

Table 4-2: Advantages and Disadvantages of Various Hand Hygiene Monitoring Approaches

Monitoring Approach	Advantages	Disadvantages
Direct observations by expert observers	Only way to reliably capture all hand hygiene opportunities Details can be observed Unforeseen qualitative issues can be detected while observing hand hygiene	Time-consuming Skilled and validated observers required Prone to observation, observer, and selection bias
Self-reports by HCWs	Inexpensive	Overestimate of true compliance Not reliable

¹ Validated observers are observers with excellent skills in monitoring hand hygiene during health care practices. Validation includes training according to the principles behind the “5 Moments,” training on facility policies related to hand hygiene expectations, and being monitored and confirmed for correct techniques by senior observers. (WHO 2009a)

Direct observations by patients	Inexpensive	Potential negative impact on patient-HCW relationship Reliability and validity required and remain to be demonstrated
Consumption of hygiene products (e.g., towels, soap, and ABHR)	Inexpensive Reflects overall hand hygiene activity (selection biased) Validity may be improved by using indirect denominators (e.g., patient-days or workload that is converted into total hand hygiene opportunities)	Does not reliably measure the need for hand hygiene (denominator) No information about the appropriate timing of hand hygiene actions Prolonged stocking of products at ward level complicates and might jeopardize the validity Validity threatened by increased patient and visitor usage Not able to discriminate between individual or professional group usage

Reprinted from: WHO Guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge. Clean Care Is Safer Care. Process and Outcome Measurement, page 162. © World Health Organization (2009).

Summary

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

CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S

Chapter Objective

The objective of this chapter is to enable healthcare workers understand the role of Personal Protective Equipment in preventing infection for health service providers as well as patients.



Learning objectives

By the end of this chapter, participants will be able to:

- Describe the benefit of PPE
- List the types, uses, effectiveness and limitation of PPE's
- Demonstrate the correct way of donning and removing PPE
- Describe PPE's used in out breaks management.

Chapter Content

- 5.1. Overview
- 5.2. Instruction for putting on and removing PPE
- 5.3. Types, Uses, effectiveness and limitation of PPE
- 5.4. Choosing PPE for Standard and Transmission-based Precaution
- 5.5. Sequence for Putting on and removing PPE
- 5.6. Types of PPE used to prevent transmission during disease outbreak

5.1. Overview

Healthcare workers are confronted each day with the difficult question of how to work safely within the potentially hazardous environment of health care facilities. Today, the most common occupational risk the healthcare personnel face is due to contact with blood and body fluids during routine works like cleaning, instrument processing and patient care. This exposure to pathogens increases risk of getting Healthcare Associated Infections and possible death. Use of risk appropriate personal protective equipment (PPE) is one of the components of Standard

Precautions, which refers to wearing of protective barriers or clothing. Hospital administrators, supervisors and healthcare workers need to be aware not only of the benefits and limitations of specific PPE, but also of the actual role PPE play in preventing infection so that they can use them effectively and efficiently.

The basic principle behind wearing personal protective equipment is to get physical barrier/protection from pathogenic microorganisms. PPE includes: gloves, masks/respirators, eyewear (face shields, goggles or glasses), caps, gowns, aprons, boots and other items. The most effective barriers are made of treated fabrics or synthetic materials that do not allow water or other liquids (blood or body fluids) to penetrate them. These fluid-resistant materials are not, however, are not widely available because they are expensive. Lightweight cotton clothes (with a thread count of 140/inch²) are materials most commonly used for surgical clothing (masks, caps and gowns) and drapes in many countries. Unfortunately, lightweight cotton does not provide an effective barrier because moisture can pass through it easily, allowing contamination.

Table 5-1: How Personal Protective Equipment Blocks the Spread of Microorganisms

WHERE MICROORGANISMS ARE FOUND (RISK ASSESSMENT)	HOW MICROORGANISMS ARE SPREAD	BARRIERS TO STOP THE SPREAD OF MICROORGANISMS	MUST BE USED FOR (examples of indications)	WHO THE BARRIERS PROTECT
Healthcare Staff				
Hair and scalp	Shedding skin or hair	Cap	Invasive procedures where tissue beneath the skin is exposed	Service Provider and Patients
Nose and mouth	Coughing, talking	Mask (water resistant),	Situation where splashing or exposure of blood, body fluids, secretions or excretions is likely	
Face (eyes nose or mouth)	Splashing	Masks, face shields, goggles		
Body, Arm and skin	Shedding skin or hair	Scrub suit, cover gowns		
Nose and mouth	Coughing, talking	Masks	Situation which call for droplet transmission	
		Special Masks (N95%)	When airborne transmission is anticipated.	
Hands	Touching	Gloves with hand washing or alcohol hand rubbing	When there is a reasonable chance of hand coming in contact with blood and other body fluids	Patient

Feet and lower legs	Splashes, Spills and Sharp Material	Closed boots or closed-toe shoes (open sandals are not acceptable)	Situation where splashing or blood, body fluids, secretions or excretions is likely	Service provider
Patient				
Mucous membrane and non-intact skin	Touching	Gloves	Situation where there is direct contact with mucous membrane and non-intact skin	Service provider and Patient
Blood and body fluids	Splashing or spraying	Gloves, eyewear, mask, drapes, and apron	Invasive procedures where tissue beneath the skin is exposed	Service provider and Patient
	Touching (contact)	Instrument processing	Situation where splashing or exposure of blood, body fluids, secretions or excretions is likely	
	Accidental exposure with contaminated needles and scalpel blades	Protective footwear, decontamination and disposal; use of a Safe or Neutral Zone during surgery		
Contaminated Items or waste	Infectious waste	Utility gloves, plastic bags and proper disposal	Collection, transportation and disposal of waste	Staff
Unprepared skin	Touching	Skin preparation, drapes, gloves	Invasive procedures where tissue beneath the skin is exposed	Patient
Clinic or hospital environment	Touching	Gloves hand washing, Appropriate dressing	Environmental cleaning and disinfection	Staff and their families

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

PPE should be;

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

5.2. Instructions for putting on and removing personal protective equipment

Putting on and removing PPE in the proper order and manner is just as important as wearing PPE. Failure to properly put on or remove PPE could lead to exposure to or lack of protection against infectious agents. The order of putting on PPE and removing PPE depends upon the purpose for which the PPE is being used. PPE is used for Standard Precautions, operating theatres, isolation rooms during Transmission-Based Precautions, and during disease outbreaks (e.g., novel respiratory disease, VHF).

5.3. Types, uses, effectiveness and limitation of PPE

Table 5-2: List of PPE and area of Protection

Types of PPE	Provides protection for
Head Covering/Caps	Hair and Scalp
Google	Eyes
Face Masks	Nose, Mouth and Lower Jaw
Face Shield	Face
Gloves	Hand
Gowns	Upper body, skin and cloth
Apron	Front of the body
Boots	Lower legs and feet
Shoe cover	Shoe

Head Covering/Caps

Head covers are most commonly used as part of surgical attire in surgical and procedure areas. When used, head covers or caps should be large enough to cover the entire scalp and hair (see Figure 5-1A–C: Surgical Head Coverings A, B, and C). Facial hair is also required to be covered for surgical procedures in sterile areas (e.g., in the operating theater) using a facial hair covering. They can be disposable or made of reusable cloth that can be laundered. In the surgical and procedure areas, a new clean head covering should be worn each day and changed sooner when soiled with blood or body fluids. The same standard and regularity of cleaning expected for surgical scrubs should be applied when cleaning head/facial coverings (e.g., laundered at the hospital and changed at least daily).

Why wear head coverings/caps

Head covers or caps are used to keep the hair, beard, and scalp covered so that flakes of skin and hair are not shed into the sterile field.

When to wear head coverings/caps

Head covers or caps are most often worn during surgery and in procedure areas where a sterile field is required. They are not necessary for most other areas in the health care facility. Head covers are not part of routine PPE for Contact, Droplet or Airborne Precautions but are used for during outbreaks for VHF (See SECTION 1CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S, **Types of Personal Protective Equipment used to Prevent Transmission during Disease Outbreak**).

How to wear head coverings/caps

Caps and facial coverings must cover all hair, and jewelry must be removed or contained within the head covering.



A. Head covering

Adapted from: Blue Sky Scrubs 2015.



B. Surgical Cap

Adapted from: Halyard Health, Inc. 2018.



C. Surgical Hood

Source: Jhpiego 2015.

Figure 5-1A–C: Surgical Head Coverings

Protective Eye Wear

There are four different types of eye protection that are effective in preventing infection in health care facilities (see Figure 5-2: Different types of Eye Protection Equipment's):

1. Goggles
2. Safety Glass
3. Masks attached shield
4. Face shield

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

Eye wear protects the staff during accidental splash of blood or other body fluid by covering the eyes. Masks and eyewear should be worn when performing any task where an accidental splash into the face could occur (e.g. performing cesarean section, vaginal delivery or cleaning instruments) when giving care to patients with droplet precautions. If face shields are not available, goggles or glasses and mask can be used together. If reusable eye/face protection is used, it should be decontaminated in accordance with the manufacturer's guidelines. Hands should always be decontaminated after removing the equipment.

Note: Personal eye glasses and contact lenses are NOT considered adequate eye protection.

(Siegel *et al.*, 2007)

Suitable protective eye/face equipment should be worn :

- As part of Standard Precautions
- As part of Droplet Precautions to protect from respiratory secretions
- During procedures and surgery when splashing is likely to happen
- During specimen collection or aerosol-generating procedures on patients with specific respiratory tract pathogens (e.g., TB or novel respiratory viruses) (WHO 2008 tract pathogens (e.g., TB or novel respiratory viruses) (WHO 2008).
- Cover the entire face area (e.g. face shield) if protection of the mouth and nose area is also required
- Be changed if visibly soiled
- Be removed using the ear-pieces / head-band to avoid touching potentially contaminated surfaces
- Be disposed of after use if single-use or placed into a receptacle for reprocessing

- Fit over personal glasses and anti-fog properties should be considered

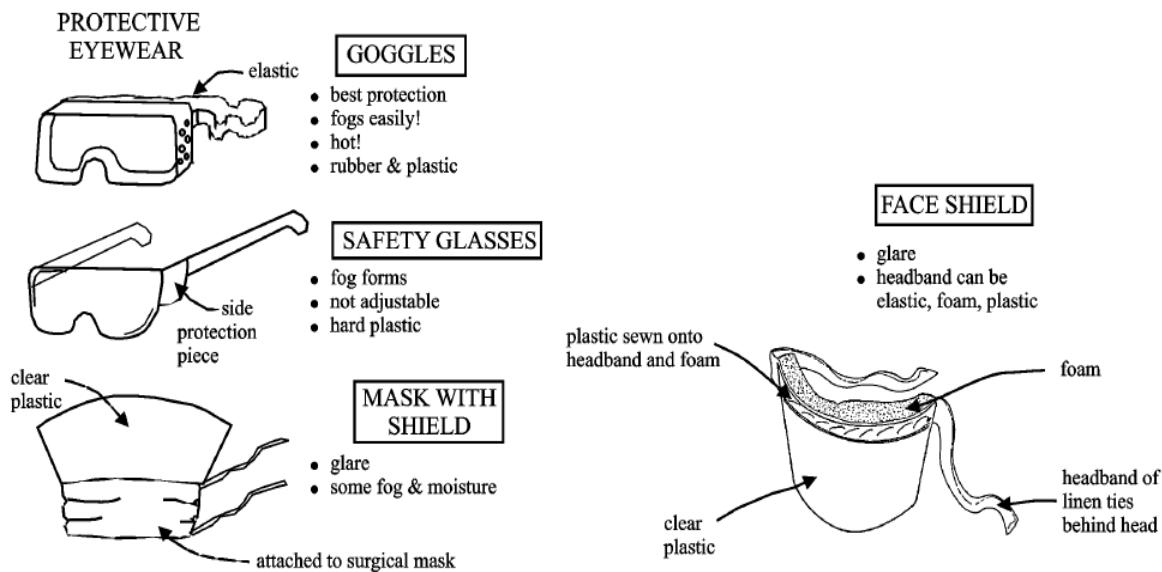


Figure 5-2: Different types of Eye Protection Equipment's

How to wear protective eyewear

Put on eye protection after putting on the isolation gown and mask (if used) but before putting on gloves (see Figure 5-3: Putting on Eye Protection).

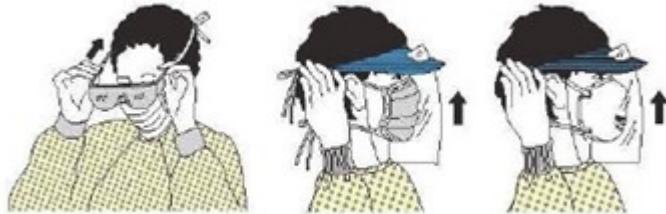


Figure 5-3: Putting on Eye Protection

Source: Siegel et al. 2007.

Removal of face shield, goggles, and mask can be performed safely after gloves have been removed (see Figure 5-4: Taking off Eye Protection). The ties, ear pieces, and/or head band used to secure the equipment to the head are considered “clean” and safe to touch with bare hands. If the ties, ear pieces, and/or head band are found to be contaminated, they should be

removed using gloved hands and the skin/face should be rinsed using ample running water and soap. The front of a mask, goggles, and face shield is considered contaminated.



Figure 5-4: Taking off Eye Protection

Source: Siegel et al. 2007.

Masks

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

There are two types of masks:

Surgical masks: Regulating bodies (such as The United States Food and Drug Administration [FDA], the European Union, and WHO) require surgical masks to have fluid-resistant properties.

Procedure/isolation masks: These are not regulated and they do not have any specifications for their manufacture.

Surgical Masks

Masks should be large enough to cover the nose, the lower part of the face, the jaw and all of the facial hair. They are worn in an attempt to retain/confine moist droplets expelled as health

workers or surgical staff speaks, cough or sneeze. Equally important, is its protective function against accidental splashes of blood or other contaminated body fluids on the health workers' nose or mouth. This preventive function, however, would not be effective unless the masks are made of fluid-resistant materials.

When removing, one should handle the masks by the strings, do it with great care as the center of the mask is the most contaminated site of all other parts (Rothrock, McEwen & Smith, 2003).

Respirators

This are special types of masks called particulate respirators worn by healthcare personnel for protection against inhalation exposure to airborne infectious agents that are $< 5\mu\text{m}$. These include infectious droplet nuclei from patients with *Micobacterium tuberculosis*, *Variola virus* (smallpox), SARS-CoV, and dust particles containing infectious particles such as spores of environmental fungi (e.g. *Aspergillus* sp.). Respirators should be worn when filtering inhaled air is deemed important. These articles contain multiple layers of filter material and fit into the face tightly allowing no air leaks around the mask when breathing. The N95 disposable particulate and air purifying respirator is the type used most commonly by healthcare personnel. Other respirators used include N-99 and N-100 particulate respirators; powered air-purifying respirators with high efficiency filters; and non-powered full-face piece electrometric negative pressure respirators (Siegel JD. *et al.*; HICPAC, 2007).



Surgical Mask



Respirator (N95)

Figure 5-5: Types of Masks frequently used by health care workers

Gowns

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

There are three types of protective gowns used in health care facilities:

- Isolation gowns,
- Surgical gowns, and
- Coverall suits

(Siegel et al., 2007)

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

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

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

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

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

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

Coveralls are full-body suits made from materials that are lightweight, breathable, and impermeable to liquids (see Figure 2-1). These are to be worn by all HCWs who work in isolation areas for treating highly infectious diseases (e.g., VHF). They are designed to go over a scrub suit and create a barrier to eliminate or reduce contact exposure to blood, body fluids, and highly infectious microorganisms (CDC 2015). Coveralls without attached hood and with thumbholes are recommended.



Figure 5-6: Coverall Suit

When to wear gowns

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

- During Standard Precautions, an isolation gown (with gloves) is worn if blood or body fluid contact, spills, or splashes onto clothing is anticipated.
- During Contact and Droplet Precautions, an isolation gown (with gloves) is used to prevent transmission of an infectious agent that cannot be prevented by Standard Precautions alone.

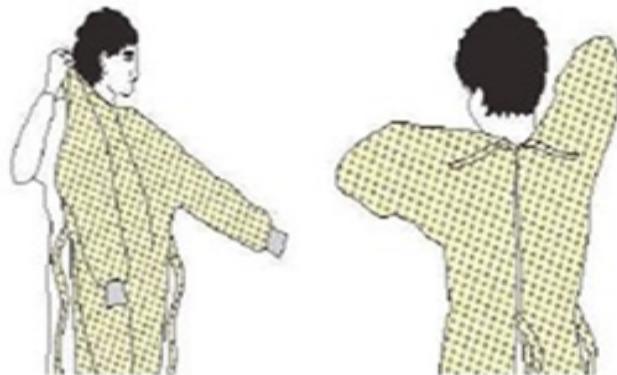
- During surgical procedures, deliveries, or other aseptic procedures, a sterile surgical gown is worn to protect the sterile field and the clothes of the scrub team or those performing the procedure.

How to wear and remove gowns

Full coverage of the arms and body front, from the neck to the mid-thigh or below, will ensure that clothing and exposed areas of the upper body are protected.

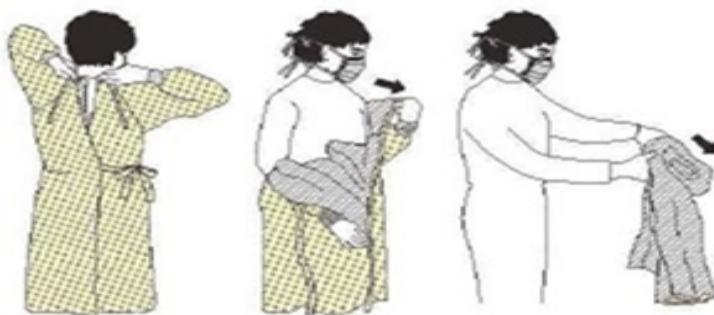
Isolation gowns are usually the first piece of PPE to be put on (see Figure 5-7 A and B: Putting on and Removing an Isolation Gown). HCWs should remove isolation gowns before leaving the patient care area to prevent possible contamination of the environment outside of the patient care area (see Figure 5-7 A and B: Putting on and Removing an Isolation Gown). (Siegel et al. 2007)

A. Proper Way to Put On an Isolation Gown



1. Perform hand hygiene.
2. Unfold the gown and insert both hands in the sleeves of the gown, one after the other. Secure both sides using the tie at the neck and at the waist.
3. Make sure that you tie the waist knot on the side so that it is easy to untie at the time of removal.

B. Proper Way to Remove an Isolation Gown



1. Release the knot around the neck, being sure not to contaminate the neck, followed by the side knot.
2. Slowly pull the gown away from your body, pulling it inside out, as you remove your hands, one after the other.
3. Fold the gown inside out, ensuring that you avoid touching the outer surface of the gown.
4. Dispose of the gown in a contaminated-waste container.

Figure 5-7 A and B: Putting on and Removing an Isolation Gown

Adapted from: Siegel et al. 2007.

Plastic Apron

It is used to protect clothing or surfaces from contamination. Reusable aprons which are made of rubber or plastic provide a waterproof barrier along the front of the personnel's body. Thus, it should also be worn during cleaning and procedures with likelihood of splashes or spillage of blood, body fluids, secretions or excretions (e.g. when conducting deliveries). Disposable waterproof aprons are also available for clinical use.

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

Gloves

Healthcare Workers Wear Gloves for the Following Three Reasons:

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

TYPES OF GLOVES

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

Clean Examination Gloves - provide protection to healthcare workers when performing many of their routine duties. These gloves can be used whenever contact with mucous membrane and non-intact skin is anticipated (e.g. during medical examinations and procedures such as pelvic examination).

Utility or Heavy-Duty Gloves - should be worn when processing instruments, equipment and other items, for handling and disposing contaminated waste, and when cleaning contaminated surfaces. Double gloving of either new examination gloves or reprocessed surgical gloves provide some protection in case utility gloves are not available.

Note:

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

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

Non-sterile Gloves can be made from:

1. Latex
2. Vinyl
3. Nitrile

Table 5-3: Advantages and Disadvantages of Different Types of Non-Sterile Gloves

Material	Advantage	Disadvantage
Latex	<ul style="list-style-type: none">• Offer best fit, natural feel, and dexterity• Approved by regulatory authorities• Provide protection against most chemicals, including acids and bases, chlorine, iodine, and formaldehyde• Offer better puncture resistance than other gloves (e.g., vinyl gloves)	<ul style="list-style-type: none">• Long contact with fatty substances (e.g., fatty tissue and vegetable oils) will disintegrate latex gloves• Not recommended for HCWs with known allergies to latex
Vinyl	<ul style="list-style-type: none">• First synthetic material gloves available on the market• Least expensive of the three types and generally available in low- and middle-income countries• Recommended if they are the only type of non-sterile glove available and the risk of exposure to blood and body fluids is high• Acceptable for short procedures/tasks (e.g.,	<ul style="list-style-type: none">• Loose-fitting (i.e., baggy), have limited elasticity, and tear easily• Have higher failure rates than latex or nitrile gloves because they tear more easily and they are loose-fitting around the wrist, which can allow fluids to

	suctioning endotracheal secretions, removing IV lines) that involve minimum risk of glove tears, have low risk of exposure to contaminants, and involve minimal stress on the gloves	contaminate an HCW's hand
Nitrile	<ul style="list-style-type: none"> • Allergy-free • Preferred choice for HCWs with latex allergies • Made from synthetic materials and are very elastic • Can be used with petroleum-based substances, including hand moisturizers • 3–5 times more puncture-resistant than latex gloves • Fit well on hands like latex gloves • More elastic than vinyl gloves • Available in various thicknesses and colors 	<ul style="list-style-type: none"> • Not recommended for HCWs with known allergies to nitrile compounds

Note:

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

WHEN TO WEAR GLOVES

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

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

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

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



Figure 5-8: The Decision Pyramid – when to and not to wear gloves

Image from WHO (2009); Hand Hygiene Why, How and When

WHEN TO USE DOUBLE GLOVES

Even the best quality, new latex rubber surgical gloves may leak up to 4% of the time. Moreover, it was found that latex gloves gradually become weaker and lose their intactness especially when exposed to fat on surfaces of wounds.

Note:

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

Although double gloving is of little benefit in preventing exposure to blood in case of needle sticks or other similar injuries, it may decrease the risk of blood-hand contact. A recent study, for instance, showed that surgeons wearing single gloves had a blood-hand contact rate of 14% while those wearing double gloves had only a rate of 5% (Tokars *et al.*, 1995; Tokars *et al.*, 1992).

Health care providers should Double Glove when:

- The procedure involves coming in contact with large amounts of blood or other body fluids (e.g. vaginal deliveries and cesarean sections).
- Performing orthopedic procedures in which sharp bone fragments, wire sutures and other sharp edged materials are likely to be encountered.
- Performing surgical procedures lasting more than 30 minutes. (Most surgeons, these days use double glove routinely).

When double gloving, the first glove should be a half size larger than normally worn gloves. The second pair, however, should be the correct size as this will help prevent the hand from cramping.

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

WHEN TO USE ELBOW LENGTH GLOVES

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

How to make Elbow Length Gloves

When readymade elbow length gloves are not available, an effective alternative material (as described below) can easily be made from new or previously used surgical latex gloves that have been re-processed (decontaminated, cleaned and dried, through the two methods of either sterilization or high-level disinfection).

Cut one or more fingers depending on the size of your hands completely off each glove just below where all the fingers join to allow all of the fingers slip into the gloves. (See Figure 5-9: Technique how to make elbow length gloves).

How to Use

- Perform surgical hand scrub.
- Put on the intact sterile to completely cover up the distal end of the fingerless gloves.
(See Figure 5-9: Technique how to make elbow length gloves).
- Put the fingerless sterile or HLD gloves and pull them up to the forearms.
- Put on the intact sterile (I.e. double glove)



Figure 5-9: Technique how to make elbow length gloves

HOW TO USE GLOVES

Although the effectiveness of gloves in preventing contamination of the healthcare workers' hands has been repeatedly confirmed (Tenorio *et al.*, 2001), wearing gloves does not replace the need for hand washing. The truth is that even the best quality latex surgical gloves may have small and unnoticeable defects; they may be torn during use; and the hands can become contaminated during removal (Bagg *et al.*, 1990; Davis, 2001).

Note:

Practice of hand hygiene, coupled with the use of protective gloves, is a key component in minimizing the spread of disease

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

I. HOW TO DON GLOVES:



1. Take out a glove from its original box

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

3. Don the first glove

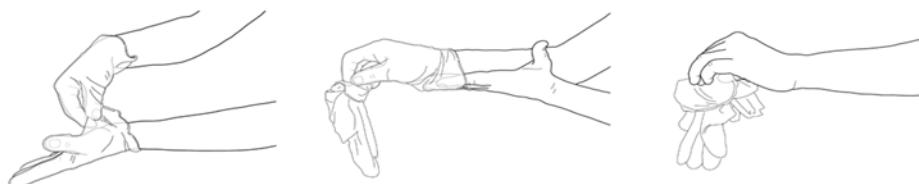


4. Take the second glove with the bare hand and touch only a restricted surface of glove corresponding to the wrist

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

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

II. HOW TO REMOVE GLOVES:



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

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

3. Discard the removed gloves

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

Figure 5-10: How to don and remove examination gloves

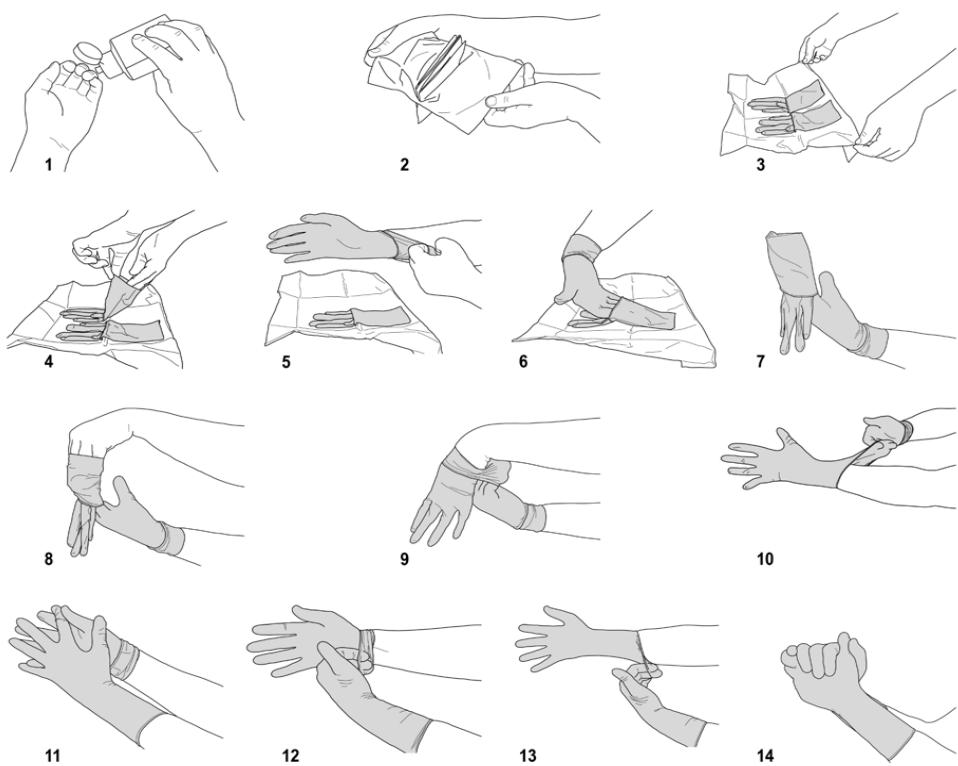


Figure 5-11: How to wear (don) sterile gloves

The purpose of donning and removing sterile gloves as indicated in Figure 5-11: How to wear (don) sterile gloves is to ensure maximum asepsis for patients and protect the healthcare workers from the patient's body fluid. In the correct usage of gloves—an instrument to achieve this double goal, the skin of the healthcare worker remains exclusively in contact with the inner surface of the glove and has no contact with the outer surface. Any error in the performance of this technique leads to a lack of asepsis requiring a change of glove.

Procedure for wearing Sterile Gloves

1. Perform hand hygiene before an “aseptic procedure” by surgical hand scrub.
2. Check the package for intactness. Open the first non-sterile packaging by peeling it completely off the heat seal (cover) to expose the second sterile wrapper, but without touching it.
3. Place the second sterile package on a clean and dry surface without touching the surface. Open the package and fold it towards the bottom so as to unfold the paper and keep it open.

4. Using the thumb and index finger of one hand, carefully grasp the folded cuff edge of the glove.
5. Slip the other hand into the glove in a single movement, keeping the folded cuff at the wrist level.
6. Pick up the second glove by sliding the fingers of the gloved hand underneath the cuff of the glove (Includes Step7).
7. In a single movement, slip the second glove on to the ungloved hand while avoiding any contact/resting of the gloved hand on surface other than the glove to be donned (contact/resting constitutes a lack of asepsis and requires a change of glove) (also includes step 9 and 10).
8. If necessary, after donning both gloves, adjust the fingers and inter-digital spaces until the gloves fit comfortably.
9. Unfold the cuff of the first gloved hand by gently slipping the fingers of the other hand inside the fold, making sure that any contact with the outer surface of the glove is avoided (lack of asepsis requiring a change of gloves) (Includes Step13).
10. The hands are gloved and must touch exclusively sterile devices or the previously-disinfected patient's body area.
11. Remove the first glove by peeling it back with the fingers of the opposite hand.
Remove the glove by rolling it inside out to the second finger joint (do not remove completely) (Includes step 16 and 17).
12. Remove the other glove by turning its outer edge on the fingers of the partially un-gloved hand.
13. Remove the glove by turning it inside out entirely (ball forming) to ensure that the skin of the health-care worker is always and exclusively in contact with the inner surface of the glove.
14. Discard gloves.
15. Perform hand hygiene after glove removal according to the recommended indication.

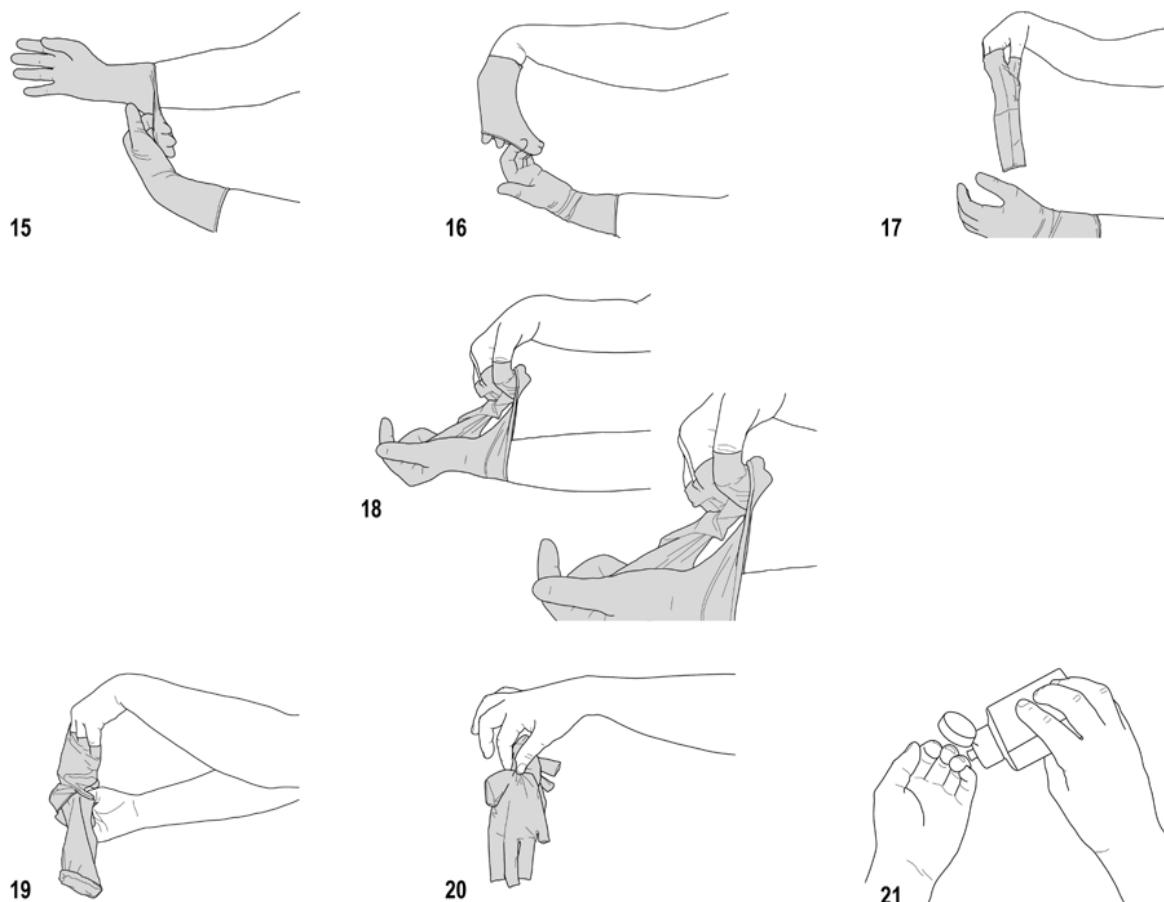


Figure 5-12: How to remove (doff) sterile gloves

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

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

SOME DOS AND DON'TS ABOUT GLOVES

- Do wear the correct size gloves, A poorly fitting glove can limit your ability to perform the task and may get damaged easily

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

Note:

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

Footwear

It's worn to protect the feet from injury by sharp or heavy items or fluids that may accidentally spill over, drip, or even pour out upon them. All footwear should have closed toes, low heels, and non-skid soles. Clean, sturdy shoes are recommended for all clinical areas. Rubber boots or leather shoes provide the best protection. They must be kept clean. For this reason, sandals and

other open-toe shoes or shoes made of soft materials are not acceptable. Rubber boots or leather shoes are acceptable but they must be kept clean and free of contamination from blood or other body fluid spills. Shoe covers are unnecessary, if clean and sturdy shoes are available for dedicated use only in the surgical area. However, Shoe covers may be needed to minimize contamination from and of shoes. Shoe covers are not meant to prevent transmission of bacteria from the floor but rather prevent contamination of shoes with blood and body fluids. (AORN 2015; Bearman *et al.*, 2014).

Wash hands before and after donning and removing PPE

5.4. Choosing PPE for Standard and Transmission-based Precaution

For the purpose of Standard Precautions, PPE are chosen based on the risk of exposure to blood or body fluids during patient care. The choice could be simply a pair of non-sterile gloves if touching contaminated surfaces or gown, gloves, mask and eye protection if extensive splashing is expected. For the purpose of transmission-based precautions septic items of PPE are designated for each type (e.g. only an N95 respirator if providing care to a suspected case of TB, as Airborne Precautions do not require use of gown or gloves). (For more information on appropriate PPE for each precaution, see Chapter 2: Standard and Transmission-Based Precautions). In case you need to wear multiple PPE, the sequence described below should be followed for safely putting on and removing PPE. For details about putting on or removing PPE, see the sections earlier in this chapter about each specific item of PPE.

5.5. Sequence for Putting on and removing PPE

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

1. Put on protective boots or shoe covers (if needed).
2. Perform hand hygiene.
3. Put on a gown.
4. Put on a procedure mask/N95 respirator.
5. Put on goggles or a face shield.
6. Lastly, put on gloves.

Source: CDC 2004.

Sequence for Removing PPE

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

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

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

1. Change from street clothes to a clean scrub suit (one that has been processed in the health care facility laundry). Remove all jewellery.
2. Put on non-skid, low-heel shoes with closed toes and back, rubber boots, or shoe covers when there is a risk of gross contamination with blood or body fluids.
3. Perform hand hygiene.
4. Put on a plastic apron if the sterile surgical gown is not fluid-resistant.
5. Put on a surgical head cover (and facial hair cover, if needed) to ensure that hair on the head (and beard) are fully covered.
6. Put on a surgical mask, one that fits well and fully covers the mouth and the nose.
7. Put on appropriate sized, well-fitting goggles or a chin-length face shield.
8. Perform a surgical hand scrub using soap and water and ABHR (see : HAND HYGIENE).
9. Put on a sterile surgical gown without contamination (see Figure 5-7 A and B: Putting on and Removing an Isolation Gown).
10. Lastly, put on sterile surgical gloves without contamination (see Figure 5-11: How to wear (don) sterile gloves).

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

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

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

Adapted from: AORN 2015.

5.6. Types of Personal Protective Equipment used to Prevent Transmission during Disease Outbreak

List of Personal Protective Equipment

PPE recommended by the World Health Organization (WHO) for HCWs who provide care and treatment to VHF (E.g. Ebola) patients includes:

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

(Ruparelia et al. 2015)

Summary

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

CHAPTER 6: SHARP AND INJECTION SAFETY

Chapter Objective

The objective of this chapter is to enable participants understand the basic concepts of safe injection and the risk and impact of unsafe injections.



Learning objectives

By the end of this chapter, participants will be able to:

- Define Injection Safety
- Describe the magnitude of unsafe injection
- Recognize the risk and impact associated with unsafe injection
- Demonstrate best practices in injection safety
- Discuss the common reasons for providing unnecessary and unsafe injection
- Identify the role of prescribers in injection safety
- Elucidate safe injection principles
- Mention injection devices and their safety features
- Demonstrate the safe medication handling
- Demonstrate how to handle sharps safely

Chapter Content

- 1.1. Overview
- 1.2. Magnitude of unsafe injection
- 1.3. The risks and impacts associated with unsafe injection practices
- 1.4. Common reason for prescribing and providing unnecessary and unsafe injection
- 1.5. Unsafe injection Practice: Transmission pathways
- 1.6. The best practices in injection safety
- 1.7. Role of prescriber in injection safety
- 1.8. Principles in safe injection practice
- 1.9. Injection devices and their safety features

- 1.10. Safe handling of medications containing vials (single and multiple dose vials)
- 1.11. Sharp safety

6.1. Overview

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

Injection safety baseline studies conducted by MOH and MMIS in 2004 and 2005 showed about 74% of injections were unsafe, about 72% of health facilities practiced unsafe disposal and the prevalence rate of needle stick injury was 30 to 35%. It is also reported that almost half (45%) of the community members have a tendency of preferring injections to other preparations.

A safe injection can be defined as; an injection that does not harm the recipient, does not expose the HCW to any avoidable risks, provided by skilled person, using appropriate injection equipment and does not result in waste that is dangerous for the community. . Unsafe injection practice, on the contrary, is the one that could harm the recipient, and/or the provider and/or may result in waste that is dangerous to the community.

6.2. Magnitude of Unsafe injection

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

- Most of the injections are therapeutic (90 to 95%); while few (5 to 10%) are given for immunization.
- The great majority (70%) of these injections are unnecessary given when oral medications could have been prescribed.
- A study of 40 health facilities using a combined survey/observation method found that about 74% of the injections were unsafe. The fact that Ethiopian patients generally prefer injections to other forms of medications further increases the risk of disease transmission;

- Injection providers (about 47%) are known to believe that oral medications are less effective than injections for the treatment of fever caused by minor illness.

6.3. Risk and Impact of Unsafe Injection

Risk of Unsafe Injection

Table 6-1: Conditions Causing Risks to Community, Patients/Clients and Providers

Community	Patient/client	Providers
<ul style="list-style-type: none"> • Unsafe waste disposal system of health facilities • Receiving injections from informal injectors • Leaving sharps in accessible place to the public, especially children • Sharing needles and syringe • Reusing needles and syringes 	<ul style="list-style-type: none"> • Use of injections when there are other suitable alternatives • Applying pressure to bleeding sites with dirty material or finger • Drug administered at incorrect anatomical site. For example, <ul style="list-style-type: none"> 1. Infants vaccinated at the buttocks rather than anterior-lateral thigh 2. Giving large boluses of intramuscular injections 3. Injecting a nerve • Use of unsterile syringes and needles (or use of “new” but damaged compromised package) • Re-use of syringe and needles • Use of opened multi-use vials stored beyond recommended time (contaminated drug use) • Using wrong diluents or wrong amount • Use of expired drugs • Syringes are loaded with different medications • Loading syringe with multiple doses • Drugs and vaccines are stored in the same refrigerator • Accidental switching of drugs • Health workers not following aseptic techniques • Patient/client moves during administration of injection • Sharps are found in unexpected places like linen • Self-medication 	<ul style="list-style-type: none"> • Shortage or absence of appropriate injection and safety devices • Carrying used needles before disposal • Placing needle on a surface prior to disposal • Recapping needles (either one or two hand) • Manually detaching needles from syringes • Manipulating used sharps (cleaning, bending, breaking or cutting hypodermic needle) • Passing on sharps from one health worker to another • Sharps are found in unexpected places like linen • Overfilling of sharps’ containers • Using a syringe on an agitated patient without assistant or patient/client moves during administration of injection

Risk to Patients

Unsafe injections can result in transmission of a wide variety of pathogens, including viruses, bacteria, fungi, and parasites. The risks of unsafe injection practices have been well-documented for the three primary blood borne pathogens: HIV, HBV, and HCV. Worldwide, each year, the overuse of injections and unsafe injection practices combine to cause an estimated:

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

(Hutin et al. 2003; Wilburn and Eijkemans 2007; WHO 2015)

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

- **Transmission of blood born infections** - occurs due to inoculation of infectious agents into the patient's body. There are about 40 blood borne pathogens that could be transmitted via injection. Among these, HBV, HCV, HIV/AIDS are the commonest and with grave implications.
- **Injection abscesses** - these are inflammatory conditions ranges from the initial signs of inflammation to big swellings occurring from suppurative processes.
- **Paralysis** following the damage of a nerve as a result of injection of a drug into a nerve and trauma.
- **Drug/allergic reactions shock** - a life threatening condition characterized by sudden collapse of the circulatory system due to immunological response to the injected drug, or other local or systemic allergic reactions.

Risk to Health Care Workers

Globally, in the course of their duties, HCWs are at an increased risk from blood borne pathogens because they handle sharps, including needles and syringes. It is estimated that 39% of HCV, 37% of HBV, and 4.4% of HIV infection among HCWs worldwide are attributable to occupational exposure to sharps injuries. (Prüss-Üstün *et al.*, 2005).

Both patients and HCWs are at risk of blood borne disease from unsafe injection practices. Eliminating unnecessary injections and using safe injection practices are the best ways to protect patients and staff from the risks.

Impacts of Unsafe Injection

Health Impacts unsafe injections have always been known to negatively affect people's health not only patients but also on care providers .The health problems could range from simple to deadly ones(see **Table 6.2**).

Table 6-2: Proportion of Infections and Total Burden of Disease Caused by Unsafe Injection Practices Annually, 2000

Infections	Estimated Burden of Infections	Estimated Proportion of Infections Due to Unsafe
Hepatitis B	22 million new cases	32%
Hepatitis C	2 million new cases	40%
HIV/AIDS	260,000 new cases	5%
Deaths in 2000 due to unsafe injection practices in the past, 501,000 deaths		

Source: WHO. "Safety of Injections. Global Facts and Figures," PP 1-2.

Socio-Economic each year, the annual global burden of indirect medical costs due to hepatitis B, hepatitis C and HIV/AIDS is estimated to be US\$ 535 million.

Psycho-Social impact includes: Stigma, discrimination and social isolation following infections like HIV, Stress associated with HIV, burden on family & the community (unproductive, children will be orphans, etc), risk of transmitting infections to family and the community. The Psycho-Social impacts can be seen at an individual, family, community and country level.

6.4. Common Reasons for Prescribing and Providing unnecessary and/or unsafe injection

1. Inadequate dissemination/promotion and use of standard treatment guidelines.
2. Prescriber's predilections to injections. Lack of knowledge on the dangers of injections, wrong perception that injections are more effective than oral

medications, give more rapid relief, are more potent are some factors influencing for an over use of injections. Other known factors are: financial incentive for prescribing injections and the fear that patients will go elsewhere if therapy is given otherwise or Perceived belief that patients prefer injections.

3. Informal providers giving injections.

6.5. Unsafe Injection Practice: Transmission Pathways

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

Even if a new needle is attached, when this syringe is used on subsequent patients, patients can become infected with blood-borne pathogens from contamination within the syringe. Even if a new needle and new syringe are used for subsequent patients, they can become infected with blood-borne pathogens from the contaminated liquid in the vial. Figure 6-1: Unsafe Injection Practices and Disease Transmission shows the pathway of transmission of blood-borne pathogens, in this case HCV, via unsafe injection practices.

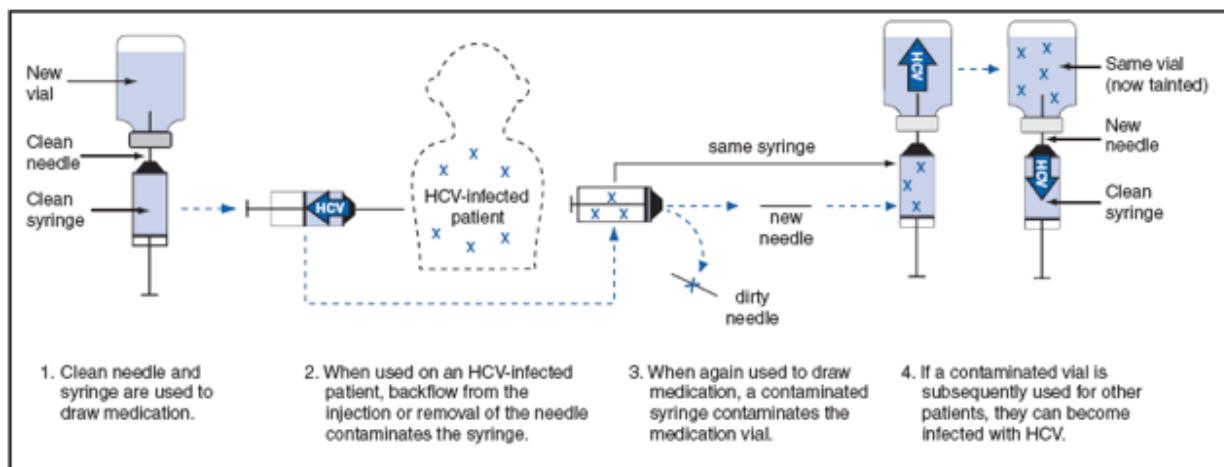


Figure 6-1: Unsafe Injection Practices and Disease Transmission

Source: CDC 2008.

6.6. Best Practices in Injection Safety

1. **Elimination of unnecessary Injection** the results of a survey conducted through interview of patients showed that 76.2% of the prescriptions had at least one injection. The study was conducted in four regions of Ethiopia. The most commonly prescribed medications include antibiotics, analgesics, antispasmodics and vitamins. All of these medications were just as effective if they were given by mouth. Many injectable medications have an oral equivalent that are equally strong, effective and much safer. Therefore, unnecessary injections should be reduced through:
 - A. **Promoting Rational Prescribing** injections should only be used during life threatening conditions, mal-absorption syndromes or inability to swallow.
 - B. **Educating the patients** encourage patients to accept oral medications; and explain the risks associated with injections when possible to limit the use only when necessary.

Make sure that the ‘right’ things/ways are fulfilled when administering injections (refer Table 6-3: Right Ways to Give Safe Injection)

2. Administer Injections Safely

Table 6-3: Right Ways to Give Safe Injection

Rights	Standards Always check and verify all ‘rights’	Method of Verification
1. Right Patient	What is the name on the prescription? Is this the right patient?	Ask patient/guardian, etc. to repeat name
2. Right Drug	Is the name of the drug on the prescription the same as the injection you are about to administer?	Verify name of drug on prescription with injection to be administered If you are unsure verify with physician or pharmacist
3. Right Formulation	Could the medication be given orally instead of as an injection?	Discuss with patient available choices

4. Right Injection Equipment	Use only sterile, non-reusable syringes, dental cartridge, etc	Check to ensure that syringe/needle package is unbroken
5. Right Dosage	Check dosage against patient's age, weight and the pharmacokinetics of the drug	Read the pharmaceutical recommendations of the drug If unsure, verify with the physician/prescriber
6. Right Time	Follow the specific dose interval	Be mindful of the action of the drug and why the time interval should be followed. Explain the importance of this to the patient
7. Right Route	Be sure to use the correct route of administration (intra-muscular, intravenous, intra-dermal or subcutaneous)	Observe the direction of the prescriber Check prescription or other related records
8. Right Storage	Right temperature, Vaccine Vial Monitor (VVM) shake test	Check cold chain issues including Vaccine Vial Monitor
9. Right Method of Disposal	Do not recap needle. Dispose of used syringe and needle immediately after use in appropriate safety box Or Use the needle cutter and safety box	Check the safety box for correct method of disposal

Standards for Administering Injections (see Box 6-1: Best Practices for Administering Injection)

- Prepare a well-laid up tray including emergency drugs for management or possible drug reaction.
- Wash hands with soap and water. Alcohol could be used as a secondary step after soap and water except for EPI injection.
- Dry up hands. You can use small paper towels or any single use towels.
- Check for the integrity of the vial/ampoule for the following expiry date, breach, leaks, particles or any contamination.
- Make sure that the right dose, formulation and route are used for the right patient or client.

- For medications that need to be reconstituted, (powder forms) it should be done according to the manufacturer's instruction and use the correct diluents.
- Draw the right dose as prescribed, including expelling the air using right injection equipment.
- Ensure aseptic technique while giving the injection.
- Administer the drug at the correct site.
- Dispose the used syringes and needles immediately into the sharp's container. (Never give used syringes and needles to patients or clients to carry home even if they came with the equipment).
- A patient should be kept in the room for at least 5 minutes after the injection has been given and be observed for any possible adverse effect or events.
- Thank the patient or the client.
- Record the date and time of injection administered.

6.7. The Role of Prescribers and Providers in Injection Safety

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

- Life threatening conditions
- Mal-absorption syndromes or
- Inability to swallow

Prescribers and Service providers should also:

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

6.8. Principles of Safe Injection Practice

Evidence based safety practice can be divided into four major areas of Intervention.

1. Use Sterile Injection Equipment

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

For curative and other purpose injections, syringes with reuse prevention devices and safety features are recommended. Where these ones are not available, standard disposable syringes can be used. Studies showed that unsafe injection practices such as using the same needle, syringe or both for more than one injection or improperly processed syringes and needles, are responsible for the transmission of HIV, HBV and HIV (Drucker *et al.*, 2001; Simonsen *et al.*, 1999). Therefore, after each use, needle and syringes should be placed in containers for disposal of sharps.

2. Prevent Contamination of Injection Equipment and Medication

- Prepare each injection in a clean designated area where blood or body fluid contamination is unlikely.
- Use single dose vials rather than multi-dose vials.
- If multi-dose vials must be used, always pierce the septum with a sterile needle and avoid leaving the needle in place in the stopper of the vial.
- Select pop-open ampoules rather than ampoules that require use of a metal file to open.
- If you are using an ampoule that requires a metal file to open, protect fingers with a clean barrier (e.g. small gauze pad) when opening the ampoule.
- Inspect medicaments and discard those with visible contamination or breaches of integrity (e.g. cracks, leaks).
- Follow product-specific recommendation for use, storage and handling.
- Swabbing of a new vial tops or ampoules with an antiseptic or disinfect is unnecessary. If swabbing with an antiseptic is selected for use, use a clean, single use swab and maintain product specific recommendation contact time. Do not use cotton balls stored wet in a multi-use container.

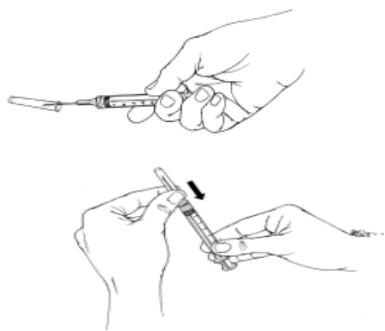
- Swabbing of clean skin before giving an injection is unnecessary. Wash skin visibly soiled or dirty with soap and water. If swabbing with an antiseptic is selected for use, use a clean, single use swab and maintain product specific recommendation contact time. Do not use cotton balls stored wet in a multi-use container.
- Discard a needle that has touched any non-sterile surface.

3. Prevent Injuries to the Provider

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

Precautions to take before an Injection, precautions are taken depending on the types of procedure being carried out.

- Anticipate and take measures to prevent sudden patient movement during and after injection.
- Do not recap, bend or break needles prior to disposal of single use needles and syringes after giving injections. However, if there is a need to recap a needle due to various reasons, needles must be recapped using the “one-handed” recap method as follows:
 - First, place the needle cap on a firm and flat surface, and then remove the hand.
 - Next, with one hand holding the syringe, use the needle to “scoop” up the cap.
 - With the cap now covering the needle tip, turn the syringe upright (vertical) so the needle and syringe are pointing toward the ceiling.
 - Finally, using the forefinger and thumb of your other hand, grasp the cap just above its open end (Figure 6-2: One Handed Recap Method) and push the cap firmly down onto the hub (the place where the needle joins the syringe under the cap).
- Do not decontaminate the needle and syringes prior to disposal.
- Do not disassemble the needle and syringe after use.
- All used syringes and needles or any other sharps should be discarded at the point of use in an enclosed sharp container which is puncture and leak proof and sealed before being completely full.
- During injection, disposable gloves are indicated only if excessive bleeding anticipated.



1. Place the cap on a flat surface, and then remove your hand from the cap. With one hand, hold the syringe and use the needle to scoop up the cap.
2. When the cap covers the needle completely, use your other hand to secure the cap on the needle hub. Handle the cap at the bottom, near the hub.

Figure 6-2: One Handed Recap Method

4. Prevent Access to Used Needles and Syringes

- Seal sharp containers for transport to a secure area in preparation for disposal.
After closing and sealing sharps containers, never open, empty or reuse them.
- Manage/dispose sharps waste in an efficient, safe and environment-friendly way to protect people from voluntary or accidental exposure to used injection equipment.
- Disposal of used syringes, needles and sharp containers.
- The following guiding principles should be used for disposal of syringes, needles, and sharps containers.
- Dispose all sharps in a safety box immediately after injection.
- If the syringe is a retractable one, make sure to engage the retraction feature before disposing of the syringe.
- Collect used syringes and needles at the point of use in an enclosed sharps container (safety box) that is puncture and leak-proof.
- Do not use boxes that are open, overflowing or punctured. Get a new one instead
Dispose safety boxes when 2/3 full.
- Dispose of the sharps and sharp containers by burning, burying or encapsulation.
- Always put on a heavy duty gloves when handling sharps containers.
- Safe Handling of Vials Containing Medication (Single-Use and Multi-Dose Vials) is discussed in 6.10. Safe preparation and administration of injection .

Box 6-1: Best Practices for Administering Injection

- **Select safe medicines**
 - Proper handling of medicines including keeping it in a clean environment.
 - Label them clearly
 - Observe proper storage conditions, including temperature and humidity (as recommended by manufacturer)
 - Check expiry dates
- **Use of sterile equipment**
 - Use needle and syringe from sealed package
 - Use syringes with re-use prevention features
- **Avoid contamination (Adhere to principles of Aseptic Technique)**
 - Wash hands
 - Prepare on clean surface
 - Do not touch part of needle that will come in contact with patient's tissue and avoid recapping. If recap is necessary, apply one hand technique.
 - Do not leave the needle in the rubber cap of the vial
- **Re-constitute drugs or vaccines safely**
 - Use new sterile syringe and needle for each reconstitution
 - Use the correct diluents/water for injection
 - Reconstitute according to the manufacturers' specifications
- **Disposal of injection wastes and sharps properly**
 - Immediate disposal of needle and syringe in puncture- and leak-proof container
- **Disseminate public health education and information.**

6.9. Injection Devices and Their Safety Features

Syringes and needles are the major devices needed to provide injection and the following are used as standard types of syringes in healthcare facilities (see Table 6-4: Types of Injection Devices: Advantages and Disadvantages).

1. Auto disable syringe.
2. Manually retractable.
3. Automatically retractable.
4. Standard Disposable.

Both private and public health facilities should use the above listed syringe and needles to provide any type of injections. After injections syringe and needles should be disposed in to safety boxes.

Table 6-4: Types of Injection Devices: Advantages and Disadvantages

Type of Device	Advantages	Disadvantages
Auto-disable syringes	<ul style="list-style-type: none"> • Cannot be reused • They save time for healthcare workers from the burden of sterilization • Eliminate the patient-to-patient disease transmission caused by the use of contaminated syringes and needles 	<ul style="list-style-type: none"> • More expensive than standard disposable (but are still affordable) • Have no safety features • Need collection and disposal system
Manually retractable	<ul style="list-style-type: none"> • Cannot be reused • Safety feature: needle retracts inside barrel • They save time for healthcare workers from the burden of sterilization • Eliminate the patient-to-patient disease transmission caused by the use of contaminated syringes and needles 	<ul style="list-style-type: none"> • Not automatic; relies on good will of healthcare worker • More costly
Automatically retractable	<p>Cannot be reused. Automatic Safety feature: needle retracts inside barrel</p> <p>It saves time for healthcare workers from the burden of sterilization</p> <p>Eliminate the patient-to-patient disease transmission caused by the use of contaminated syringes and needles</p>	<ul style="list-style-type: none"> • Most costly

Standard Disposable	<ul style="list-style-type: none"> • Cheap • Available on local market. • They save time for healthcare workers from the burden of sterilization • Eliminate the patient-to-patient disease transmission caused by the use of contaminated syringes and needles 	<ul style="list-style-type: none"> • Can be reused without Sterilization • Have no safety features • Need sharps container or needle remover • Carry a high risk of infections
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Special Note:

- All patients undergoing an injection should be counseled before injection is given e.g. on the type of drug, side effects, possible adverse effects/events following the administration of the injection and total number of doses to be given by injection.
- Self-injecting patients such as diabetic patients should be properly informed about their medications and how to ensure safety or injection. In case a patient needs to take the injection equipment home, he/she should be counseled on the storage, disposal and sterility of their drugs and equipment.

6.10. Safe preparation and administration of injection

Practical guidance on use of safe injection devices

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

Use a new device for every patient, including for withdrawing medication. This practice is considered a very basic IPC precaution and is promoted by WHO (Safe Injection Global Network [SIGN]) and the US Centers for Disease Control and Prevention (CDC), among others. Figure 6-3 shows the “ONE and ONLY Campaign,” which advocates for one needle, one syringe, and only one use.

Figure 6-3: One and Only Campaign



Inspect the packaging of the device to ensure that the protective barrier has not been breached.

Discard the device if the package has been punctured, torn, or damaged by exposure to moisture, or if the expiry date has passed. (WHO 2010)

Practical guidance on handling parenteral medication

When giving medication:

- **ALWAYS** follow the one needle, one syringe, and one injection rule.
- **DO NOT** use a single-loaded syringe to administer medication to several patients even if you change the needle every time between patients. See Figure 6-1: Unsafe Injection Practices and Disease Transmissionin this chapter. (Always follow the one needle, one syringe, one injection rule.)
- **DO NOT** use the same mixing syringe and needle to reconstitute several vials. Figure 6-1: Unsafe Injection Practices and Disease Transmission, in this chapter.
- **DO NOT** combine leftover medications for later use.
- **DO NOT** use single-use vials for multiple patients, if at all possible.

When using single-use vials:

- Vials labeled by the manufacturer as “single-dose,” “single-use,” or “preservative-free” should be used only for a single patient.
- There may be circumstances when the contents of single-use vials must be used for multiple patients. In this situation, contents from an unopened single-use vial can be repackaged one time into multiple single-use syringes for multiple patients. However, this should be performed only by a trained HCW in an area away from patient care and in accordance with strict IPC standards. Label as described below. Store for only 24 hours.
- Check that you have the right medication vial for the patient’s prescription.
- Double-check the expiration date and if the vial has previously been opened, the current date is within 24 hours of opening (unless a shorter or longer time frame is otherwise specified by the manufacturer).
- Follow the principle of “**ONE SYRINGE, ONE NEEDLE, ONLY ONE TIME**”.
- Discard the single-use vial after use.

Discard a single-use vial:

- If sterility or content is compromised
- If the expiry date or time has passed
- If found to be undated, improperly stored, inadvertently contaminated, perceived to be contaminated, or already punctured, regardless of expiration date

When using multi-dose vials:

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

Discard a multi-dose vial:

- If sterility or content is compromised
- If the expiry date or time has passed (even if the vial contains antimicrobial preservatives)
- If it is not properly stored after opening, or within 28 days of opening, unless a shorter or longer time frame is otherwise specified by the manufacturer, or follow the manufacturer’s instructions for the time the vial can be used once opened

- If found to be undated, improperly stored, inadvertently contaminated, perceived to be contaminated, or has a visible hole in the rubber septum, regardless of expiration date, if thought to be a single-use rather than multi-dose vial

Practical guidance on setting up for preparing injections

Three steps must be followed when preparing injections

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

Procedure for vials with a rubber septum

Many vials have a rubber septum (stopper).

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

Reconstitution

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

Delay in administration

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

Labeling

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

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

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

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

Procedure for Pop-Open Ampoules

- Whenever possible, use vials with a rubber septum. If not available, use pop-open ampoules rather than ampoules that require use of a metal file to open. When opening glass ampoules, always protect fingers with a clean barrier, such as a small gauze pad (see Figure 6-4: Breaking Open an Ampoule).
- Pop-open vials cannot be stored for later use.
(Hutin et al. 2003)

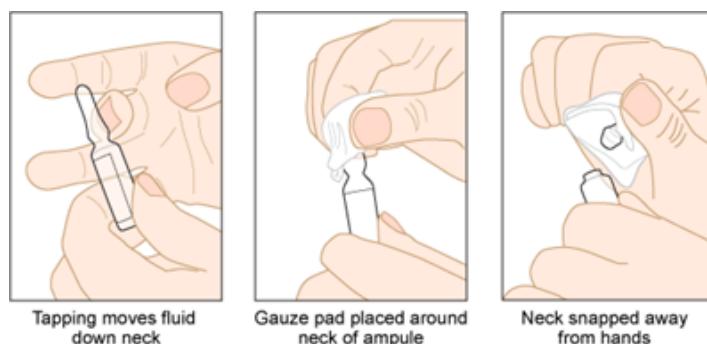


Figure 6-4: Breaking Open an Ampoule

Source: Doyle and McCutcheon 2015.

Safe Administration of Injections

- Aseptic techniques should be followed for all injections.

Practical guidance on administering injections

General

- When administering an injection:
 - Ensure that the patient is adequately prepared for and informed about the procedure.
 - Check the drug chart or prescription for the medication and the five “rights”: right patient, right drug, right dose, right route, right time.
 - Perform hand hygiene.
 - Wipe the top of the vial with 70% alcohol (isopropyl alcohol or ethanol) using a swab or cotton-wool ball. Allow it to dry.

- Open the package in front of the patient to reassure the person that the syringe and needle have not been used previously.
- Use a sterile syringe and needle to withdraw the medication from the ampoule or vial.

Important points

- **DO NOT** allow the needle to touch any contaminated surface.
- **DO NOT** reuse a syringe, even if the needle has been changed.
- **DO NOT** touch the rubber septum after disinfection with the 70% alcohol (isopropyl alcohol or ethanol).
- **DO NOT** re-enter a multi-dose vial with the same needle used for mixing or reconstituting medications.
- **DO NOT** re-enter a vial with a needle or syringe used on a patient if that vial will be used to withdraw medication again (whether it is for the same patient or for another patient).
- **DO NOT** use bags or bottles of intravenous solution as a common source of supply for injections (e.g., normal saline flushes) for multiple patients. These are not manufactured as multi-dose and do not have any preservative.

How to withdraw medication using an auto disable syringe

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

- Open the sterile pack containing the needle and syringe and attach the needle firmly.
- Remove the needle cap and insert the needle tip until it touches the bottom of the bottle as shown in Figure 5.5 (to avoid drawing air into the syringe, the needle tip should stay below the fluid level in the bottle).

- While holding the bottle with one hand, slowly pull back on the plunger of the syringe and draw up fluid to just above the fill line make (Figure 5.5). For the solo shot FX syringes used with DMPA, the “fill line” mark is at 1ml.

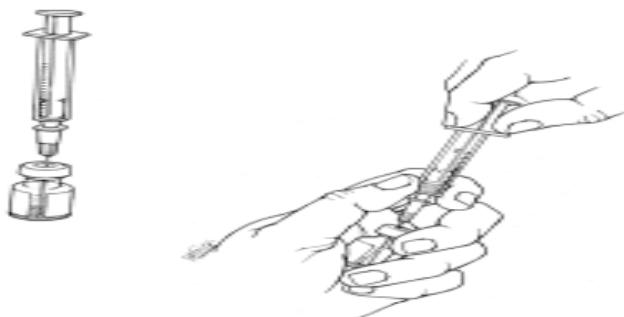


Figure 6-5: Withdrawing Medication Using an Auto-Disable Syringe

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

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

6.11. Sharps Safety

Safety or Sharps Boxes

Safety or sharps box is a puncture and leak-resistant container for disposal of sharps including hypodermic needles, needles from IV bags, lancets, scalpels and suture needles and it may be made of thick cards or disposable plastic bottles with narrow necks.

Categories of Sharps:

- Operating room- specific sharps requiring similar disposal include: surgical drain trocars, needle point cautery tips, wire sutures, orthopedic drill bits and a range of hollow injection.

- Special needles used by radiologists and anesthesiologists for various medical invasive procedures as well.
- Routine use needles and other sharps e.g. blades, pins.

Proper Management of Safety Box:

- Can be free-standing or fixed.
- Should be easily accessible to health worker for easy disposal of needles
- Should not be easily accessible for public
- Dispose when 3/4 full
- Use 1 per defined area of need.

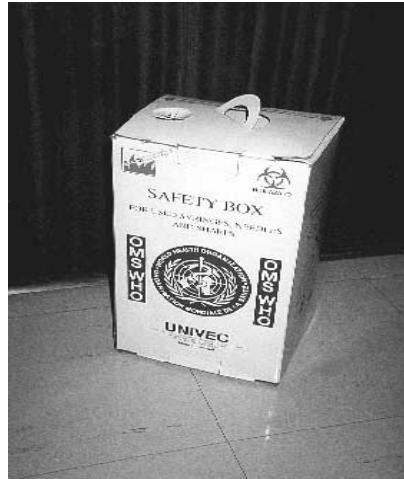


Figure 6-6: Standard Safety Box

Sharps containers-dos and don'ts:

- Do put sharps containers as close to the point of use as possible, ideally within arm's reach.
- Do attach containers to walls or other surfaces if at all possible.
- Do mark them clearly so that people will not unknowingly use them as for discarding other items.
- Do place them at a convenient height so staff can use and replace them easily.

- Do mark the fill line at the three quarters full level.
- Don't shake a container to settle its contents and make room for more sharps.
- Don't place containers in high traffic areas where people could bump into them or be stuck by someone carrying sharps to be disposed of.
- Don't place containers on the floor or anywhere they could be knocked over or easily reached by a child.
- Don't place containers near light switches, overhead fans or thermostat controls where people might accidentally put their hand into them.
- Do not put the following items on the sharp box: latex gloves, IV bags or extension tubes, dressing materials (like adhesive tape and gauze), compresses, cotton pads, empty vials and ampoule broken thermometers

Safe Disposal of Used Needles and Syringes

- Use of best practices can help to prevent sharps injuries to HCWs.

Other Sharps Safety Dos and Don'ts

- Do wear gloves when using needles
- Do discard needles with syringes and other sharps immediately after use
- Do discard needles and other sharps in sharps container
- Do not walk around with needles and other sharps
- Do use receivers to pass sharps to others and alert them before passing the sharps
- Do not remove break, bend manipulate, or manually remove needles before disposal.
- Do not recap needles after use but if a needle must be recapped, use a single-handed scoop technique.
- Do not leave sharps lying around the facility
- Do not point needles and other sharps at yourself or others

Summary

Injection safety is;

- An integral component of infection prevention and control,
- An element of Standard Precautions,

- Key element of patient and healthcare workers safety,
- Supported by infection prevention and control policies and procedures such as hygiene of the hand, housekeeping, and waste management.

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

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

Chapter Objective

The objective of this chapter is to equip participants with the required knowledge and skill in processing instruments and other items (before reuse) so as to reduce the transmission of infections during clinical procedures and patient care.



Learning objectives

By the end of this chapter, participants will be able to:

- ⊕ Understand General overview of sterile services
- ⊕ Describe the steps of instruments and other items processing
- ⊕ List commonly used disinfectants
- ⊕ Explain how disinfectant solutions are prepared
- ⊕ Elucidate the steps of cleaning process, sterilization and HLD
- ⊕ Explain how to store safely sterilized and high level disinfected instrument and other items

Chapter Content

- 7.1. Overview
- 7.2. Level of disinfection or serialization required
- 7.3. Guideline for processing items
- 7.4. Properties of an ideal disinfectant
- 7.5. Commonly used disinfectants
- 7.6. Disposal of used chemical containers
- 7.7. Description of steps in processing item
- 7.8. Monitoring sterilization procedure
- 7.9. Safe storage and transport of sterile/ HLD Instrument

7.1. Overview

- Instruments which are reused without being properly processed and made safe are one of the causes of infections in developing countries.
- Healthcare workers are increasingly at risk of becoming infected with serious blood borne viruses such as HBV, HCV and HIV. Some research findings showed that there are 8 to 16 million new infections of Hepatitis B annually due to unsterile injections in developing countries.
- On the other hand, it was found that HIV survives in needles and syringes for more than 4 weeks at room temperature.
- Thus, the greatest risk results from the staff's direct contact with these life threatening infections while they perform or assist with surgical procedures (physicians, nurses and midwives); process surgical instruments and equipment (staff); perform housekeeping and waste management tasks; including disposal of infectious waste items.
- The basic infection prevention processes recommended to reduce disease transmission from soiled instruments; surgical gloves and other reusable items are by way of cleaning and either sterilization or high-level disinfection (HLD). Regardless of the type of the operative procedures, the steps in processing surgical instruments and other items are the same.
- After completing an operation or invasive medical procedure or while still wearing gloves all reusable items should be cleaned at the point of use (soaked in a solution of warm water and detergent to prevent blood from drying on the surface of the items).
- Following pre-cleaning at the point of use, the instruments and reusable items are transported to instrument processing area, preferably centrally, where they should be thoroughly cleaned with soap and water and be completely rinsed and dried.

7.2. Level of Disinfection or Sterilization Required

- A rational approach for processing medical devices and surgical instruments for patient care was first described by Earle H. Spaulding more than 45 years ago (Spaulding 1968) and it is still relevant in making decisions about the final approach to instrument processing.

- Spaulding classified instruments and patient care devices into three categories, based upon how the device is used. Items are classified as:
 - Non-critical—come in contact with intact skin but not mucous membranes
 - Semi-critical—come in contact with mucous membranes or non-intact skin
 - Critical—come in contact with sterile areas of the body including the vascular system

Table 7-1: Spaulding's Risk Classification and Level of Processing

Risk category	Level of disinfection/sterilization	Examples
Critical	Sterilization	Reusable surgical instruments
Semi-critical	High-level disinfection	Respiratory instruments, specula used for vaginal examination ,endoscopes
Non-critical	Cleaning	Blood pressure cuffs, stethoscopes

7.3. Guidelines for Processing Items

- In all steps, special attention should be given to proper handling of the instruments and other items to minimize the risk of accidental injury or exposure to blood and other body fluids of the sterile processing staff and to attain high quality end result.
- Each item, be it soiled metal instruments or a pair of surgical gloves, requires special handling and processing in order to:
 - Minimize the risk of accidental injury or exposure to blood or body fluid to the cleaning and housekeeping staff; and
 - Provide a high-quality end product (i.e. sterile (if not available high-level disinfected instruments and other items).

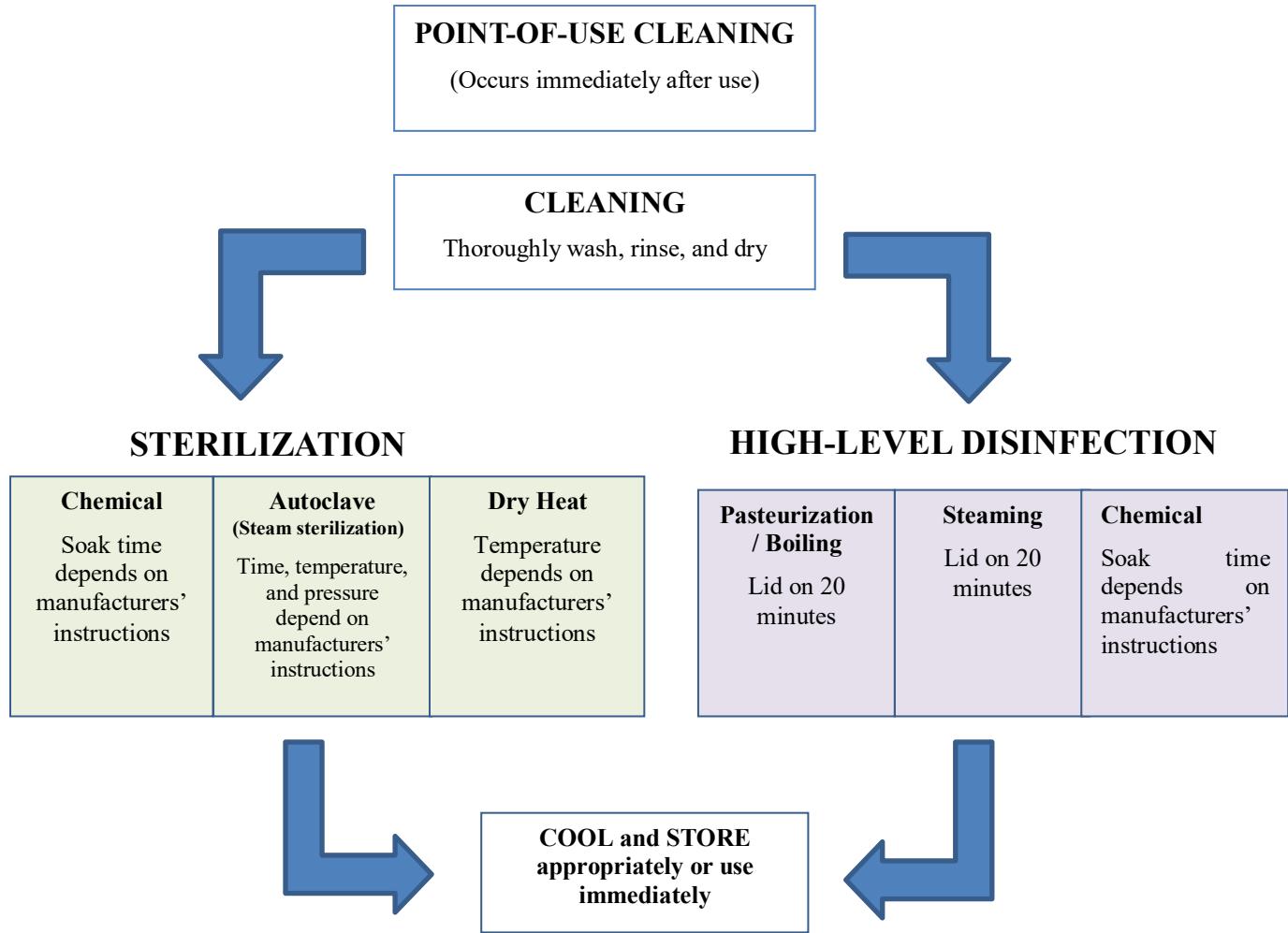


Figure 7-1: Work flow for instrument processing and other medical devices

7.4. Properties of an Ideal Disinfectant

- Wide antimicrobial spectrum
- Rapidly kills microorganisms
- Active in the presence of organic matter and compatible with soaps, detergents, and other chemicals encountered in use
- Non-toxic
- Does not cause the deterioration of cloth, rubber, plastics, and other materials
- Leaves an antimicrobial film on the treated surface
- Easy to use with clear label instructions
- Pleasant odor or no odor to facilitate its routine use

- Not prohibitively high in cost
- Soluble in water
- Stable in concentrate and at use-dilution
- Good cleaning properties
- Environmentally friendly on disposal

7.5. Commonly Used Chemical Disinfectants

List and Properties of commonly used chemical disinfectants in healthcare settings

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

ALCOHOLS

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

Advantages

- Rapidly kill all fungi and bacteria including Mycobacteria; Isopropyl alcohol kills most viruses including HBV and HIV while Ethyl alcohol kills all viruses; both are also tuberculocidal (Rutala, 1996).
- Rapid killing action
- Not corrosive to metal.

- Less costly in comparison with other disinfectants.
- Useful for soaking rubber or latex items occasionally.
- Leave no chemical residue and therefore do not require rinsing.

Limitation

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

Considerations for Use

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

CHLORINE AND CHLORINE RELEASING COMPOUNDS

Chlorine solutions - are fast acting, very effective against HBV, HCV and HIV/AIDS, relatively cheaper and readily available intermediate level disinfectants (CDC, 1987; WHO, 1989). A major disadvantage is that concentrated Chlorine solutions (>0.5%) can corrode metals.

NOTE: CHLORINE SOLUTIONS SHOULD NOT BE USED AS for HLD

Hypochlorite's are the most widely used chemicals among Chlorine disinfectants and are available in liquid (sodium hypochlorite) and solid (Calcium hypochlorite and Sodium dichloroisocyanurate) forms. Chlorine-releasing compounds available in powder (Calcium hypochlorite or Chlorinated lime) or tablet form (Sodium dichloroisocyanurate). (Rutala *et al.*, 1998).

Box 7-1: Effect of soaking instruments in chlorine solution

Soaking of instruments in disinfectant prior to cleaning

According to the WHO and PHAO, soaking of instruments in 0.5% chlorine solution or any other disinfectant prior to cleaning is not recommended for the following reasons:

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

FORMALDEHYDE

Formaldehyde in both liquid and gaseous forms can be used for a chemical sterilization, as well as a high-level disinfectant (Taylor, Barbeito & Gremillion 1969; Tulis, 1973). A commercially available solution of Formaldehyde (Formalin) which contains 35 to 40% formaldehyde by weight should be diluted with boiled water (1:5) to a final solution containing about 8% Formaldehyde. Despite its limitation, formaldehyde continues to be used in many countries because both liquid and solid forms (Para formaldehyde) are very cheap and readily available. Switching over to a less toxic compounds such as Glutaraldehydes or other newer high-level disinfectants, is strongly recommended but difficult to implement because of the high cost of these alternatives.

Note:

Formaldehyde is being used as a high level disinfectant as well as a sterilant in Ethiopia, but globally it's slowly being phased out because of its toxicity.

Advantages

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

Limitation

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

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

GLUTARALDEHYDE

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

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

Advantages

- Not readily inactivated by organic materials.
- Can generally be used for up to 14 to 28 days.

- Can safely be used on surgical endoscopes (laparoscopes) for they will not corrode metal or damage lenses instruments (endoscopes), plastics or rubber.

Limitation

- Can cause skin irritation or dermatitis with chronic exposure.
- Vapors are irritating to mucous membranes (eye, nose and mouth) and respiratory tract.
- Works best at room temperature (20 to 250C or 68 to 770F).
- Is costly.

ORTHOPHTHALALDEHYDE (OPA)

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

Once OPA solution is poured into the disinfection container, it can be used for 14 days as long as the solution concentration meets the minimum effective concentration. The concentration must be tested using the approved test strips provided by the manufacturer before the first use and then regularly to assure that the minimum concentration is met. The manufacturer recommends testing the solution prior to each use, and it should be done at a minimum daily. A log should be kept to document the quality control results. OPA must be used within 24 months of the date of manufacture. Unopened bottles should be stored in a cool, dry place. Once the bottle of OPA is opened, it must be discarded within 75 days or by the bottle expiration date, whichever date comes first. HCWs handling OPA must wear personal protective equipment (PPE), including gloves and face and eye protection. OPA stains unprotected skin gray.

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

After disinfection time, items are removed from the disinfection solution and rinsed. OPA requires three complete rinses in water for 1 minute each. Items that may come in contact with non-intact skin and mucous membranes may be rinsed with clean, potable water. If the water quality is not reliable, a final rinse with 70% isopropyl alcohol will help eliminate any microbes and speed the drying process. When used for HLD of endoscopes, all lumens and channels should be rinsed with 70% alcohol after the third water rinse to help dry the channels. If items are not rinsed properly, the residual OPA can cause staining of patients' and HCWs' skin.

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

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

IODINE AND IODOPHOR SOLUTIONS

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

Note:

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

Iodophors are not high-level disinfectants because conclusive evidence is lacking on their effectiveness against bacterial endospores and some fungi. For an instance, *Pseudomonas* species, a group of gram-negative bacteria, have been known to multiply in Iodophors

(Favero, 1985; Rutala, 1993). These solutions are generally nontoxic and nonirritating to skin and mucous membranes. Iodophors must be properly diluted to be effective. Interestingly enough, correctly diluted Iodophors have more active killing power than the full strength Iodophors due to the decreased availability of “free” Iodine in the latter.

Advantages

- They do not cause deterioration or softening of plastic items if they are kept dry between soakings.
- Diluted solutions of Iodine and Iodophors are nontoxic and nonirritating (unless there is known allergy to it).
- Can be used for disinfection of blood culture bottles and medical equipment such as thermometers.

Limitation

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

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

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

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

HYDROGEN PEROXIDE

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

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

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

The major limitation of this compound is that it is highly corrosive and should not be used to disinfect copper, aluminum, zinc or brass. It loses its potency rapidly when exposed to heat and light, it should be stored in a cool and dark place. WHO does not recommend using H_2O_2 in hot (tropical) climates because of its instability in the presence of heat and light (WHO, 1989).

OTHER CHEMICAL STERILANTS:

- **Paracetic acid (Peroxyacetic acid)** - the acid is rapidly acting and effective against all microorganisms. Unlike other similar compounds, its activity will not be impeded by organic matters on items to be sterilized and it decomposes into safe products. When diluted, it is very unstable and must be used with a specially designed automatic sterilizer

(APIC, 2002). It is usually used for sterilizing different types of endoscopes and other heat-sensitive instruments.

- **Para formaldehyde** - this solid polymer of formaldehyde may be vaporized by dry heat in an enclosed area to sterilize objects (Taylor et al., 1969). This technique, called “self-sterilization” (Tulis, 1973), may be suitable for sterilizing endoscopes and other heat-sensitive instruments.
- **Gas plasma sterilization (hydrogen peroxide based)** - this method can sterilize items in less than an hour and has no harmful by products. It does not penetrate well, however, and cannot be used on paper or linen. A specialized sterilizer is required for performing gas plasma sterilization (Taurasi, 1997).

7.6. Disposal of Used Chemical Containers

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

Disposal of Used Chemicals

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

PRODUCTS NOT TO BE USED AS DISINFECTANTS

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

Antiseptics that should not be Used as Disinfectants are:

- Acridine derivatives (e.g. gentian or crystal violet)
- Cetrimide (e.g. Cetavlon®)
- Chlorhexidine gluconate and cetrimide in various concentrations (e.g. Savlon)
- Chlorhexidine gluconate (e.g. Hibiscrub®, Hibitane®)
- Chlorinated lime and Boric acid (e.g. Eusol®)
- Chloroxylenol in alcohol (e.g. Dettol®)
- Hexachlorophene (e.g. PhisoHex®)
- Mercury compounds

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

Storage of Disinfectants

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

7.7. Description Steps in Processing Items

Cleaning

Cleaning is a critical step in instrument processing because:

- It reduces damage to instruments. At the end of a clinical or surgical procedure, surgical instrument and equipment are contaminated with tissue particles, body fluids, and blood. Long contact with blood is corrosive and can damage surgical instruments.
- It makes instruments easier to process. Once blood dries on an instrument, it is difficult to clean, especially if the blood has entered the hinges and sockets.

- Bioburden and residual cleaning agents remaining on an item can inactivate chemical disinfectants or sterilants and protect microorganisms from destruction, which can result in disinfection and sterilization failures.
- And also instruments and materials used during an operation that are covered with blood and tissue remains may also have been in touch also with chemicals and fluids, dirt and dust.
- Hinged instruments may have remnants of blood and tissue from the operation. The tubing of hollow instruments may be also full of these soiled materials.
- Therefore, it is important to follow all the necessary steps to properly clean instruments prior to high-level disinfection or sterilization.
- Before transport to the instrument processing area, HCWs should perform point-of-use cleaning— wiping instruments to remove tissue and blood immediately at the conclusion of the procedure.
- Once instruments are in the instrument processing area, cleaning involves thorough cleaning of them with water and a detergent and/or an enzymatic cleaner followed by thorough rinsing, and then drying before further processing.
- Cleaning is a process of physically removing infectious agents and other organic matters on which they live and thrive but does not necessarily destroy infectious agents.
- It is an essential pre-requisite to ensure effective disinfection or sterilization by reducing the number of microorganisms, especially endospores causing tetanus usually found on soiled instruments and equipment.
- Neither sterilization nor high level disinfection could be effective without prior cleaning.
- **Cleaning is the first step in reprocessing a device after use**
- Failure to properly clean an instrument may allow foreign material (e.g. soil and organic materials, including microorganisms) located outside and inside of the device to hinder disinfection and/or sterilization.
- Cleaning is accomplished by using a manual process with cleaning chemicals (detergent) and water, brushing or flushing and thoroughly cleaned prior to disinfection or sterilization, irrespective of available resources.
- **One can clean without sterilizing, but one cannot sterilize without cleaning!**

Table 7-2: Effectiveness of Methods of Processing Instruments

METHOD	EFFECTIVENESS (kill or remove microorganisms)	END POINT
Cleaning (soap and rinsing with water)	Up to 80%	Until visibly clean
High-Level Disinfection	95% (does not inactivate endospores)	Boiling or chemical for 20 minutes
Sterilization	100%	High-pressure steam, dry heat or chemical for the recommended time

- A study showed that following the standard cleaning, most non lumen surgical instruments are found to contain less than 100 colony-forming units (CFU) consisting of relatively non-pathogenic microorganisms (Rutala et al., 1998). This study confirmed that **thorough cleaning is more effective** than was previously assumed and documented the importance of cleaning in producing the desired safe outcome of surgery.
- Thorough rinsing with clean water removes any soap residue that can interfere with sterilization or HLD.
- After rinsing, items should be dried especially if they will be sterilized or high-level disinfected using chemical disinfectants

Steps of manual cleaning:

1. Put on Personal Protective Equipment (PPE) including a water resistant gown, gloves, face mask and head cover.
If gloves are torn or damaged, they should be discarded; otherwise, they should be cleaned and left to dry for re-use in the following day.
Even when wearing heavy-duty utility gloves, care should be taken to prevent needle sticks or cuts when washing sharps.
2. Fill sink or appropriate basin with sufficient warm water for complete immersion of the devices being cleaned.

3. Add the appropriate quantity of detergent following the manufacturer's instructions for dosage.
4. Clean the device under the surface of the water so that aerosols are not produced.
5. All devices be disassembled so that all surfaces may be cleaned and disinfected, irrespective of the cleaning method chose.
6. Use appropriate brushes to properly clean box locks, lumens and other hard-to-clean areas
 - A. Use soft (nylon) bristle brushes so that the surface of the instrument is not damaged.
 - B. Brushes used to clean lumens must be the same diameter as the instrument to ensure that all internal surfaces can be reached.
 - C. Brushes must also be long enough to exit the distal end of the instrument

NOTE

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

7. In another sink or basin, completely immerse the device in clean purified water and rinse the device thoroughly.
8. Air-dry or hand-dry using a disposable clean, non-linting cloth.
9. Items that cannot be cleaned thoroughly should not be reused, but be discarded after use.

Summary of cleaning:

- Surgical instruments should be disassembled to allow effective cleaning
- Physical cleaning reduces the bioburden or the microbial load sufficiently to allow the process of sterilization or high-level disinfection to be effective
- Dirt protects microorganisms from contact with the disinfectants, steam and other chemicals, thereby rendering the process ineffective
- Some chemicals used for reprocessing devices are inactivated in the presence of organic matter

- Some chemicals used for reprocessing are inactivated when mixed with other chemicals (incompatible)
- The life of the instruments is prolonged if soil and debris are removed regularly

Cleaning Products:

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

Properties associated with ideal cleaning agents:

- Emulsification
- Surfactation
- Dispersion and suspension
- Water softening
- Free rinsing
- Non-toxic

Selection of cleaning agents

- Deposits of dust, soil and microbial residue on equipment can contribute to healthcare-associated infections. Cleaning agents remove organic, inorganic and microbial contaminants. No single compound has all the properties that are required to remove all soil deposits. The first step in cleaning is the use of surfactants or surface-active agents to reduce tension, which assists in soil being held in the cleaning solution.
- Example:- **Enzymatic (Proteolytic) Cleaners**
If blood has dried or hardened, soaking in a warm solution of an enzymatic cleaner is required. Cleaning agents containing enzymes to break down proteinaceous matter may be used for sensitive equipment if the equipment manufacturer approves their use.

Summary of recommendations

- Disposable sharps shall be disposed of in an appropriate, puncture-resistant, sharps container at the point of use prior to transportation

- Soiled medical devices shall be handled in a manner that reduces the risk of exposure and/or injury to staff/visitors/patients/residents or contamination of environmental surfaces
- Contaminated devices shall not be transported through areas designated for the storage of clean or sterile supplies, visit/patient/resident care areas of high-traffic areas
- Sterile and soiled devices should not be transported together
- Reusable medical devices must be thoroughly cleaned before disinfection or sterilization
- If cleaning cannot be done immediately, the medical device should be pre-treated to prevent organic matter from drying on it.
- The process for cleaning (decontamination) should include written protocols for disassembly, sorting, pre-treatment, physical removal of organic material, rinsing and drying

Preparation and Packaging for Reprocessing

- The inspection, assembly and packaging of reusable surgical instruments and medical devices is a crucial part of the reprocessing cycle.
- All instruments and other items should be thoroughly cleaned and dried before being disinfected or prepared for sterilization.
- In some cases, it is not necessary to completely dry the items (needles or the like which have small openings) being sterilized for the small amount of water left inside these openings help in the steam sterilization process.
- For such items, flushing them with distilled or boiled water just prior to packaging for steam sterilization should be done after cleaning.
- Finally, **all jointed instruments should be open (or be unlocked) and disassembled.** Reusable cloth items should be laundered and dried after use or prior to sterilization in order to:
 - Remove organic matter, and
 - Prolong the life of the cloth by restoring the fabric's normal moisture (water) content.

Inspection and Function Testing (Post-Cleaning)

- Each set should be inspected separately
- Box joints, serrations and crevices should be critically inspected for cleanliness
- Hinges on devices, such as artery forceps and clamps, should be checked for ease of movement
- Jaws and teeth should be checked for alignment
- Ratchets should be checked for security
- Multi-part instruments should be assembled to ensure that all parts are complete and working
- Multi-part instruments should be assembled or disassembled for sterilization per manufacturers' instructions.
- Any damaged, incomplete or malfunctioning devices should be reported immediately to the supervisor.
- Cutting edges on devices, such as scissors, rongeurs, chisels and curettes, should be checked for sharpness.
- Hinges on devices, such as artery forceps and clamps, should be checked for ease of movement.
- Each device should be checked after each cleaning cycle to ensure that all screws on jointed devices are tight and have not become loose during the cleaning process.

Packing and Wrapping for Steam Sterilization

Wrapping items to be sterilized permit sterile items to be handled and stored without being contaminated (See Figure 7-2: Typical Wrapping Techniques for typical wrapping techniques).

Materials used for wrappers should:

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

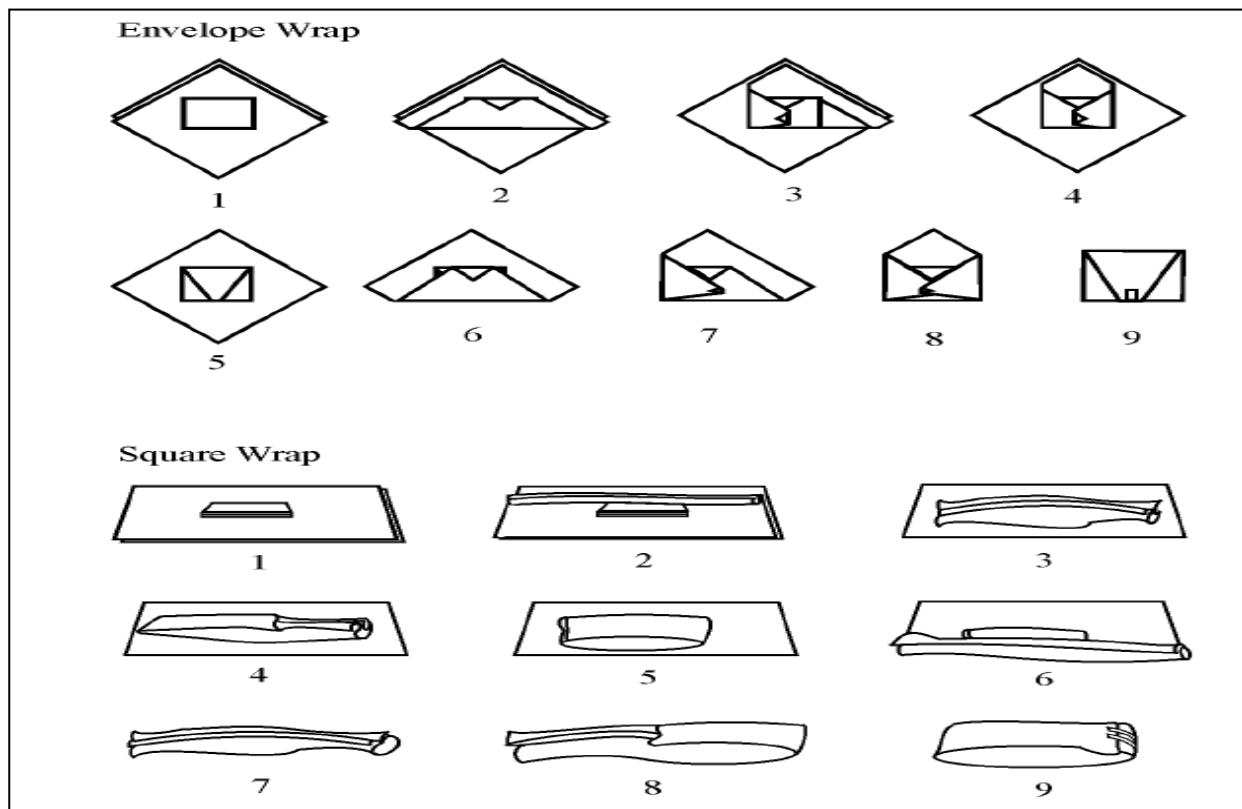


Figure 7-2: Typical Wrapping Techniques

Types of materials that can be used as wrappers include:

- **Muslin cloth (140 thread count)** - use two double thicknesses wraps (four layers in all) as this is the least effective of all materials used for wrapping.

Paper - double wrapping (two layers) is recommended. Use it for steam sterilization only and avoid reuse.

Tips for wrapping

- At least two layers of wrapping should always be used to reduce the possibility of contaminating the contents during unwrapping.
- Do not wrap packages too tightly.
- If they are wrapped too tightly, air can become trapped at the center of the packages preventing the temperature from getting high enough to kill all the microorganisms.
- Also, wrapping with strings or rubber bands or tying linen too tightly can prevent steam from reaching all surfaces.

- The outer wrapper of the pack can be loosely secured using linen ties.
- Packs can be secured with linen ties made from the same cloth.
- Hemmed strips of about $\frac{1}{2}$ inch wide and of varied lengths.
- One or two of such strips can be used for each package. Because they can fit to almost any size of package, they eliminate the need for an expensive and hard-to-remove indicator tape.
- Do not wrap items in any waterproof material such as plastic or canvas for steam sterilization as the steam cannot penetrate the material and leave the item unsterilized.
- Wrappers should not be reused if they are torn, stained with oils or have hard or gummy deposits.

Packing and Wrapping For Dry Heat Sterilization

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

Packaging Materials for Dry-Heat Sterilizer

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

High-Level Disinfection

- Sterilization is the safest and most effective method for the reprocessing of surgical instruments because it kills all vegetative microorganisms and microbial spores.

- However, sterilization is not always suitable because some materials cannot withstand the high temperatures used during the sterilization process and sterilization may not be consistently available in some low-resource settings.
- There are three levels of disinfection: low-level, intermediate-level, and high-level.
- The level of disinfection needed is based on how the item will be used.
- Per the Spaulding classification, devices that come in contact with intact skin are classified as non-critical items and should be processed by intermediate- or low-level disinfection.
- Surgical instruments and medical devices that come in contact with non-intact skin or mucous membranes (classified as semi-critical devices) must, at a minimum, be high level disinfected, though sterilization is always preferable when possible.

High-Level Disinfection can be achieved by:

- Pasteurization/ Boiling in water,
- Steaming
- Soaking instruments in chemical disinfectants (chemical disinfection).
- To be effective, all steps in performing each method must be monitored carefully. Essentially all vegetative forms of bacteria are killed by moist heat at temperatures of 60 to 75°C within 10 minutes (Salle, 1973).
- Hepatitis B virus, which is one of the most difficult viruses to kill, is inactivated in 10 minutes when heated to 80°C (Kobayashi et al., 1984; Russell et al., 1982).
- Even though many types of spores can be killed when boiled at 99.5°C for 15 to 20 minutes (Williams & Zimmerman, 1951), Clostridium tetani spores are quite heat-resistant and can survive even boiling for up to 90 minutes (Spaulding, 1939).

Boiling Versus Steaming

- In both boiling and steaming, moist heat is used to kill microorganisms.
- Steaming has several distinct advantages over boiling for the final processing of surgical gloves and other items such as plastic cannula and syringes.
- It is less destructive and more cost-effective for it uses much less fuel than boiling.

- For example, only about a liter of water is needed to steam gloves or instruments, whereas 4 to 5 liters are required for boiling.
- Besides, it is free from discoloration of instruments resulting from calcium or other heavy metals contained in some tap water for the steam contains only pure water molecules.
- Finally, although boiling and steaming gloves are equally easy to do, drying boiled gloves is not practical because it is difficult to prevent contamination while they are being dried in the open air.
- If steaming is instead opted to, they remain in the closed steamer pan which results in little or no contamination of gloves.
- The major limitation of steaming is that if the steamers available locally are small, they can practically be used only for a small number of items (e.g. one set of instruments or 15 to 20 pairs of surgical gloves) per tray or pan.
- For steaming to be effective, the bottom pan must contain enough water to continue boiling throughout the steaming process.
- By contrast, large boiling pots are easier to use for metal instruments and do not need to be monitored the entire time to be sure that the process is being done correctly.
- Both boiling and steaming share some advantages and limitations over chemical high-level disinfection which is the only other method of HLD.

Advantages

- Inexpensive procedures.
- Easily taught to healthcare workers.
- Require no special chemicals or dilutions and leave no chemical residue.
- Heat sources (boilers or rice cookers) are commonly available.

Limitation

- Length of processing time must be carefully measured (i.e. start timing only after the steam begins to escape or water has reached a rolling boil). Once timing starts, no additional items or water can be added.

- Objects cannot be packaged prior to HLD; therefore, there is a greater chance of contamination if items are to be stored.
- Requires a fuel source that may be unreliable.

High-Level Disinfection by Boiling

- **Pasteurization** can be used to achieve HLD of instruments and medical devices. It is carried out by heating at 77°C (170.6°F) for 30 minutes or boiling at 100°C (212°F) for 20 minutes.
- **Boiling** has been a common practice for HLD of instruments and equipment used for semi-critical and sometimes critical procedures as it was the only available option in some low-income countries.
- **Pasteurization/ Boiling** in water is an effective and practical way to high-level disinfect instruments and other items. Although boiling instruments in water for 20 minutes will kill all vegetative forms of bacteria, viruses (including HBV, HCV and HIV), yeasts and fungi; it will not kill all endospores reliably.

Instructions for HLD by Boiling

STEP 1 Clean all instruments along with other items to be high level disinfected.

STEP 2 If possible, completely immerse items in the water. Adjust the water level so that there is at least 2.5cm (1 inch) of water above the instruments.

Further, make sure that all bowls and containers to be boiled are full of water. For example, one needs to empty bowls that turned bottom side up and float on the surface containing air pockets.

STEP 3 Close-lid over pan and bring water to a gentle rolling boil. Boiling too vigorously wastes fuel, rapidly evaporates the water and may damage delicate [or sharp] instruments or other items.

Hence, a gentle rolling boil is sufficient and will prevent instruments or other items from being bounced around and possibly damaged by striking other instruments or the side walls of the boiling pot.

STEP 4 Start timer. In the HLD log, note time on the clock and record the time when rolling boil begins.

STEP 5 Boil all items for the required time: 30 minute at 77°C (170.6°F) or 20 minutes at 100°C (212°F).

STEP 6 Remove all items after the recommended time with a high-level disinfected forceps.

Never leave boiled instruments in the water that has stopped boiling. Because, as the water cools and the steam condense, air and dust particles are drawn down into the container and may contaminate those instruments (Perkins, 1983).

STEP 7 Use instruments and other items immediately or else, pick them up with high-level disinfected forceps or gloves and place objects in a high-level disinfected container with a tight-fitting cover.

If any pooled water remains in the bottom of the container, remove the already dried items and place them in another high-level disinfected container that is dry and can be tightly covered.

Tips on Boiling

- Always boil for the required time period in a container with a lid.
- Start timing when the water begins to boil.
- Metal instruments should be completely covered with water during boiling.
- Do not add anything to the pot after timing begins.

High-Level Disinfection by Steaming

Materials needed for high-level disinfection by steaming include:

- Steamer pan without holes to hold water (such as momo steamer)
- Two to three additional pans with holes to allow steam to move to upper pan
- The pans should be deep enough to fit the largest item being steamed
- A tight-fitting lid to cover the upper pan
- An additional bottom pan for drying the processed items

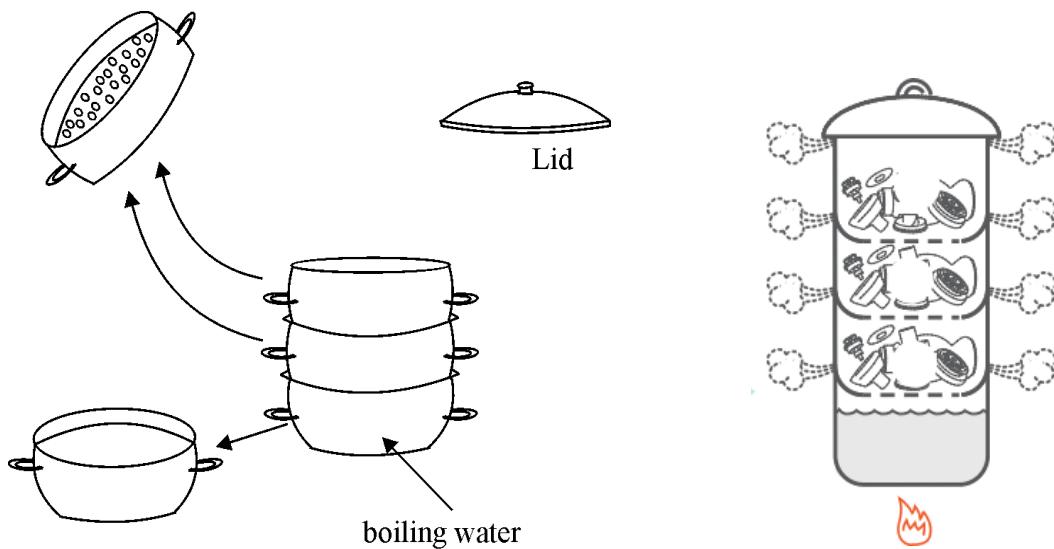


Figure 7-3: Steamer Used for HLD

Instructions for HLD by Steaming

After instruments and other items have been thoroughly cleaned, they are ready for HLD by steaming.

STEP 1 Perform hand hygiene and

STEP 2 Fill the bottom pan of the steamer with approximately 1 liter of clean water – about half the volume of the pan

STEP 3 Place instruments, plastic MVA cannula and other items in one of the steamer pans with holes in its bottom (**Figure 8.3**).

To make removal from the pan easier, do not overfill the pan.

Repeat this process up until three steamer pans have been filled. Stack the filled steamer pans on top of a bottom pan containing water for boiling. A second empty pan without holes should be placed on the counter next to the heat source (**see Step 7**)

STEP 4 Place a lid on the top pan and bring the water to a full rolling boil.

It should be noted that when water only simmers, very little steam is formed and the temperature may not get high enough to kill microorganisms.

STEP 5 When steam begins to come out between the pans and the lid, start the timer or note the time on a clock and record the time in the HLD log.

STEP 6 Steam items for 20 minutes.

STEP 7 Remove the top steamer pan and put the lid on the pan that was below it (the pan now on top). Gently shake excess water from the pan just removed.

STEP 8 Put the pan just removed onto the empty pan (see Step 3). Repeat until all pans are restacked on this empty pan and cover the top pan with the lid. This step allows the items to cool and dry without becoming contaminated.

STEP 9 Allow items to dry in the air while in the steamer pans (1 to 2 hours) before using.

STEP 10 Using a high-level disinfected forceps; transfer the dry items to a dry, high-level disinfected container3 with a tight-fitting cover.

Instruments and other items can also be stored in the stacked and covered steamer pans as long as a bottom pan (with no holes) is used.

High-Level Disinfection Using Chemicals

- Although a number of disinfectants are commercially available in most countries, four disinfectants- OPA, Glutaraldehydes, Formaldehyde and Peroxide-are routinely used as high- level disinfectants.
- These chemicals can achieve high-level disinfection if the items being disinfected are thoroughly cleaned before immersion.
- A high-level disinfectant should be selected for use based on the characteristics of the items to be disinfected, the physical area (i.e. whether it is well ventilated) and the skills of personnel available to do the procedure.

Key Steps in Chemical High-Level Disinfection

- Thoroughly Clean instruments and other items that may have been contaminated with blood and body fluids and thoroughly clean and dry them before placing them in the disinfectant solution.
- Completely immerse all items in the high-level disinfectant.
- Soak them for 20 minutes.
- Remove items using high-level disinfected or sterile forceps or gloves.
- Rinse well with boiled and filtered (if necessary) water three times and air dry.
- Use promptly or store in a dry, high-level disinfected and covered container.

How to Prepare an HLD Container

- **For small containers**, boil water in the covered container for 20 minutes; then pour out the water which can be used for other purposes; replace the cover; and allow the container to dry.
- **For large containers**, fill a plastic container with 0.5% chlorine solution and immerse the cover in chlorine solution as well. Then soak them for 20 minutes. Thereafter, rinse the cover and the inside of the container three times with boiled water and allow them to dry in the air. Note that large metal containers cannot be HLD using chemicals.

Factors That Affect Disinfection Process

- Quantity and location of the microorganisms
- Quantity and location of organic matter
- Concentration of the disinfectant
- Physical and chemical factors
- Duration of exposure
- Resistance of microorganism to the chemical agent

Sterilization

- Sterilization is a process in which the destruction of all micro-organisms including bacterial endospores takes place.
- This can be achieved by either physical or chemical methods and is necessary especially for medical devices penetrating sterile body sites or having direct contact with the blood (Spaulding, 1939).
- Sterilization in health facilities can be achieved by high pressure steam (autoclaves), dry heat (oven), chemical sterilants (Glutaraldehyde or formaldehyde solutions) or physical agents (radiation).

Note:

- Rinsing an item with Alcohol and then igniting it with a match (flaming) is not an effective method of disinfection or sterilization.

Essentials of Sterilization Process:

1. The sterilants and sterilizing equipment must be validated and appropriate in design and operation to correctly integrate key yardsticks like: time, temperature, contact, pressure (for steam sterilization) and right sterilants (for chemical sterilization) to be as effective as they should be.
2. Instruments must be thoroughly cleaned to reduce dirt in order to guarantee effectiveness of the sterilization process.
The higher the dirt the greater the challenge to the sterilization process. Therefore, it could be said that the effective sterilization is entwined with an effective removal of the dirt before making it ready for sterilization.
3. There must be close and adequate contact between the chemical sterilant and all surfaces and crevices of the device to be sterilized.

The Effectiveness of any Sterilization Method is also dependent Upon Four Other Factors:

1. The type of micro-organism present.
2. The number of micro-organisms present.
3. The amount and type of organic material that protects the micro-organisms. Blood or tissue remaining on poorly cleaned instruments acts as a shield to microorganisms during the sterilization process.
4. The number of cracks and scratches on an instrument that might harbor micro-organisms.

Important Reminder:

- Sterilization is a process, not a single event; therefore, all phases and steps in the process must be carried out correctly.

Method of Sterilization

1. High Pressure Steam Sterilization (Autoclaves)
2. Dry-heat sterilization (oven)
3. Chemical Sterilization

Standard Conditions for Steam Sterilization

- Steam sterilization (Gravity): In the usual practice, the temperature in steaming process should be 1210C (2500F) and its pressure, 106 kPa (15 lbs/in²) the time being 20 minutes for unwrapped items; and 30 minutes for wrapped items.
- As an alternative, it could be set at a higher temperature of 1320C (2700F) with the pressure of 30lbs/in²; and the duration being 15 minutes for wrapped items.
- Whatever the case may be, one should allow all items to dry before removing them from the sterilizer.

Note:

Pressure settings (kPa or lbs/in²) may vary slightly depending on the sterilizer used. When possible, follow manufacturers' recommendations.

Remember:

- Exposure time begins only after the sterilizer has reached the target temperature.
- Do not overload the sterilizer (Leave at least 7.5 cm [3 inches] between the items and walls of sterilizer). Overloading alters heat convection and increases the time required to sterilize.

High Pressure Steam Sterilization (Autoclaves)

- Steam Sterilization is generally considered the method of choice for sterilizing instruments and other items used in healthcare facilities.
- In settings where electricity is a problem, instruments can be sterilized in a non-electric steam sterilizer using kerosene or other fuel as a heat source.

Rationale of Steam Sterilization:

- Saturated steam is an extremely effective carrier of thermal energy that makes it many times more effective in conveying the necessary energy to the items to be sterilized than dry air.
- Steam is an effective sterilant in that it can soften any resistant and protective outer layer of the micro-organisms allowing coagulation of the inner sensitive portion of the micro-organisms.

Advantages

- Most commonly used effective method of sterilization.
- Sterilization cycle time is shorter in steam sterilization than in any other type of sterilization.

Limitation

- Requires a continuous source of heat (wood fuel, kerosene or electricity).
- Requires a trained biomedical technician to perform preventative maintenance.
- Requires strict adherence to time, temperature and pressure settings.
- Difficult to produce dry packs because breaks in procedure are common (e.g. not allowing items to dry before removing, especially in hot, humid climates).
- Repeated sterilization cycles can cause pitting and dulling of cutting edges of instruments i.e. scissors).
- Plastic items cannot withstand high temperatures.

There are three types of high-pressure steam sterilizers:

- Gravity displacement
- Prevacuum
- Flash or Immediate use sterilizers (IUS)

Operation

- Instructions for operating on the steam sterilizers (autoclaves) and its routine maintenance should be included in the basic training of healthcare staff.
- A steam sterilizer will reliably sterilize items only when kept in good working condition and operated correctly.
- Sterilization by steam requires four conditions: adequate contact, sufficient temperature, proper time and sufficient moisture.
- Even if these conditions are all necessary for sterilization to take place, sterilization failures in clinics and hospitals are most often caused by lack of steam contact or failure to attain adequate temperature (Webb, 1986).

Contact

- The most frequent reason for sterilization failure is the lack of contact between the steam and the microorganisms.
- This failure may be related to human error or mechanical malfunction. Frequent causes of steam contact failure include the following:
 - Failure to clean the object being sterilized adequately.
 - Instruments which are closed locked or stacked.
 - Packages wrapped too tightly.
 - Packs which are over staffed.
 - Wrong position of container.
 - Clogged strainer.
 - Other mechanical problems

Temperature

- The next most important factor in steam sterilization is temperature.
- The most commonly used temperature for steam sterilization is 1210C (2500F).
- When an object at room temperature is placed in a sterilizer, the steam transmits thermal energy to the object until the object reaches the same temperature as the steam.
- Under normal circumstances, this equilibrium occurs within a few minutes.

- If the steam is unsaturated (too dry) or if the steam is prevented from reaching all parts of the object, the temperature may never reach the level required for sterilization.
- The only way to be certain that the sterilizer is working correctly is, to make sure that the temperature at all points inside the load has reached the full operating temperature of 121°C (250°F).

Timing

- Just as it takes a certain amount of time to cook food, sterilization/killing micro-organisms/does need time to do the work.
- In both cases, the hotter the temperature, the less time is required.
- Sterilization time is measured in D-values.
- A D-value is the amount of time required to kill 90% of the microorganisms present.
- Different microorganisms are killed in different scales/measures of time.
- In other words, each kind of microorganism has a different set of D-values corresponding with certain measure/level of temperature.

Moisture

- Adequate moisture content of the sterilizer atmosphere is mandatory for effective sterilization by steam.
- Adequate moisture content implies that the steam must be “saturated” having a relative humidity of 100%. When any cool object is placed in the sterilizer, the steam at the surface of the object cools and becomes supersaturated. Water begins to condense on the surface of the object. This condensation produces two immediate effects:
 - The volume of gas in the sterilizer chamber decreases as the steam (water vapor) changes to liquid state and more steam is drawn into the chamber and hence comes in to an increased contact with the articles being sterilized.
 - Very large amount of thermal energy is transferred to the object raising the temperature of the article significantly.

The amount of heat released is best explained by comparing the calories required to change the temperature of steam against the calories absorbed when water is converted to water vapor (steam).

- If the steam is not saturated (less than 100% relative humidity), two problems will soon develop which individually or together interfere with the adequacy of the sterilization process:
 - Articles in the sterilizer will remain dry and the microorganisms present cannot be killed as readily as under wet conditions (Water vapor softens the capsules of microorganisms making them more vulnerable to destruction by heat).
 - Articles in the sterilizer will remain “cool” much longer especially if they are wrapped. Again using the home kitchen as an example, if a kettle of beans is placed in an oven (dry heat), it may take hours for them to be cooked. On the other hand, if they are placed in a pressure cooker (saturated steam) they will cook them much more quickly. Saturated steam is a much better “carrier” of thermal energy than dry air.
- In summary, saturation of the steam is vital to sterilizer operation because water vapor is the best carrier of thermal energy which at times make the microorganisms more vulnerable to destruction by heat (Webb, 1986).

Effective Sterilization Depends On Correctly Following Procedures of the Process

These include:

- Routine maintenance,
- Preparing items to be sterilized,
- Packaging and wrapping,
- Loading,
- Operating, and
- Unloading the sterilizer.

Routine Maintenance

- The outlet screen (or pin-trap) should be removed daily and cleaned using a mild soap and brush under running water.
- The chamber should be cleaned daily using a soft cloth, or for large sterilizers, a long-handled mop which is used only for this purpose. Do not use abrasives or steel wool because they may scratch the stainless steel surface and increase the occurrence of corrosion.
- All door gaskets should be cleaned daily with a lint-free cloth and checked for defects. Defective rubber gaskets should be replaced.
- The carriage (loading cart used to hold the packs placed in a sterilizer) should be cleaned daily using a mild soap and lint-free cloth.
- The exhaust line (or chamber drain) should be flushed weekly. This will keep the drain free of substances that might hinder air or steam removal from the chamber (should be done with caution, For cleaning procedure Refer the IPC National Reference Manual).

Loading and Unloading

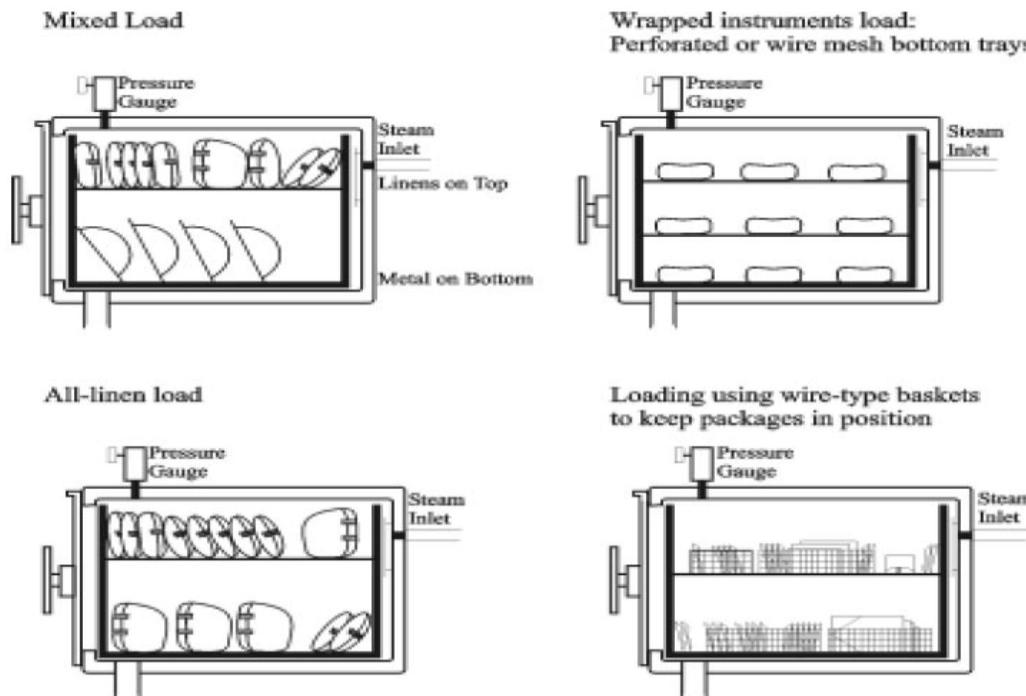
Objectives

- To load items into the autoclave in such a way that it allows passage of the most steam through the load.
- To unload the steam autoclave so as to maintain the sterility of the items processed through a sterilizing cycle.

General Principles

- The total weight of an individual pack should not exceed 11 kg (24 pounds).
- When loading, leave sufficient space for steam to circulate freely and avoid overloading. Always leave 3 inches between the top-most pack and the top of the chamber. Items should not touch the chamber wall. Never overload the sterilization chamber.
- Do not place packages on the floor of the chamber.
- Place all packs (linen, gloves, etc) on edge and place canisters, utensils and treatment trays on their sides.

- Place instrument sets in trays having mesh or perforated bottoms flat on the shelves.
- In combination loads of cloth (or paper) packs and instruments trays, place linens on top shelves and trays on lower shelves. This prevents any condensation (moisture) which forms on cool metal when steam initially contacts with the item from dripping onto linen packs
- Load packages containing similar types of item in one load, when possible. For example, all textile packs should be sterilized in one cycle
- Nested packs should be positioned in the same direction to help prevent air pockets so that the condensation can drain and the steam can circulate freely. Shelves (metal wire) or a loading cart must be used to ensure proper loading. It is preferable to use the cart that comes with the sterilizer. See Figure 7-4: Loading Steam Sterilizer



Source: AAMI 1990.

Figure 7-4: Loading Steam Sterilizer

- The fundamental rule in loading the sterilizer is to prepare all items and arrange the load in such a manner as to encounter the least possible resistance to the passage of steam through the load (i.e. from the top of the chamber toward the bottom).

Unloading Tips

- Open the sterilizer door slightly 12-14 cm (5-6 inches) at the end of the cycle (when the chamber gauge reaches “0”) and allow items to remain inside to reduce the potential for condensation (formation of water drops on the packages).
- Allow instrument packs to dry completely before removal (usually takes 30 minutes). Cooling time could be as long as 2 hours, based on room temperature and humidity.
- Wet packs are never acceptable.
- Return any pack that is wet for reprocessing (remove items from the package and repackage before reprocessing).
- Do not handle the packs during the cooling time
- Place sterile trays and packs on surfaces padded with paper or fabric (avoid placing warm packs on cold metal surfaces so as to prevent condensation).
- Store when packs reach room temperature (usually takes about an hour).
- Sterilized packs and articles should be handled gently and used as reasonably as possible.
- Return any pack that drops on the floor for reprocessing (remove items from the package and repackage before reprocessing).
- **If a pack is dropped, turns to be moist or comes into contact with moisture, it must be considered contaminated.**

Instructions of Operating a Steam Sterilizer

STEP 1 Thoroughly clean and dry all instruments and other items to be sterilized.

STEP 2 All jointed instruments should be in an open or unlock position, while instruments composed of more than one part or sliding parts should be disassembled.

STEP 3 Instruments should not be held tightly together by rubber bands or any other means that will prevent steam contact with all surfaces.

STEP 4 Arrange packs in the chamber to allow free circulation and penetration of steam to all surfaces.

STEP 5 When using a steam sterilizer, it is best to wrap clean instruments or other clean items in a double thickness of muslin or newsprint. (Unwrapped instruments must be used

immediately after removal from the sterilizer, unless they are kept in a covered, sterile container.)

STEP 6 Sterilize at 121⁰C (2500F) for 30 minutes for wrapped items and 20 minutes for unwrapped items; set time of the clock.

STEP 7 Wait 20 to 30 minutes (or until the pressure gauge reads zero) to permit the sterilizer to cool sufficiently. Then open the lid or door to allow steam to escape. Allow instrument packs to dry completely before removal which may take up to 30 minutes (Wet packs act like a wick drawing in bacteria, viruses and fungi from the environment). Wrapped instrument packs are considered unacceptable if there are water droplets or visible moisture on the package exterior when they are removed from the steam sterilizer chamber. If using rigid containers (e.g. drums), close the gaskets.

STEP 8 To prevent condensation when removing the packs from the chamber, place sterile trays and packs on a surface padded with paper or fabric.

STEP 9 After sterilizing, items wrapped in cloth or papers are considered sterile as long as the pack remains clean, dry (including no water stains) and intact. Unwrapped items must be used immediately or stored in covered sterile containers.

- Maintain a steam sterilizer log including heat begun, correct temperature and pressure achieved, heat turned down, and heat turned off.
- Each load should be monitored with mechanical (time, temperature and pressure) and chemical (internal and external chemical test strips) indicators.
- Autoclave should be tested daily with an air-removal test to ensure proper removal of air.
- If steam escapes from the safety valve or under the lid, the autoclave is not working correctly. Rather, it is merely steaming items at low-pressure (which may be equivalent to HDL, not sterilization). Then, what is to be done?
 - If steam escapes from the safety valve instead of the pressure valve, the pressure valve must be cleaned and inspected.
 - If steam escapes from under the lid, the gasket (rubber ring) must be cleaned and dried or replaced.

Note: - For operation of non-electric gravity displacement steam sterilizer Refer the National Reference Manual for IPC.

Dry Heat Sterilization Method

- Dry heat sterilization is caused by hot air that destroys micro-organisms through oxidation that causes slow destruction of the micro-organisms protein.
- Dry heat sterilization methods have limited value because it is difficult to maintain the same temperature throughout the process.
- Moreover, dry heat sterilization takes longer than steam sterilization, because the moisture in the steam sterilization process significantly speeds up the penetration of heat and shortens the time needed to kill microorganism.
- When available, dry heat is a practical means by which needles and other sharp instruments are sterilized.
- Dry-heat sterilization can be achieved with a simple oven as long as a thermometer is used to verify the temperature inside the oven.
- Dry heat sterilization is accomplished by thermal (heat) conduction. Initially, heat is absorbed by the exterior surface of an item and then passed to the next layer.
- Eventually, the entire object reaches the temperature needed for sterilization.

Note

Just as with steam sterilization, thorough cleaning of the object prior to dry heat sterilization is critical. If an instrument is not properly cleaned, effective sterilization cannot be ensured regardless of how long the instrument is heated.

Advantages

- An effective method as dry heat reaches all surfaces of instruments by conduction , even for instruments that cannot be disassembled.
- Protective of sharps or instruments with a cutting edge (fewer problems with dulling of cutting edges).
- Leaves no chemical residue.
- Eliminates “wet pack” problems in humid climates.

Limitation

- Plastic and rubber items cannot be dry-heat sterilized because temperatures used (160 to 170°C) are too high for these materials.
- Dry heat penetrates materials slowly and unevenly.
- Requires oven and continuous source of electricity.

Conditions for Effective Use of Dry-Heat Sterilizers

- Adherence to specific instructions
- Airflow rate and distribution
- Load configuration and distribution
- Temperature
- Time

Instructions for Operating on Dry Heat Oven

STEP 1 Decontaminate, clean and dry all instruments and other items to be sterilized.

STEP 2 If desired, wrap instruments in aluminum foil or place in a metal container with a tight-fitting closed lid. Wrapping helps prevent recontamination prior to use. Hypodermic or suture needles should be placed in glass tubes with cotton stoppers.

STEP 3 Place loose (unwrapped) instruments in metal containers or on trays in the oven and heat them to the desired temperature.

STEP 4 After the desired temperature is reached, begin timing. The following temperature/time ratios are recommended (APIC 2002):

- 170°C (340°F) 60 minutes
- 160°C (320°F) 120 minutes
- 150°C (300°F) 150 minutes
- 140°C (285°F) 180 minutes
- 121°C (250°F) overnight

Depending on the temperature selected, the total cycle time (preheating, sterilization time and cool down) will range from about 2.5 hours at 170°C to more than 8 hours at 121°C.

Note:

Use dry heat only for items that can withstand a temperature of 170°C (340°F) (Perkins, 1983). Needles and other instruments with cutting edges should be sterilized at lower temperatures (160°C [320°F]) because higher temperatures can destroy the sharpness of cutting edges (Ibid).

STEP 5 After cooling, remove packs and/or metal containers and store.

Loose items should be removed with sterile forceps/pickups and used immediately or placed in a sterile container with a tight-fitting lid until the time of use.

Dry heat:

- Heat treatment in 1700C (3400F) for an hour (total cycle time-placing instruments in the oven for an hour, and then cooling for 2 to 2.5 hours), or
- Heat treatment in 1600C (3200F) for 2 hours (total cycle time is from 3 to 3.5 hours).

Preventing Errors

- Sterilization equipment should be calibrated and processes should be validated.
- The coldest point should have a minimum temperature of 170°C (338°F) for sterilization to be effective.
- Instruments should be wrapped in materials that can withstand high temperatures (aluminum foils, stainless steel containers, peel pouches).
- Do not stack the packages tightly; leave enough room between surfaces.
- Carry out chemical and biological controls on a regular basis as per the manufacturer's instructions.

Chemical Sterilization

- Chemical sterilization is an alternative to high-pressure steam or dry-heat sterilization and often called "cold sterilization".
- If objects need to be sterilized and when the availing methods like high-pressure steam or dry-heat sterilization would damage them or equipment are not available (or operational), they can be chemically sterilized.

- Many chemicals, both in liquid and gas form, are available for processing instruments. Chemicals that are approved as sterilant's can also be used as high-level disinfectants but those approved only for HLD cannot be used as sterilants.
- **Formaldehyde is no longer included as a sterilant or a high-level disinfectant due to its toxicity.**

Table 7-3: Liquid Chemicals Used for Sterilization

Chemical	Sterilant	Soak Time for Sterilization	High-Level Disinfectant	Soak Time for HLD	Effective Life
Glutaraldehyde 2–4%	Yes	10 hrs at 20–25°C (68–77°F) or 7 hrs, 40 min at 35°C (95°F)	Yes	20–90 min at 20–25°C (68–77°F)	14 days
Glutaraldehyde 3.4% and isopropanol 20.1%	Yes	8 hrs at 20°C (68°F)	Yes	10 min at 20°C (68°F)	14 days
Hydrogen peroxide 7.5%	Yes	6 hrs at 20°C (68°F)	Yes	30 min at 20°C (68°F)	21 days
Peracetic acid 0.31–0.38%	Yes	2 hrs at 20°C (68°F)	Yes	5 min at 25°C (77°F)	5 days
Hydrogen peroxide 8.3% and paracetic acid 7%	Yes	5 hrs at 25°C (77°F)	Yes	5 min at 25°C (77°F)	5 days
Hydrogen peroxide 1.0% and paracetic acid 0.08%	Yes	8 hrs at 20°C (68°F)	Yes	25 min at 20°C (68°F)	14 days

Instructions on the use of Chemical Sterilization

STEP 1 Thoroughly clean and dry all instruments and other items to be sterilized.

STEP 2 Check the expiry date on the container and prepare the chemical sterilant solution following manufactures instruction.

STEP 3 Completely submerge items in a clean container filled with the chemical solution and place the lid on the container for the recommended period of time..

STEP 4 Remove objects from the solution with sterile forceps; rinse all surfaces three times in sterile water; and air dry them. Ideally, three separate (sequential) rinse containers should be used.

STEP 5 Store objects in a sterile container with a tight-fitting lid if they will not be used immediately.

7.8. Monitoring Sterilization Procedures

Sterilization procedures can be monitored routinely using a combination of biological, chemical and mechanical indicators as parameters. Different sterilization processes have different monitoring requirement.

Biological Indicators

Monitoring the sterilization process with reliable biological indicators at regular intervals is strongly recommended. Measurements should be performed with a biological indicator that employs spores of established resistance in a known population. The biological indicator types and minimum recommended intervals should be:

- **Steam Sterilizers** - a highly resistant but relatively harmless (nonpathogenic) microorganism called *Geobacillus stearothermophilus* is used to test steam sterilizers.
- **Dry-Heat Sterilizers** - *Bacillus subtilis*, is used as an indicator on weekly basis and as deemed necessary.

Chemical Indicators

Chemical indicators include indicator tape or labels which monitor time, temperature and pressure for steam sterilization and for dry-heat sterilization. These indicators should be used on the inside and outside of each package or container.

- **External Indicators** - are used to verify whether the items have been exposed to the correct conditions of the sterilization process and the specific pack has been sterilized.
- **Internal Indicators** - are placed inside a pack or container in the area most difficult for the sterilization agent to reach (i.e. the middle of a linen pack). This is the indicator that tells if the item has been sterilized.

Chemical indicators like heat sensitive tape or glass vials containing pellets that melt at certain temperatures and duration do not imply achieved/successful sterilization. They do,

- However, indicate whether mechanical or procedural problems have occurred in the sterilization process.

Mechanical Indicators

Mechanical indicators for sterilizers provide a visible record of the time, temperature and pressure for the sterilization cycle. This is usually a printout or graph from the sterilizer or it can be a log of time, temperature and pressure kept by the person responsible for the sterilization process that day.

7.9. Safe Storage and Transport of Sterile/ HLD Instrument

- All sterile items should be stored appropriately to protect them from dust, dirt, moisture, animals and insects.
- The storage area should be located next to the place of sterilization or connected to it in a separately enclosed area with limited access that is used just to store sterile and clean patient care supplies.
- In smaller clinics, this area may be just a room close to the Central Supplies Department or in the Operating Room.

Instructions for Storing Sterile Items

1. Keep the storage area clean, dry, dust-free and lint-free.
2. Control temperature and humidity (approximate temperature 24°C and relative humidity <70%) when possible.
3. Packs and containers with sterile (or high-level disinfected) items should be stored 20 to 25cm off the floor, 45 to 50cm from the ceiling and 15 to 20cm from an outside wall.
4. Do not use cardboard boxes for storage because cardboard boxes shed dust and debris and may harbor insects.
5. Date and rotate the supplies (first in/first out). This process serves as a reminder, but does not guarantee sterility of the packs.
6. Distribute sterile and high-level disinfected items from this area.

Shelf Life

- The shelf life of an item (how long items can be considered sterile) after sterilization is event-related. An item remains sterile until something causes the package or container to become contaminated as time goes on since sterilization is not the determining factor.
- To make sure items remain sterile until you need them, prevent events that can contaminate sterile packs and protect them by placing them in plastic covers (thick polyethylene bags). An event can be a tear or worn-out area in the wrapping, the package becoming wet or anything else that will enable microorganism to enter the package becoming wet or anything else that will enable microorganism to enter the package or container.
- Before using any sterile item, look at the package to make sure that the wrapping is intact and the seal is unbroken, clean and dry (as well as having no water stains).
- If the quality of wrapping clothes is poor and plastic bags are not available, limiting the shelf life is a reasonable option to resort to and secure the sterility of the instruments.

The Shelf Life of Sterilization Depends on the Following Factors:

- Quality of the wrapper or container.
- Number of times a package is handled before use.
- Number of people who have handled the package.
- Whether the package is stored on open or closed shelves.
- Condition of storage area (e.g. humidity and cleanliness).
- Frequent or improper handling or storage.
- Use of plastic dust cover and method of sealing

Summary

- Applying Spaulding's classification of non-critical, semi-critical, or critical items determines the method that should be used to process instruments. Cleaning is the most important step in instrument processing because it makes instruments safer for additional processing prevents bio-burden from drying on instruments and ensures that there are no residual bio-burden or cleaning chemicals on the instruments that may interfere with the subsequent high-level disinfection or sterilization process. Policies should be in place and all HCWs who perform instrument cleaning throughout the facility should be trained and competent in the appropriate way to clean surgical instruments and other equipment. All semi-critical instruments and devices that come in contact with mucous membranes and non-intact skin should be, at a minimum, high-level disinfected. HLD can be carried out by soaking in a high-level disinfectant, steaming or by boiling. Sterilization of medical devices and surgical instruments plays a vital role in reducing surgical site infections and infection as a result of other invasive procedures. Monitoring the quality of the sterilization process as well as appropriately following recommendations will assist health care facilities in optimizing the safety of sterile medical devices and surgical instruments used for patient care.

CHAPTER 8: PROCESSING REUSABLE TEXTILES AND LAUNDRY SERVICE

Chapter Objective

The objective of this chapter is to equip participants with the required knowledge and skill of processing reusable textile and laundry Service.



Learning objectives

By the end of this Chapter, participants will be able to:

- Explain Minimum requirements for standard Laundry service
- Elaborate Periodic Monitoring and routine maintenance of laundry service
- List the personal protective equipment used in processing textile and laundry service
- Describe Key steps in processing used textile
- Demonstrate how used textiles collected, transported, sorted
- Demonstrate how used textiles can be washed, and dried
- Distinguish the steps of hand washing and machine washing
- Illustrate how clean textiles should be stored, transported, and distributed hygienically

Chapter content

- 8.1. Minimum requirements for standard Laundry service
- 8.2. Periodic Monitoring and routine maintenance of laundry services
- 8.3. The use of Personal protective equipment
- 8.4. Key steps in processing used textile
- 8.5. Collecting, transporting and sorting used textile
- 8.6. Washing, and drying (Laundering) used textile
- 8.7. Storing, Transporting, and Distributing Hygienically Clean Textiles

8.1. Minimum requirements for standard laundry service

The Minimum requirements of standard laundry are:

- The receiving area for contaminated textiles *has bigger space* compared with the clean areas of the laundry (accordance with FMOH-construction standards).
- Laundry areas should have hand washing facilities and products and appropriate PPE
- Laundry equipment are used and maintained according to manufacturers' instructions.
- Textiles or fabrics not left in machines overnight.
- Gross soil from items is removed off washing and drying machines before washing.

8.2. Periodic Monitoring and routine maintenance of laundry services

There is a need to conduct periodic monitoring to make sure that:

- Facility should develop check-list and conduct monitoring and inspection of laundry unit on weekly basis that includes cleanliness, functionality, availability of all necessary detergent, PPE, water and space for collection, storage, and recording/information on place to assess efficiency of the unit.
- Facility has weekly, monthly, quarterly and yearly plan and report of laundry activity.
- Facility has a plan to conduct microbiologic sampling during outbreak investigations if epidemiologic evidence indicates health-care textiles and clothing has a role for disease transmission.

There is a need to conduct routine maintenance of laundry to make sure that:

- The facility use and maintain laundry equipment according to manufacturers' instruction.
- Spare parts are available for parts which can easily be damaged and needing replacements on regular basis.
- The laundry staffs are trained on users' maintenance and focal person is assigned for managing the machine and reporting.

8.3. The use of Personal protective equipment

Utility gloves, plastic or rubber apron, protective eyewear and closed shoes that protect feet from dropped items and spilled blood and body fluids should always be used when collecting and handling, transporting, sorting, hand washing soiled textile or loading it in automatic washers.

Please note that, if utility gloves are not available, putting on two pairs of surgical gloves (double gloving)

Table 8-1: Recommended PPE for Processing Textiles for different activities

Activity	Type of PPE
Collecting soiled textiles	Thick utility or heavy-duty household gloves
Transporting soiled textiles	Closed-toe shoes to minimize the risk of accidental injury from sharp objects or contact with blood or body fluids
Sorting soiled textiles	Thick utility or heavy-duty household gloves
Hand washing soiled textiles	Protective eyewear and mask or face shield
Loading washers	Fluid-resistant gowns or plastic or rubber aprons
Handling disinfectant cleaning solutions	Closed-toe shoes

Source: OSHA; Sehulster et

8.4. Key steps in processing used textile

Processing textile consists of all the steps required to collect, transport and sort soiled textile as well as to launder (wash, dry and fold or pack), store and distribute it. Safely processing textile from multiple sources is a complex process. To reduce the risk of contamination, procedures should be in place to safely handle, process, and store textiles.

Key steps in processing used textiles:

1. Wear heavy-duty utility gloves and other PPE when collecting, handling, transporting, sorting, and washing soiled textiles (see table-9.1).
2. Use PPE for Standard Precautions, carefully scrape off solid body fluids (e.g., stool or vomit) using a firm, flat object and dispose in toilet or sluice before item is placed in collection container.
3. Use leak-proof containers for all textiles or at least those grossly contaminated with blood or body fluids to protect staff from exposure to blood and body fluids.
4. Do not sort textiles in patient care areas.

5. Confine the soiled textiles to designated areas until transported to the laundry. Using the principles of Standard Precautions, handle all discarded textiles as soiled, including items on which there is no visible contamination.
6. Launder all textiles present during procedures, regardless of whether or not they are visibly dirty or were used in the procedure, including sterile towel drapes contained in an opened surgical pack that were not used during the procedure.
7. Transport textiles in covered containers or closed bags.
8. Handle soiled textiles with minimum agitation to avoid contamination of air, surfaces, and individuals.
9. Handle soiled textiles as little as possible and with minimum contact to avoid accidents, injuries, and the spread of microorganisms.
10. Sort textiles in the laundry area carefully before washing.
11. Follow special guidelines for textiles used in isolation areas for patients with highly infectious diseases (e.g., AWD, Measles,).

8.5. Collecting, transporting and sorting used textile

Collecting of used textiles after invasive medical or surgical procedures or when changing in patient rooms:

Collecting

- Collect and remove soiled textiles from patient rooms after each procedure daily, or as needed.
- Use Standard Precautions, including PPE (see above), when collecting used textiles.
- Do not sort textiles in patient care areas.
- Collect used textiles at the point of use. Use leak-proof containers for all textiles; *cloth bags are adequate for patient care textiles not soaked with blood or body fluids.*
- Roll items that are heavily contaminated with blood or body fluids carefully into the center of the item and place in a leak-proof bag or a container with a lid if leak-proof bags are not available.
- Do not sort or rinse textiles heavily contaminated with blood and body fluids in patient care areas.
- Label clearly or use color-coded containers for collecting and transporting used textiles.
- Wash and dry containers routinely before subsequent use.

Handling

- Handle soiled textiles as little as possible. To avoid the spread of microorganisms in the environment and among HCWs and patients, do not shake soiled textiles.
- Two bags may be indicated if the textile cannot be placed in the bag without contaminating the outside of the bag.

Transporting

- Transport collected used textiles to the processing area in closed bags, containers with lids, or covered carts.
- Transport soiled textiles and clean textiles separately. If there are separate carts, trolleys, or containers available for soiled and clean textiles, they should be labeled accordingly. If soiled and clean textiles are transported in the same cart or container:
 - Clean the containers and trolleys or carts thoroughly after transporting soiled textiles using disinfectant cleaning solution (see the Environmental Cleaning chapter in this module for guidance on disinfectants); or
 - Keep soiled textiles in separate areas of the same cart where clean textiles are located and cover both.

Sorting Soiled textiles

- Sorting textiles also allows for customization of washing processes for various categories of textiles or soil level. It also increases efficiency during inspection, folding, ironing, etc. Soiled textiles may also contain non-infectious items (e.g., coins and keys). These items pose no risk and should be returned directly to the patient. Please note that:
- The processing area for soiled textile must be separate from other areas used for folding and storing clean textile, patient care and food preparation.
- Maintain adequate ventilation and physical barriers between the clean and soiled textile areas.
- Do not sort or pre-rinse soiled textiles in patient care areas; they should be sorted in the laundry area.

- Sort soiled textiles into appropriate wash loads by classification such as color, type of fabric, soil type or soil load, and/or type of item (e.g., whites' items, cloth nappies/diapers, cotton/wool items, mop heads, surgical drapes, etc.).
- Always wear protective eyewear, utility gloves, appropriate footwear and plastic or rubber apron while handling soiled textile.
- Wash hands after removing the gloves.

8.6. Washing and Drying (Laundering) Textile

Washing textiles

Laundering standards in healthcare facilities should address key, specific standards, for example, water quality and temperature, amount of agitation needed, and chemical properties needed to properly clean surgical attire. Effective laundering is dependent on the following factors, which, when used together, have a greater effect than when used separately:

- Duration of cleaning
- Mechanical action (i.e., agitation)
- Chemicals used in the process
- Temperature of water and air in the machine dryer

If one of these factors is decreased (e.g., temperature), then other factors (e.g., chemicals, mechanical action, or time) must be increased to result in the same level of cleanliness.

Laundering cycles consist of flush, main wash, disinfecting (bleaching), rinsing, and souring (addition of a mild acid agent).

Decontamination of textiles by presoaking with soap, water, and chlorine solution prior to washing is not necessary unless the item is heavily soiled or will be hand washed. *Repeated soaking of textiles in chlorine solution (even dilute solution), can cause fabric to deteriorate more quickly.*

Machine Washing

While using machine for washing textile:

- Do not overload the machine.

- A pre-wash rinse cycle of 15 minutes will remove remaining gross spillage.
- In cold water washes, chemicals such as bleach must be added (2ml of household bleach for every liter of water) with detergent to facilitate disinfection.
- During the rinse cycle, souring agent should be added to the rinse cycle to reduce alkalinity and prevent yellowing. This decreases the likelihood of skin irritation and further reduces the number of bacteria present.
- Air dry or machine dry before further processing. Textile should be dried as soon as possible after washing to prevent the re-growth of any bacteria not killed by the washing procedure

Steps for Machine Washing

Heavy-duty washers or dryers are recommended for larger health care facilities (*any health facility providing OR and inpatient service and hospitals*). To properly machine wash textiles:

STEP 1: Wear PPE while handling and loading machines.

STEP 2: Separate heavily soiled textiles from non-soiled textiles and wash separately.

STEP 3: Follow manufacturers' instructions to adjust temperature settings, cycle time, type of soap, and other washing agents to be added.

STEP 4: For hot-water washing at 70–80°C (158–176°F), use soap for ≥ 25 minutes to aid in loosening soil. Add bleach and sour if stain removal is required. If not using hot water, soaking textiles in 0.05%–0.5% chlorine solution for 15–30 minutes and then wash with soap and water to remove the bleach.

STEP 5: When the wash cycle is complete, check the item for cleanliness. Rewash if it is dirty or stained. (Heavily soiled textiles may require two wash cycles.)

Hand Washing Textile

Using Cold Water

Using cold water saves energy. Cool water cycles rely heavily on the action of bleach to kill microbes. Temperatures of 22–25°C (71–77°F) for washing textiles is satisfactory for removing microbes if the water cycle, type of soap or detergent, strength of chlorine solution, and other

additives are used in proper concentrations. WHO recommends soaking textiles in 0.05%–0.5% chlorine solution for 15–30 minutes and then washing with soap and water to remove the bleach.

Steps for washing textiles by hand

The steps to properly hand wash textiles are:

STEP 1: Wear PPE while washing textiles by hand.

STEP 2: Separate heavily soiled textiles from non-soiled textiles and wash separately.

STEP 3: Wash the entire item in water with soap to remove all dirt and debris, even if not visible.

STEP 4: Soak in clean water with chlorine solution (0.005–0.015% or 50–150 parts per million [ppm]²) for 30 minutes. Add sour (a mild acid agent) to prevent yellowing of the textile.

STEP 5: Wash again with soap and water to remove bleach.

STEP 6: Check the item for cleanliness. Rewash if it is still dirty or stained.

STEP 7: Rinse the item with clean water.

Please note that:

Lower temperature or cold water washing are satisfactory if the cleaning products (type of soap or detergent , amount of bleach and other additive) are appropriate and used in proper concentration. Using cold water also saves energy.

8.7. Drying, inspecting, and folding textiles

Steps to dry, inspect, and fold hand- and machine-washed textiles:

STEP 1: Completely air or machine-dry cleaned textile before further processing. A cycle in the dryer has been associated with elimination of pathogenic bacteria. For air-drying, direct sunlight is preferred. Keep the fabric off the ground, away from dust and moisture.

² To make 10 liters of 0.005% or 50 ppm bleach solution, add 15 mL of 3.5% chlorine to 10 liters of water. To make 10 liters of 0.015% or 150 ppm bleach solution, add 45 mL of 3.5% chlorine to 10 liters of water. For guidance on preparing sodium hypochlorite solution, see Table 2-3 in Chapter 2, Environmental Cleaning, in this module.

If tap water is contaminated, use water that has been boiled for 10 minutes and filtered to remove particulate matter (if necessary) or use chlorinated water- water treated with a dilute bleach solution (sodium hypochlorite) to make the final concentration 0.001%.

STEP 2: After textiles are totally dry, check for holes and threadbare (worn) areas. If these are present, the item must be discarded or repaired before reuse or storage:

STEP 3: Air-dried textiles should be ironed. Ironing has been associated with the elimination of pathogenic bacteria and is essential to prevent parasites in some regions.

STEP 4: Clean, dry textiles should be folded. If sterile textiles are required (e.g., in the OT), prepare and sterilize wrapped packs. In neonatal intensive care units, hygienically laundered textiles can safely be used; it is not necessary to use sterilized textiles. (AORN 2013; Bearman et al. 2014; Sehulster et al. 2015; SEARO/WHO 2004; Tietjen et al. 2003)

8.8. Storing, Transporting, and Distributing Hygienically Clean Textiles

Storing Hygienically Clean Textiles

Procedures for proper storing of hygienically clean textiles:

- Store clean textiles in clean, closed storage areas.
- Store clean textiles in an area free of pests, dust, and lint and at room temperatures of 20–25.6°C (68–78°F).
- Use physical barriers to separate folding and storage rooms from soiled areas.
- Ensure that storage shelves are: 2.5 to 5 cm (1 to 2 inches) from the wall
 - Bottom shelf: 15 to 20 cm (6 to 8 inches) from the floor
 - Top shelf: 30 to 45 cm (12 to 18 inches) below the ceiling
- Keep shelves clean and textiles covered, which can be achieved by: Covering clean textiles on a clean cart
- Wrapping bundles of clean textiles in plastic or other suitable material and closing securely
- Restrict access to the laundry storage room to authorized staff.
- Store hygienically clean surgical attire as close to the point of use as possible to avoid any microbial contamination.
- Handle stored textiles as little as possible.

8.9. Transporting Clean Textiles

Procedures for proper transporting of clean textiles:

- Hygienically clean and soiled textiles should be transported separately. If separate trolleys or containers are used for clean and soiled textiles, they should be labeled accordingly.
- If clean and soiled textiles must be transported in the same cart, the following are options in order of preference:
 - Thoroughly clean the containers and trolley with disinfectant cleaning solution (e.g., 0.5% hypochlorite solution) before transporting hygienically clean textiles; or
 - Keep hygienically clean textiles in separate areas of the same trolley where soiled textiles are located and cover both.
 - Wrap or cover hygienically clean textiles during transport to avoid contamination.

8.10. Distributing Hygienically Clean Textiles

It is important to protect hygienically clean textiles from environmental contaminants (e.g., dust and dirt) until they are distributed for use. Outbreaks associated with textiles have resulted from contamination of clean textiles; several outbreaks of *Bacillus cereus* in hospital settings were linked to contaminated textiles. (Balm et al. 2012; Duffy et al. 2014; Hosein et al. 2013; Sasahara et al. 2011)

To avoid contamination of textiles in health care facilities:

- Do not leave extra textiles in patients' rooms.
- Handle clean textiles as little as possible.
- Avoid shaking clean textiles where dust and lint can be released into the room.
- Do not conduct routine microbiologic sampling of clean textiles.
- Clean soiled mattresses and pillows using the following guidelines before putting clean textiles on them:

Clean plastic-covered mattresses and pillows by wiping down with detergent. Mattresses without plastic covers that have any blood or body fluids should have the stains removed by either steam cleaning or manual washing. HCWs should wear PPE during this cleaning process.

KEY NOTES:

- ✓ Do not presorts or wash textile at the point of use
- ✓ The workers should not carry wet and soiled textile close to their body even though they are wearing a plastic or rubber apron.
- ✓ Presoaking in soap, water and bleach is necessary only for heavily soiled textile
- ✓ Ironing especially using a steam iron will destroy pathogens
- ✓ Handle stored textile as little as possible Sterilization is the preferred end process for surgical gowns, textile drapes and wrappers

Table 8-2: Guidelines for Processing Textile and Personal Protective Equipment (PPE)

ITEM	DECONTAMINATION	CLEANING	HIGH-LEVEL DISINFECTION	STERILIZATION
Protective eyewear (plastic goggles and face shields)	Wipe with 0.5% chlorine solution. Rinse with clean water. After each procedure or when visibly soiled.	Wash with liquid soap and water. Rinse with clean water, then air or towel dry. ² After each procedure or when visibly soiled.	Not necessary	Not necessary
Linens (caps, masks, scrubsuits or covergowns)	Not necessary. (Laundry staff should wear plastic aprons, gloves, and protective foot and eyewear when handling soiled items.)	Wash with liquid soap and water, removing all dirt particles. Rinse with clean water, air or machine dry. ² Air-dried attire can be ironed before use.	Not necessary	Not necessary
Aprons (heavy plastic or rubber)	Wipe with 0.5% chlorine solution. Rinse with clean water. Between each procedure or each time they are taken off.	Wash with liquid soap and water. Rinse with clean water, air or towel dry at the end of the day or when visibly soiled. ²	Not necessary	Not necessary
Footwear (rubber shoes or boots)	Wipe with 0.5% chlorine solution. Rinse with clean water. At the end of the day or when visibly soiled.	Wash with liquid soap and water. Rinse with clean water, air or towel dry at the end of the day or when visibly soiled. ²	Not necessary	Not necessary
Surgical gowns, linen drapes and wrappers	Not necessary. (Laundry staff should wear plastic aprons, gloves and protective foot and eyewear when handling soiled items.)	Wash with liquid soap and water, removing all particles. Rinse with clean water, air or machine dry. ²	Not practical	Preferred
Paper or disposable plastic items	Place in plastic bag or leakproof, covered waste container for disposal.			

Summary

Facility staffs are often responsible for handling and processing reusable textiles at the facility. Although soiled textiles may contain large numbers of microorganisms, the overall risk of disease transmission is low if textiles are handled, transported, and laundered in a manner that avoids transfer of microorganisms to patients, HCWs, and the environment. Health care outbreaks can occur because of contaminated textiles and HCWs can experience injuries and exposures if recommendations are not followed.

CHAPTER 9: ENVIRONMENTAL CLEANING

Chapter Objectives

The objective of the Chapter is to enable participants understand how to properly conduct environmental cleaning in healthcare setups.



Learning objectives

By the end of this Chapter, participants will be able to:

- Explain the importance of house keeping
- State the general principles of housekeeping in health care facilities
- Able how to select cleaning solutions
- List the type of PPE used during environmental cleaning
- Demonstrate how to prepare disinfectant cleaning solution
- Identify cleaning methods
- Explain how to clean low and high risk area

Chapter content

- 9.1. Significance of housekeeping in hospitals and clinics.
- 9.2. General principles of cleaning.
- 9.3. Ways of preparing disinfectant cleaning solutions.
- 9.4. When and how to clean low and high risk areas.
- 9.5. Cleaning spills of blood or other body fluids.
- 9.6. Cleaning the housekeeping equipment

9.1. Significance of housekeeping in hospitals and clinics

Accumulation of dust, soil and microbial contaminants on environmental surfaces is both unsightly and potential source of HAIs. Effective and efficient cleaning methods and schedules

are, therefore, necessary to maintain a clean and healthy environment in healthcare settings (Chou, 2002).

Housekeeping practices in the healthcare facilities including: the **compound**, the **floors, walls, various type of equipment, tables and other surfaces**.

The purpose of general housekeeping is to:

- ✓ Reduce the number of microorganisms that may come in contact with patients, visitors, staff and the community; and
- ✓ Provide a clean and pleasant atmosphere for patients and staff.

If the purpose of housekeeping as stated above is to be achieved, it is important that housekeeping staff be trained to perform their assigned tasks and are supervised on a regular basis. As part of their training, it is important that the housekeeping staff:

- ✓ Understand the risk of exposure to contaminated items and surfaces when performing environmental cleaning procedures; and
- ✓ Follow recommended policies and guidelines including the use of appropriate personal protective equipment (PPE).

Housekeeping is a very simple activity which is based on the above simple practical principles but its impact in preventing a range of health facility acquired infections is very tremendous.

Table 9-1: Cleaning different areas with different risk level in health facilities

Areas	Level of risk	Cleaned using
waiting rooms and administrative offices	Low-risk	Soap and water
Toilets and latrines; Patient rooms items touched bare handedly by patients and staff	High-risk (heavy contamination)	Disinfectants like 0.5% Chlorine or 1% Phenol
Operating rooms, pre- and postoperative recovery areas, dressing areas and intensive care units (ICUs).		
Blood or body fluid spills areas		

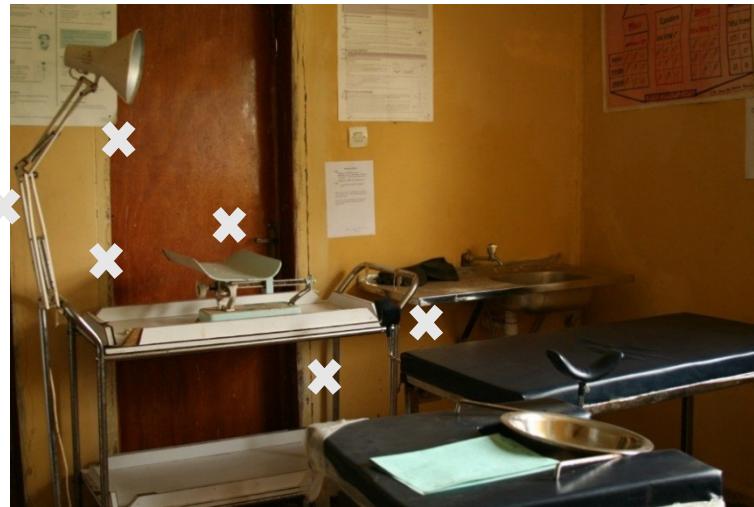


Figure 9-1: Frequently touched surfaces at health facilities

Source: Jhpiego.

Disinfection of admission room after discharge pf a patient is very important. For instance, a study in the area (McFarland *et al.*, 1989) found that when patients who did not have *Clostridium difficile* were admitted to a room previously occupied by a patient with these bacteria, the risk of infection from the bacteria for these new patients is known to increase in many folds-even in the context of correct use of precautions to prevent cross contamination

9.2. General principles for cleaning

- Scrubbing (frictional cleaning) is the best way to physically remove dirt, debris and microorganisms.
- Cleaning is required prior to any disinfection process because dirt, debris and other materials can decrease the effectiveness of many chemical disinfectants.
- Cleaning products should be selected on the basis of their use, efficacy, safety and cost.
- Cleaning should always progress from the least soiled areas to the most soiled areas and from high to low areas so that the dirtiest areas and debris falling on the floor will be cleaned up last.
- Dry sweeping, mopping and dusting should be avoided to prevent dust, debris and microorganisms from getting into the air and landing on clean surfaces. Airborne fungal spores are especially important as they can cause fatal infections in immune-suppressed patients (AORN *et al.*, 1991).

- Instructions for mixing (dilution) should strictly be followed when using disinfectants. (Too much or too little water may reduce the effectiveness of disinfectants).
- Cleaning methods and written cleaning schedules should be based on the type of the surface, the amount and the extent of the soil present and the purpose of the area.
- Routine cleaning is necessary to maintain the standard of cleanliness. Also, schedules and procedures should be consistent and posted.

9.3. How to select cleaning products

There are different types of cleaning products which are used for different purposes. There are some basic facts which should be remembered before making selections of the products.

1. An ideal cleaning product should accomplish the following:

- Able to suspend fats in water
- Saponification of fat (make fats water-soluble).
- Surfaction (decreasing surface tension of water and allowing greater penetration of the agent into the dirt or soil).
- Dispersion (break up of soil into small particles).
- Protein destruction (break up proteins).
- Softening the water by removing calcium and magnesium from it.

2. The Main Guiding Principles for Resource Limited Areas are:

- Unnecessarily expensive products should not be selected.
- What is selected and bought should be based on evidence (not to be left to chance).
- The right product should be for the right purpose.

3. Selection of disinfectants and cleaning products should be based on the following factors:

- Intended use of the product/s.
- Efficacy of the product/s.
- Acceptability of the product/s.
- Environment friendly.
- Safety of the product/s.

- Cost-effectiveness of the product/s.

9.4. Personal protective equipment for housekeeping

The housekeeping staff in health facilities deals with dirt, soils and other materials that expose them to risks of infections and other health hazards. To avoid this hazardous exposure, they have to be equipped with the relevant personal protective equipment.

Some of personal protective equipment for housekeeping purposes are:

- Gloves preferably the utility or Heavy duty gloves
- Protective shoes
- Plastic or rubber apron
- Masks
- Protective eye wears

The housekeeping staffs should use the above mentioned PPEs for

- Handling disinfectant cleaning solutions
- Cleaning patient care areas
- Cleaning heavily contaminated areas
- Handling soiled linens
- Handling soiled items and instruments
- Handling or disposing of wastes
- When spills or splashes are expected

9.5. How to prepare a disinfectant cleaning solution

When we use Chlorine solution, we should be very cautious. Although chlorine-containing solutions (sodium hypochlorite) are excellent and inexpensive disinfectants, **they should not be mixed with cleaning solutions containing an acid** (e.g. phosphoric acid) like Ammonia or Ammonium chloride (NH₄Cl). So doing will release chlorine gas and other by-products that can result in temporary illness (nausea, tearing, headache or shortness of breath) of the staff inhaling fumes in a poorly ventilated area (CDC, 1991).

To find out if a cleaning solution contains ammonia, first check the label. If it is not mentioned among the ingredients, you may still be able to detect ammonia when opening the product by its pungent and burning smell. If one is exposed to Chlorine gas or Ammonium chloride or other unpleasant (noxious) gases with strong odors, the subject should immediately leave the room or the area until it becomes completely ventilated.

STEP 1 Prepare a 0.5% Chlorine solution from liquid concentrates (see Equation 1-1) for directions) or from Chlorine powder compounds (see Equation 1-2). Alternative disinfectants that can be used include 1 to 2% Phenols or 5% Carbolic acid.

STEP 2 Add enough detergent to the 0.5% Chlorine solution or another disinfectant to make a mild and soapy cleaning solution.

HOW TO PREPARE CHLORINE SOLUTION

1. Formula for making a dilute solution from a concentrated solution

- Check concentration (% concentrate) of the chlorine solution.
- Determine total parts of water using the formula below.

Equation 1-1

$$\text{Total Parts (TP) of water} = \left\lceil \frac{\% \text{ Concentrate}}{\% \text{ Dilute}} \right\rceil - 1$$

Mix 1 part concentrated bleach with the total parts water required

Example: Make a dilute solution (0.5%) from 5% concentrated solution

STEP 1: Calculate TP water

$$\begin{aligned}\text{Total Parts (TP) of water} &= \left\lceil \frac{5 \%}{0.5 \%} \right\rceil - 1 \\ &= 9\end{aligned}$$

STEP 2: Take 1 part concentrated solution and add to 9 parts water.

2. Formula for making a dilute solution from a dry powder

- Check concentration (% concentrate) of the powder you are using.
- Determine amount of chlorine (gm.) to be add in a liter of water using the formula below.

Equation 1-2

$$Gm/Lit = \left[\frac{\% \text{ Dilute}}{\% \text{ Concentrate}} \right] * 1000$$

- Mix the calculated amount of dry powdered with one liter of water.

Example: Make a dilute chlorine solution (0.5%) from a concentrated powder (35%)

STEP 1: Calculate grams/liter:

$$\begin{aligned} Gm/Lit &= \left[\frac{0.5 \%}{35 \%} \right] * 1,000 \\ &= 14.2 \text{ gm/lit} \end{aligned}$$

STEP 2: Add 14.2 grams to 1 liter of water

9.6. Cleaning methods

Cleaning should start with the least soiled area and extend to the most soiled area and from high to low surfaces. Common methods of cleaning are briefly described below:

Wet Mopping Method-(Preferable for Floor Cleaning)

- **Single-Bucket (Basin) Technique –**
 - ✓ Only one bucket of cleaning solution is used here.
 - ✓ The solution, however, needs to be changed when dirty.
 - ✓ The killing power of the cleaning product decreases with the increased load of soil and organic material present
- **Double-Bucket Technique –**
 - ✓ Two different buckets are used here---

- ✓ One containing a cleaning solution and the other containing water for rinsing.
- ✓ The mop is always rinsed and wrung out before it is dipped into the cleaning solution.
- ✓ The double-bucket technique extends the life of the cleaning solution (fewer changes are required) saving both labor and material costs.

▪ **Triple-Bucket Technique –**

- ✓ The third bucket is used for wringing out the mop before rinsing
- ✓ This extends the life of the rinse water.

Flooding Followed by Wet Vacuuming Method

- It is preferable for surgical suits.
- It eliminates mopping and minimizes the spread of micro-organisms.
- It increases the contact time of the disinfectant and the area to be cleaned.
- Preferably, it should be done at night when the traffic flow of the facility is low.

Dusting

- Should be used for cleaning walls, ceilings, doors, windows, furniture and other environmental surfaces.
- Clean clothes or mops are made wet with cleaning solution contained in a basin or bucket. The double-bucket system minimizes the contamination of the cleaning solution.
- Dry dusting should be avoided and dust cloths should not be shaken either for fear of spreading of micro-organisms.
- Should be performed in a systematic way using a starting point as a reference to ensure that all surfaces have been reached.
- Check for a stain that may indicate possible leaks when doing high dusting, (ceiling tiles and walls). Leaking holes or cracks should be repaired as soon as possible because moist structure provides a reservoir for fungal growth.

Dry Vacuuming

* This is recommended only for cleaning carpets.

9.7. Schedules and procedures for specific areas

- In health facilities, housekeeping activities should be scheduled.
- Housekeeping schedule should be planned, written and closely followed.
- Cleaning schedules should be developed according to the need of each area.

- A. Walls, Windows, Ceilings and Doors, including Door Handles** - these should be cleaned at the spot when visibly dirty with a damp cloth, detergent and water. In general, routine damp dusting is adequate for these areas (disinfection is unnecessary). These surfaces are seldom heavily contaminated with microorganisms as long as the surfaces remain dry and intact (Russellet *et al.*, 1982).
- B. Chairs, Lamps, Tables, Tablettops, Beds, Handrails, Grab Bars, Lights, Tops of Doors and Counters** - these items should be wiped daily and whenever visibly soiled with a damp cloth containing disinfectant cleaning solution. A disinfectant should be used when contaminations from blood or other body fluid spills are present.
- C. Non-Critical Equipment** - (e.g. stethoscopes and blood pressure cuffs) these ones can just be wiped daily and whenever visibly soiled with a damp cloth with detergent and water. If the equipment is visibly soiled with blood or other body fluids or when the patient is under contact precautions, however, it should be cleaned and disinfected before it is reused.
- D. Floors** - floors usually cleaned (daily and as needed) with a wet mop, detergent and water. A disinfectant should be used during an actual or potential contamination from sources like blood or other body fluid spills as described below.
- E. Sinks** - scrub frequently (daily or more often as needed) with a separate mop, cloth or brush is using a disinfectant cleaning solution. Following this, it needs to be rinsed with water.
- F. Toilets and Latrines** - scrub them frequently (daily and more often as needed) with a separate mop, cloth or brush and a disinfectant cleaning solution.
- G. Patient Rooms** - they should be cleaned daily and right after patient is discharged using the processes described above. The same cleaning process applies to rooms of patients

who are under isolation precautions. Any cleaning equipment used in the rooms of patients under isolation precautions should be cleaned and disinfected before being used in another room.

H. Procedure Rooms - wipe horizontal surfaces, equipment and furniture used for the procedures, with a disinfectant cleaning solution after each procedure and whenever visibly soiled. Clean blood or other body fluid spills as described below.

I. Examination Rooms - wipe horizontal surfaces with a disinfectant cleaning solution whenever visibly soiled. Linen or paper on the examination table should be changed and laid out for each patient. Clean blood or other body fluid spills as described below.

J. Laboratory - wipe countertops with a disinfectant cleaning solution after each shift and whenever visibly soiled. Clean blood or other body fluid spills as described below.

K. Curtains - change and clean curtains according to the routine schedule and when visibly soiled.

L. Carpets - vacuuming daily carpets in patient rooms or weekly in offices or conference rooms.

M. Soiled Linen - collect soiled linen daily (or more often as needed) put them in closed and leak proof containers.

N. Waste - collect waste from all areas at least daily (or more frequently as needed) and avoid overflowing.

O. Waste Containers - clean contaminated waste containers each time following emptying. Clean no contaminated waste containers when visibly soiled and at least once a week. Use a disinfectant cleaning solution and scrub to remove soil and organic material.

Schedule and procedures for the operating room

- At the beginning of each day, all flat (horizontal) surfaces (table, chairs, etc.) should be wiped with a clean, lint-free and moist cloth to remove dust and lint that may have collected overnight.
- Total cleaning is not necessary between each case for surgical procedures.

- Total cleaning or terminal cleaning (mopping floors and scrubbing all surfaces from top to bottom) of the operating room should be done at the end of each day.

Note:

Do not dry mop or sweep the operating room. (This causes dust, debris and microorganisms to become airborne and contaminate clean surfaces).

Total cleaning

STEP 1: Move covered decontamination buckets to the central supply or processing room. A clean bucket containing a fresh 0.5% Chlorine solution or other locally available and approved disinfectants should be provided at the beginning of each day and after each case.

STEP 2 Remove covered contaminated waste container and replace it with a clean container.

Arrange for burning (incineration) or burial as soon as possible.

STEP 3 Close and remove sharps containers when three quarters full.

STEP 4 Remove soiled linen in closed leak proof containers.

STEP 5 Soak a cloth in disinfectant cleaning solution and wipe down all surfaces, including counters, tabletops, sinks, lights, etc. Wash from top to bottom so that any debris that falls on the floor will be cleaned up last.

Note:

All areas of the surgical suite, scrub sinks, scrub or utility areas, hallways and equipment should be totally cleaned regardless of their being used during the 24-hour surgery period.

Walls and Ceilings - wipe them with a damp cloth with detergent and water as needed for visible soil.

Note:

If walls and ceilings are deteriorating or damp, cover them up with clean plastic sheets during procedures.

Chairs, Lamps, Sink Tabletops and Counters - wipe them with a damp cloth with disinfectant cleaning solution.

Operating Room Lamp - wipe them with a damp cloth with disinfectant cleaning solution.

Note:

The double or triple bucket method is recommended for the cleaning of the operating room and other areas of the surgical suite.

Operating Room Table - wipe it with a 0.5% Chlorine solution (or other approved disinfectant) to decontaminate. Then clean top, sides, base, legs and any accessories (e.g. leg stirrups) with a damp cloth and disinfectant cleaning solution.

Floors - clean with a wet mop using a disinfectant cleaning solution.

Vents (heating or air conditioning) - wipe them with a damp cloth with soap and water. When carrying out, the following is advised.

Spills - clean spills with a 0.5% chlorine solution or other locally available and approved disinfectants (see below).

Operating Room Bed - wipe all surfaces and mattress pads with a disinfectant cleaning solution.

Instrument Tables (Trolley and Mayo stand) and other Flat Surfaces - wipe all flat surfaces that have come in to an immediate contact with a patient or body fluids with a disinfectant cleaning solution.

Center of Operating Room Surrounding the Operating Room Bed - mop it with a disinfectant cleaning solution (if visibly soiled).

Waste - collect and remove all waste from the operating room in closed leak proof containers.

Sharps Containers - close and remove containers from the operating room when they are three quarters full.

Containers with a 0.5% Chlorine Solution for Decontamination - remove covered containers with instruments from the operating room and replace them with clean containers with a fresh 0.5% chlorine solution.

Soiled linen - remove soiled linen in leak proof, covered waste containers.

Note:

- Cleaning the filters in air conditioners regularly will help them run more efficiently and decrease the growth of molds.
- Because all patients are considered potentially susceptible and at times infectious, standard precautions are to be used and no additional measures are necessary even if a client is known to have an infection.

How to clean spills of blood and other body fluids

Clean spills of blood, body fluids and other potentially infectious fluids immediately:

- ☞ For small spills, remove visible material using a cloth soaked in a 0.5% Chlorine solution, then wipe clean with a disinfectant cleaning solution while wearing utility or examination gloves.
- ☞ For large spills, flood the area with a 0.5% Chlorine solution leave for 10 minutes and mop up the solution and then clean as usual with detergent and water while wearing gloves.

How to manage spills of mercury from broken thermometer and blood pressure equipment:

- Put examination gloves on both hands,
- Collect all droplets of mercury with a spoon.
- Place in a small, closed container for disposal (possibly encapsulation and burial of the waste away from water resource area) or reuse,
- Wash or clean the area with a chlorine solution,
- Remove used gloves carefully and wash hands properly,

How to clean soiled and contaminated cleaning equipment

- STEP 1** Decontaminate cleaning equipment that has been contaminated with blood or body fluids by soaking it for 10 minutes in a 0.5% Chlorine solution or other locally approved and available disinfectants.
- STEP 2** Wash cleaning buckets, cloths, brushes, mops and the like with detergent and water daily or right away if visibly dirty.
- STEP 3** Rinse them in clean water.
- STEP 4** Dry them completely before reuse. (Wet clothes and mop heads are heavily contaminated with microorganisms).

Summary

- ☞ Housekeeping practices in the healthcare facilities including: the compound, the floors, walls, various type of equipment, tables and other surfaces
- ☞ Dust, soil and microbial contaminants on environmental surfaces are potential source of HAIs.
- ☞ Effective and efficient cleaning methods and schedules are necessary to maintain a clean and healthy environment in healthcare settings
- ☞ Cleaning should start with the least soiled area and extend to the most soiled area and from high to low surfaces.
- ☞ It is important that housekeeping staff be trained to perform their assigned tasks and are supervised on a regular basis.
- ☞ Total cleaning or terminal cleaning (mopping floors and scrubbing all surfaces from top to bottom) of the operating room should be done at the end of each day.
- ☞ Do not dry mop or sweep the operating room.

CHAPTER 10: HEALTHCARE WASTE MANAGEMENT

Chapter Objective

The objective of this chapter is to enable healthcare workers understand how infections are transmitted in healthcare facilities and identify the associated risk to healthcare workers, patients/clients as well as the community at large.



Learning objectives

By the end of this chapter, participants will be able to:

- Define Health care waste
- Describe risks related to health care waste
- Framework of types of health care waste
- Understand the stapes in Health care waste management
- Demonstrate how health care waste are collected, transported, stored, treated and disposed in a heath care facility
- Describe the method of health care waste disposal

Chapter Content

- 10.1. Overview
- 10.2. Risks related to heath care waste
- 10.3. Categories of heath care waste
- 10.4. Sources of health care waste
- 10.5. Management of heath care waste

10.1. Overview

Health-care waste is a by-product of health care that includes potential risk and non-risk wastes. It includes all the waste generated by healthcare establishments, research facilities and laboratories.

Health care waste, produced in the course of delivering health care, is potentially hazardous, and effective management is critical to infection prevention and control in health care.

A health care facility is responsible for managing public health and protecting the environment with regard to the waste produced. However, the waste management process (generation, collection, transport, storage, and disposal) entails considerable complexity, involving clinical and non-clinical staff across a facility, and often depends on outside agencies.

Managing waste remains particularly challenging for facilities in limited-resource settings. Lack of organization, financial resources, training, segregation, equipment, locations for storage, access to PPE, municipal support, and safe disposal locations have been identified as among the challenges (Awodele et al. 2016; Caniato et al. 2016).

10.2. Risks Related to Healthcare Waste

Anyone who comes into contact with waste, both in the community and within the facility (HCWs, patients, visitors, laundry workers, cleaners, porters, etc.) may be at risk.

Risks from health care waste include

- Exposure to pathogenic organisms, harmful chemicals, toxins, or radioactive substances, and
- Injury from sharp items.

Exposure to toxic agents contained in health care waste can cause skin, respiratory tract, and neurological conditions. Recommendations for reducing the risk from injury and infection are described in this chapter.

Infectious health care waste includes waste that has the potential for causing infection. HCWs can be infected when they are exposed to waste through a skin puncture, broken skin, splashes into the mouth or eyes, inhalation, or ingestion.

Infectious conditions potentially transmitted from health care waste include

- ✓ Gastrointestinal conditions (i.e., Diarrhea and Vomiting),
- ✓ Respiratory conditions,
- ✓ Skin and eye infections,
- ✓ Meningitis,
- ✓ Blood borne virus infections (e.g., HIV, Hepatitis B and C), and
- ✓ Hemorrhagic fever including Ebola virus disease.

Applying infection prevention and control recommendations to all aspects of waste handling (generation, collection, transport, storage, and disposal) minimizes the risks to human health and the environment.

10.3. Categories of Healthcare Wastes

Categorizing the waste produced in health care facilities is a useful method of understand the handling and disposal requirements for each type of waste. Approximately 75–90% of the general waste produced by health care facilities is non-contaminated and poses no risk of infection for those who handle it. Similar in nature to municipal waste, all or most general waste can be discarded in dumps or landfills or burned in incinerators. (WHO 2014).

Infectious waste from health care facilities must be handled and disposed of properly because they may carry microorganisms that have the potential to infect individuals who come in contact with them.

There are other types of waste generated in health care facilities that do not contain infectious agents but are considered hazardous because of the potential harm they can cause to the environment.[see table 10.1 for details various categories of waste generated by health care facilities, as defined by WHO].

10.4. Sources of Health Care Wastes

The types and amount of health care waste generated in a health care facility depend upon the size of the facility as well as the range of services provided. The larger the facility (e.g., university hospital, regional hospital) and the more services provided (e.g., tertiary health care facility with a trauma center, cancer treatment department), the more waste is produced and the greater variety of waste generated. [See Table 10-1: Categories of Waste Generated by Health Care Facilities], as it provides examples of health care waste from different sources in health care facilities.

Table 10-1: Categories of Waste Generated by Health Care Facilities

Waste Category	Descriptions and Examples
Non-Hazardous Health Care Waste	
General waste	Waste that does not pose any particular biological, chemical, radioactive, or physical hazard (e.g., paper boxes, newspapers and magazines, polyethylene bottles, polyester bags, wood, other papers, metals [e.g., aluminum cans and containers], high-density polyethylene [e.g., milk containers, saline bottles], glass, and construction/demolition materials).
Hazardous Health Care Waste	
Sharps waste	Used or unused sharps (e.g., hypodermic, intravenous, or other needles, auto-disable syringes, syringes with attached needles, infusion sets, scalpels, pipettes, knives, blades, and broken glass).
Infectious waste	Infectious waste is waste that is potentially contaminated with blood, body fluids, or pathogenic organisms, including, but not limited to, laboratory cultures, microbiological stocks, excreta, and items soiled with blood or body fluids.
Pathological waste	Waste that contains human tissues or fluids, organs, body parts, fetuses, and unused blood products.
Pharmaceutical waste	Pharmaceuticals that are expired or no longer needed and items contaminated by or containing pharmaceuticals.
Cytotoxic waste	Cytotoxic waste contains by-products of drugs that kill dividing cells, which are used for treatment of certain cancers. It also includes waste materials that can damage human genes (e.g., DNA) and may cause cancers or congenital deformities among babies. This waste can include sharps, PPE, and body fluid exposed to the drugs.

Chemical waste	Waste containing chemical substances (e.g., laboratory reagents, film developer); disinfectants that are expired or no longer needed; solvents; and waste with a high content of heavy metals (e.g., batteries, broken thermometers, and blood pressure gauges).
Radioactive waste	Waste containing radioactive substances (e.g., unused liquids from radiotherapy or laboratory research; contaminated glassware, packages, or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclides; and sealed sources—containers in which radioactive substances are stored and sealed).

Adapted from: World Health Organization (WHO). 2013. *Safe Management of Wastes from Health-Care Activities*, 2nd ed. page 4. WHO: Geneva, Switzerland.

http://apps.who.int/iris/bitstream/10665/85349/1/9789241548564_eng.pdf?ua=1.

10.5. Management of Health Care Waste

Reduction of Health Care Waste

- The preferred strategies for reducing health care waste are to minimize waste generation by preventing waste production, reducing waste production, reusing and recycling waste, and recovering useful substances from waste. The least preferable strategy is treating and disposing of health care waste.

Segregation of Waste at Point of Generation

- While general waste is the least expensive and easiest to dispose of, infectious and hazardous waste, which makes up 15% of waste, is more expensive and risky to handle. When general waste is mixed with infectious or hazardous waste, the cross-contamination is introduced and all the resulting waste must be treated as infectious and hazardous.
- Mixed waste occurs when wastes are not properly separated at the point of generation or are mixed during any part of the waste management process.
- Segregation at the point of waste generation will reduce the amount of waste that the facility must treat as infectious or hazardous and is a key strategy for improving waste management at health care facilities.
- Use the following guidelines when disposing of infectious and general waste at the point of generation in all types of health care facilities:

- The HCW who generates the waste should segregate it where it is generated (e.g., before leaving a patient's room, examination room, operating theater or laboratory).
- The waste should be separated into the local or WHO categories (based on its potential hazard and final disposal method) [see Table 10.2 in this chapter].
- Separating wastes by hand after generation puts HCWs at risk and should not be allowed.
- Deposit infectious waste in a labeled or color-coded, leak-proof, puncture-resistant container.
- Use leak-proof (plastic or galvanized metal) containers with tight-fitting covers for contaminated and hazardous wastes to protect patients and HCWs.
- Where available and feasible, use sturdy plastic bags/bin liners inside of the waste collection containers to assist with waste collection and transport. Do not re-use plastic bags or bin liners.
- Use puncture-resistant sharps containers for all disposable sharps (e.g., sharps that will not be reused).

Note:

Training HCWs and having conveniently placed sharps containers close to where sharps are used will help eliminate problems with improper disposal.

Methods to encourage waste segregation include:

- Employ a “Three-Bin System” to segregate waste into separate bins for general, non-hazardous wastes, infectious waste, and sharps
- Use standardized, colored plastic bags (if available) or colored waste containers or standardized, clearly labeled containers to alert HCWs to the contents of the containers.
- Place waste containers and sharps containers at or close to the point of waste generation so waste and sharps can be placed directly into the container.

Note: The sharps container should be placed at the point of use so that HCWs do not have to carry sharp items.

- Utilize tools such as a kidney dish or bowl to separate waste and transport it safely from the point of waste generation to waste containers when waste containers and sharps containers cannot be placed close to the point of waste generation.
- Train HCWs on the importance, categories, and methods of waste segregation.

Note: it is important to train all HCWs, including clinicians and cleaning staff, and patients to keep infectious and non-infectious waste separate.

- Use workplace reminders (posters, signs) to remind staff how to segregate waste.
- Talk with HCWs, in each area of the facility, about the barriers to segregation in their departments since these will vary widely according to the types of tasks performed and the workflow.

Table 10-2: WHO recommended segregation arrangement

Type of Waste	Color of Container and Markings	Type of Container
Highly infectious waste	Yellow, marked “highly infectious” with biohazard symbol	Strong, leak-proof plastic bag or container capable of being autoclaved
Other infectious waste, (includes all pathological waste)	Yellow with biohazard symbol	Leak-proof plastic bag or container
Sharps	Yellow, marked “SHARPS” with biohazard symbol	Puncture-proof container
Chemical and pharmaceutical waste	Brown, labeled with appropriate hazard symbol	Plastic bag or rigid container
Radioactive waste	Labeled with radiation symbol	Lead box
General health care waste	Black	Plastic bag or container

Source: World Health Organization (WHO). 2014. *Safe Management of Wastes from Health-Care Activities*, 2nd ed., page 79. WHO: Geneva, Switzerland. http://apps.who.int/iris/bitstream/10665/85349/1/9789241548564_eng.pdf?ua=1.

In addition, use symbols to indicate the different categories of infectious and hazardous waste (see Figure 10-1: Hazardous Waste Symbols for Health Care Facilities).

After segregation in patient care areas, separation during collection, transport, and storage of waste must be maintained to obtain any benefit. All HCWs, including cleaners, porters, and those

collecting, transporting, storing, and disposing of the waste, must be educated about the importance of segregation.



Biohazard



Radiation



Chemical Corrosive



Highly Flammable Chemical



Toxic Chemical



Explosive Chemical

Figure 10-1: Hazardous Waste Symbols for Health Care Facilities

Collection and Transportation of Waste in Health Care Facilities

To manage waste in health care facilities and ensure timely and safe disposal, waste collection and transportation systems should be developed using the following criteria:

Waste collection routes should be carefully planned and drawn out, taking into consideration the principle of collecting from least to most infectious waste (e.g., the laboratory would be last on a collection route).

Waste collection timetables for each route should be carefully planned according to the waste generation patterns of the various departments. For example, operating theaters, labor and delivery areas, laboratories, and outpatient clinics may generate more waste at different times than other areas and require more frequent collection schedules.

Collect waste on a regular basis such as daily or sooner if needed according to the rate it is generated and the size of the waste containers. Waste bags and sharps containers should **NOT** be filled more than three-quarters full.

Note: Waste bags and sharps containers should NOT be filled more than three-quarters full.

Staff should be trained to understand risks and safety procedures for handling waste:

- Do not mix infectious/hazardous and general waste during collection or transport.
- Collect and transport infectious waste to disposal sites in leak-proof, covered, contaminated-waste containers.
- Do not use equipment (e.g., wheelbarrow, trolley/cart) that is used to hold and transport wastes for any other purpose in the health care facility.
- Use PPE when handling wastes.

Note:

- ✓ Never use hands to compress waste into containers.
- ✓ Hold plastic bags at the top.
- ✓ Keep bags from touching or brushing against the body while lifting or during transport.

Steps for collection and transport of solid infectious wastes:

STEP 1: Wear heavy-duty or utility gloves and closed-toe shoes when handling and transporting all waste.

STEP 2: Collect waste containers and transport to the storage area or treatment area for final disposal.

STEP 3: Clean infectious-waste containers each time they are emptied using soap/detergent and water, disinfect with a low- to intermediate-level disinfectant, and allow them to dry before reuse. Clean non-contaminated-waste containers at least once a week or when visibly soiled.

STEP 4: Remove utility gloves and perform hand hygiene after handling wastes.

STEP 5: Wash and dry gloves [see SECTION 1CHAPTER 9: ENVIRONMENTAL CLEANING].

When using plastic bags/bin liners:

- ✓ Tie bags securely to provide a barrier between the waste and the HCW.
- ✓ Label bags with the date and type of waste in them.

- ✓ Do not shake or squeeze bags in an attempt to reduce volume when sealing them.
- ✓ Carry sealed bags at the top (i.e., by their necks) to the transportation trolley/cart/bin.
- ✓ Do not lift or hold bags by the bottoms or sides.
- ✓ Carry bags away from the body.
- ✓ Ensure that bags are not broken, opened, or dropped.
- ✓ Do not throw bags.

When bags/bin liners are not available:

- Use waste containers with lids.
 - Clearly identify the containers by appropriate color/labeling, for example, “pathological waste,” “infectious waste,” and “general municipal waste.”
- (WHO 2014)

Steps for collection and transport of sharps containers:

STEP 1: Wear heavy-duty utility gloves closed-toe shoes.

STEP 2: Pick up the sharps container from the clinical area—ensure that the container is closed tightly so no sharps are spilled during transport.

STEP 3: Place the container in the designated part of the storage area when it is ready for disposal.

STEP 4: Remove utility gloves and perform hand hygiene after handling waste.

STEP 5: Wash and dry gloves (see **SECTION 1CHAPTER 9: ENVIRONMENTAL CLEANING** of this manual).

Storage of Waste in Health Care Facilities

Waste storage areas in the health care facility should be kept clean, organized, protected from pests and the public (children or scavengers), and well-shaded to reduce heat buildup).

Recommendations for waste storage areas include:

- An easy-to-clean, hard floor with good drainage
- Separate areas for infectious and general waste
- Separate cabinets to store pharmaceutical and other toxic wastes
- A good water supply with a sink for hand hygiene

- Regular cleaning
- Identification (signs) as a “waste storage area”
- Lockable door/gate.

Disposal of Health Care Waste

Recommended Waste Disposal Methods

- Choosing the best currently available waste disposal method and working towards safer waste disposal to protect the community and the environment is essential. [see reference manual Table 10.5 Summarizes options for waste treatment that health care facilities can choose based on available resources and the volume and types of waste generated].
- Specific steps are required for disposing of different categories of waste. Infectious and hazardous waste should be treated prior to final disposal.

Disposal of solid infectious waste

- Solid infectious waste consists of those items defined in national guidelines. Items such as surgical specimens and those soaked with blood or body fluids are included. The method of disposal for these items depends upon the type of material from which they are constructed.

Disposable sharps

Sharps (e.g., hypodermic needles, suture needles, razors, and scalpel blades—see national guidelines for specific items) require special handling because they are the items most likely to injure the HCWs who use them as well as people in the community if these items go to the municipal landfill without proper treatment methods.

Treatment and disposal methods for sharps include:

- By autoclave, followed by shredding (mechanical), and then disposal in a landfill or sharps pit
- By incineration (sharp objects may not be completely destroyed by incineration, but it does make them less likely to be reused or repurposed and less risky to handle) and disposal in an ash pit

- By shredding (mechanical) and disposal in a sharps pit (there is a risk of exposure to staff handling non-decontaminated sharps).
- If other treatment options are not available, small quantities of sharps waste can be encapsulated and disposed of in a landfill.

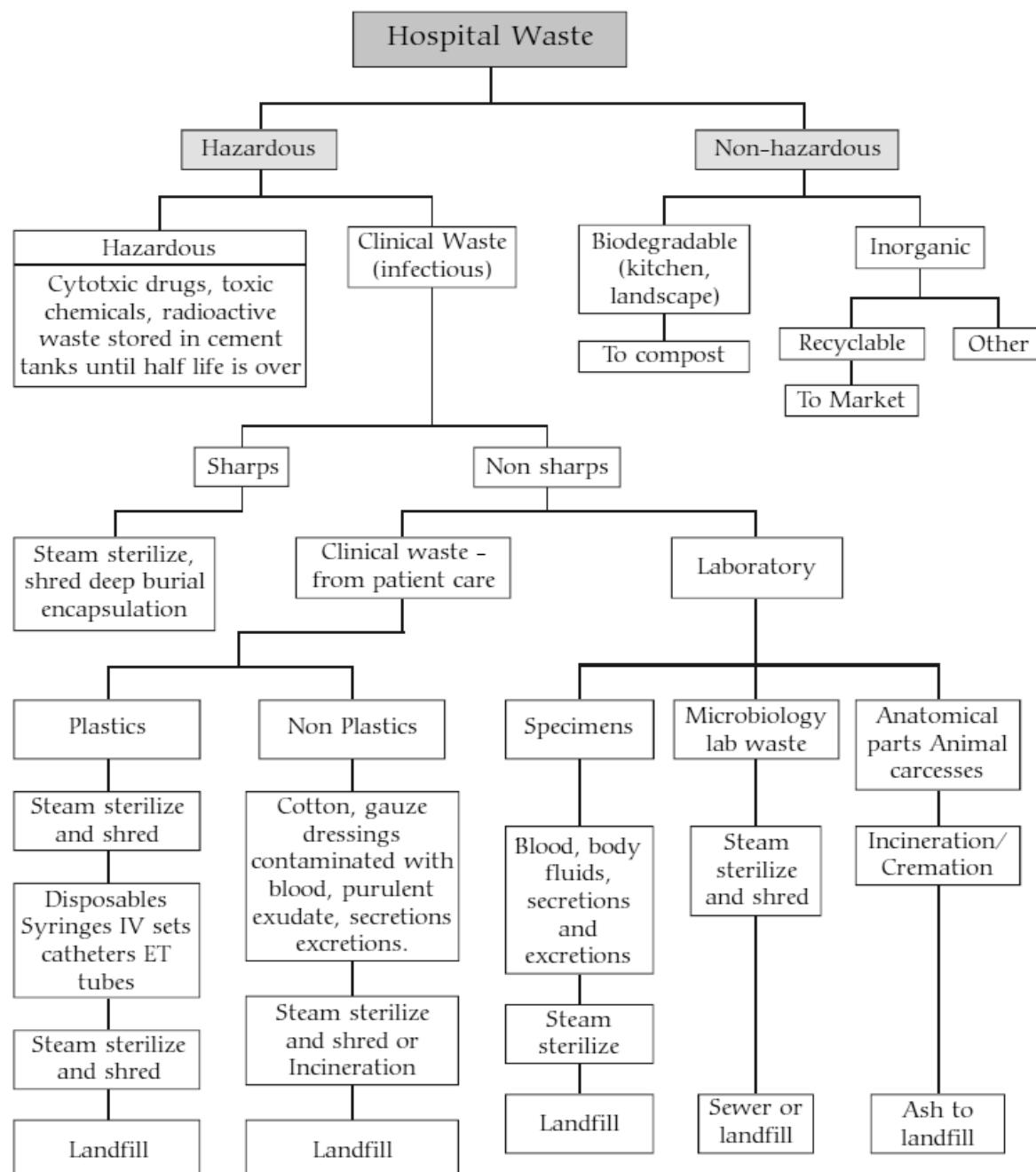


Figure 10-2: Practical Classification of Hospital Wastes and Methods of Disposal

Source: WHO. *Practical Guidelines for Infection Control for Health Care Facilities*, page 25.
URL: http://www.wpro.who.int/publications/docs/practical_guidelines_infection_control.pdf.
WHO/South East Asia Regional Office 2004. All rights reserved.

Disposal of liquid infectious waste

- Liquid infectious waste includes liquid culture media, blood, body fluids, and human excreta. Products that can be added to liquid waste to solidify it for safer handling may be available.

Steps for proper handling of liquid infectious waste in volumes greater than 20 mL:

STEP 1: Put on PPE (utility gloves, face protection, long-sleeved, fluid-resistant gown, and plastic apron, protective shoes) (see SECTION 1CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S) when handling liquid wastes.

STEP 2: Determine if wastes require pre-treatment before disposal. Blood and other infectious agents from laboratory work should be sterilized by steam sterilization at the earliest stage (i.e., inside the health care facility) prior to disposal, if possible

STEP 3: Carefully pour liquid wastes down a utility sink drain or into a flushable toilet and thoroughly rinse with water to remove residual wastes. Clean and disinfect the surfaces (e.g., toilet or sink) to remove residual wastes using 1.0% chlorine solution, and **avoid splashing the chlorine solution**. If a sewerage system does not exist, dispose of liquids using incineration or burial and not into open drains.

STEP 4: Wash the container that held the waste with detergent and water, disinfect using intermediate- or low-level disinfectant, and dry completely before storing and using. (See SECTION 1CHAPTER 9: ENVIRONMENTAL CLEANING, in this manual)

STEP 5: Remove PPE.

STEP 6: Perform hand hygiene.

(WHO 2014)

Disposal of liquid waste from highly infectious diseases

- During outbreaks of cholera and viral hemorrhagic fever such as Ebola Virus Disease, health care facility sewage must be treated and disinfected. *Vibrio cholerae*, the causative agent of cholera, and Ebola virus are easily killed and do not require use of strong disinfectants.
- Chlorine solutions are not effective in disinfecting liquids with high organic content, such as blood and stool. Therefore, in situations such as a cholera and outbreaks of viral hemorrhagic fever, feces and vomit should be mixed with lime milk (calcium oxide) dry powder in a ratio of 1:2 for a minimum of 6 hours of contact before disposing. Urine can be mixed with a 1:1 ratio with 2 hours of minimum contact before disposing. (WHO 2014)

Disposal of pathological waste

- Pathological waste consists of tissues, organs, body parts, placentas, blood, body fluids, and other waste from surgery and autopsy. It also includes human fetuses. It is sometimes referred to as anatomical waste. Containers with pathological waste should be appropriately labeled using recommended labeling for infectious waste.
- Traditional options for disposal of pathological wastes:
 - Burying in cemeteries or special burial sites
 - Burning in crematoria or specially designed incinerators
 - Placenta pit

Steps for using a placenta pit

- Construct a placenta pit and dispose of placentas in the pit (see reference manual chapter 10 Figure A-4 in Appendix 5-A. Methods of Waste Disposal for Low-Resource Settings for details.)
- Open the cover of the pit and dispose of placentas and other organic waste into the pit as soon as possible without adding any disinfection to allow appropriate biodegradation to kill microorganisms and other cells.
- Keep the opening of the pit covered with a heavy lid or a concrete slab.
- Close the pit once it is filled up to 0.5 meter below the underneath slab. Keep it closed for 2 years.

- The contents of the pit can be safely removed and disposed of in a sanitary landfill and the pit can be used again.
- If a placenta pit is not available, for example, in areas with high water table, the option is to incinerate or bury the pathological waste in a burial pit. Never leave pathological waste out in the open.

Other Hazardous Wastes

Chemical waste

- Chemical waste includes residues of chemicals in their packaging, outdated or decomposed chemicals, or chemicals that are no longer required.
- Small quantities of chemical waste are generally collected in containers with infectious waste and can be incinerated, encapsulated, or buried.
- Large quantities of chemical waste should not be collected with infectious waste. Since there is no safe and inexpensive method for the disposal of chemical waste, the following options are recommended:
 - Return the chemical waste to the original supplier. This is the best option for the disposal of specific chemical waste.
 - Incinerate at a high temperature.
- Because these chemical waste disposal methods can be expensive and may be impractical, it is important to keep chemical waste to a minimum. (See the Reduction of Health Care Waste section in this chapter.)

Note: Different types of chemical waste should never be mixed. Chemical waste should not be disposed of in a sewer system.

Chemical containers

- For plastic containers that held toxic substances such as glutaraldehyde (e.g., Cidex) or formaldehyde, rinse three times (dispose of rinse water as chemical waste) with water and dispose of by burning, encapsulating, or burying. Do not reuse these containers for other purposes.
- Wear proper PPE to protect eyes and skin from splashes and rinse glass containers thoroughly with water. Glass containers may be washed with soap, rinsed, and reused.

Pharmaceutical waste

- Small quantities of non-hazardous pharmaceutical (drugs or medicines) waste are usually incinerated, encapsulated, or safely buried. Examples of non-hazardous pharmaceutical waste include vitamins, salts and amino acids (ampoules and fluids), solid or semi-solid tablets, granules, powders, creams, gels, lotions and suppositories, and aerosols (e.g., sprays and inhalers).
- All controlled substances, cytotoxic/genotoxic drugs, anti-infective/antibiotic drugs, and disinfectants and antiseptics are considered hazardous waste (WHO 2014). It should be noted that temperatures reached in a single-chamber drum or brick incinerator may be insufficient to totally destroy pharmaceuticals and therefore they can remain hazardous.
- Options for disposal of small quantities of pharmaceutical waste, such as outdated drugs (except cytotoxic drugs and antibiotics), include the following:
 - Return of expired pharmaceuticals to the donor or manufacturer
 - Encapsulation and burial in a sanitary landfill
 - Chemical decomposition as per manufacturers' recommendations
- For moderate quantities of relatively mild liquid (e.g., vitamin solutions, cough syrups, intravenous solutions, eye drops)—dilute in large amounts of water and discharge into a sewer. Antibiotics or cytotoxic drugs should not be discharged into municipal sewers or watercourses.
- Large quantities of pharmaceutical waste may be disposed of by the following methods:
 - Water-soluble, relatively mild pharmaceutical mixtures (e.g., vitamin solutions, cough syrups, intravenous solutions, eye drops) may be diluted in large amounts of water and then discharged into sanitation systems.
 - Pharmaceutical waste can be returned to the original supplier if possible.
 - Cytotoxic drugs and antibiotics may be incinerated; the residues (i.e., what is left over after the wastes have been incinerated) can go into a landfill. An incinerator that is capable of reaching a combustion temperature of at least 1,200°C (2,192°F) should be used. Temperatures below 1,200°C may release cytotoxic vapors.

- Residues from cytotoxic drugs or other cytotoxic waste should never be mixed with other pharmaceutical waste.
- Cytotoxic waste should never be discharged into natural water sources (rivers, lakes, etc.) or landfills.
- If the above options are not available, cytotoxic substances may be encapsulated.

Waste with a high content of heavy metals

- Examples of wastes with heavy metal content include batteries that contain cadmium, thermometers, and blood pressure machines containing mercury.
- Mercury is a potent neurotoxin, especially during fetal and infant development. When released into water or air, mercury will enter the environment and contaminate lakes, rivers, and streams. To minimize the risk of mercury pollution, mercury-containing products (e.g., thermometers and blood pressure equipment) should be replaced with those that do not contain mercury.

Note: Do **not** touch mercury droplets with your hands unless wearing non-sterile or utility gloves.

- Waste with high content of heavy metals should not be incinerated because of the toxic metallic vapors released in the air nor should it be buried without encapsulation (i.e., placed in a closed, tight container) because it may pollute groundwater. Usually, health care facilities have small amounts of this type of waste.
- Disposal options include:
 - Recycling—the best disposal solution, if available.
 - Encapsulation, if recycling is not feasible—encapsulated waste may be disposed of in a landfill.

Steps for disposal of mercury:

STEP 1: Put non-sterile gloves on both hands.

STEP 2: Collect all droplets of mercury with a spoon.

STEP 3: Place mercury in a small, plastic container with a tight-fitting lid and send it to the manufacturer. If this is not possible, encapsulate mercury before final disposal in a landfill.

- The procedure for final disposal of mercury is very complex and requires expertise. Stabilization of mercury into an insoluble substance and use of an encapsulation approach are currently being recommended for disposal of mercury.

Non-recyclable aerosol containers

- Pressurized containers should never be burned or incinerated because of the risk of explosion. Before aerosol containers are buried, any residual pressure should be released.
- In summary, avoid buying or using chemical products that create difficult or expensive disposal challenges, whenever possible. The ability of the health care facility to safely dispose of the product after it is finished should be one of the considerations during product selection.

Summary

Health care waste is potentially hazardous. Health care facilities are responsible for managing the waste they produce and appropriate management requires collective efforts of various HCWs. Guidelines for disposal of waste from health care facilities set out by WHO in 2014 may not be immediately attainable by many facilities. Waste minimization to limit the volume of hazardous waste produced and waste segregation to minimize the proportion of the total waste that is infectious or hazardous are key waste management measures in all settings. Choosing the best available waste disposal method and working towards safer waste disposal to protect the community and the environment is essential. Effective waste management will save resources, reduce costs, and prevent injuries and exposure to infectious disease.

CHAPTER 11: FOOD AND WATER SAFETY

Chapter objective

The objective of this chapter is to equip participants with the basic knowledge and skill required to apply food and water safety rules at health facilities.



Learning objectives

By the end of this chapter, participants will be able to:

- Describe importance of food and water safety
- Elaborate the standards of food safety at health facilities.
- Explain causes of Food Contamination and poisoning and actions for prevention
- Conduct water quality monitoring
- Elucidate how to make water safe in health facilities
- Explain food and water safety rules

Chapter content

- 11.1. Overview
- 11.2. Principles and standards of food safety at health facilities
- 11.3. Types of food contamination
- 11.4. Prevention of food and water-borne diseases occurrence among patients hospitalized in healthcare settings
- 11.5. Water and health,
- 11.6. Drinking water Quality and safety measures

11.1. Overview

Healthcare Associated diarrhea is a common problem in hospitals (Lynch et al 1997). The main factors associated with this includes; poorly trained food handling staff, using unsafe practices involving the storage, preparation and handling of raw meat, chicken, fish and fresh eggs as well as some vegetables and use of unsafe drinking water. Healthcare Associated transmission of fecal organisms by contaminated food or water can be reduced considerably by improving sanitation, food handling and staff hygiene.

Planning, implementing and monitoring food and water service in healthcare facilities are of great value in preventing food and water contamination which at times leads to infection or outbreaks among the hospitalized patients from such causes.

Potentially hazardous foods

- Potentially hazardous foods support the growth of bacteria. They need to be kept at temperatures either below 5°C or above 60°C to prevent the growth of any food poisoning bacteria that may be present in the food.
- Examples of potentially hazardous foods include meat, poultry, seafood, eggs, dairy foods, gravies and cooked rice.

11.2. Principles and standards of food safety at health facilities

All activities in the food service department should be monitored regularly to be sure that safety principles and standards are being followed. These include:

Hygiene of Food Service Staff:

- Health and hygiene of *staff Supervised* by a knowledgeable person.
- ***Hand hygiene*** (hand washing or the use of waterless, alcohol based hand rub at critical times) plays crucial role in preventing healthcare associated diarrhea
- Should *report any gastrointestinal problems or skin lesions* especially on hands. Food handlers should undergo quarterly medical checkup.

- ***Food handlers with diarrhea should be immediately removed from handling foods.*** They should not return to food handling or work with immune compromised patients or intensive care or transplant patients until all symptoms are over for 24–48 hours.
- They need to ***know how to inspect properly; prepare and store foods*** they handle;
- ***Know how to clean and operate equipment*** they use such as knives and dishwashers
- ***Kitchen staff should have access to PPE*** (face masks, hair covers, and plastic aprons at a minimum). Other personal protective equipment should be supplied as necessary
- ***Able to plan and conduct management of wastes.***

Holding temperatures:

- Food should be held above 60°C/140°F or below 7 °C/45°F
- Thermometers for food storage should be checked periodically.
- Warm, perishable foods should be cooled before being stored.

Cooking of food

- A. Food should be ***cooked thoroughly***
- B. Frozen food items should be thawed before cooking to ***avoid the presence of cold spots in the interior.***

Cleanliness of kitchen and equipment

- A. ***Cleanliness*** of the kitchen has to be ***done on daily basis***, monitored and verified. The kitchen should be cleaned ***at the end of each day.***
- B. Ensure equipment cleaning and disinfection, especially cutting boards used for preparing raw meat, fish or poultry.
- C. Utensils used to cater food and cups for drinking has to be properly washed/ sanitized using the proper dish washing methods.
- D. ***Washing food utensils:*** Food utensils should be washed with three compartment washing system. These are washing, cleansing and sanitizing compartments.

Purchasing, transportation and storage of food:

- Purchase raw food from known vendors that meet local inspection standards, if possible.
- Foods prepared at homes should not be shared with other hospitalized patients.

- Purchased raw food has to be transported to the health care facilities with transportation free from biological and chemical contaminants.
- Storage of raw and cooked food should be separate and with recommended temperature based on the type of food to be stored (for example easily perishable and cereals). It has to be monitored on daily basis including food handling

Educate or assist the hospitalized patients and care takers:

- A. Educate about hand washing during critical times(before preparing food, before eating, after toilet)

11.3. Food contamination

Hazards that can contaminate food: Food can be contaminated by the following three main hazard types:

1. **Physical hazards** (foreign objects) – metal, wood, glass, plastic, etc.
2. **Chemical hazards** – bleach, caustic soda, detergents, pesticides, etc.
3. **Microbiological** – bacteria, viruses, moulds and parasites.

Please note that:

Food that is contaminated with any of these hazards is unsafe and unsuitable to eat.

Bacterial food poisoning

- To survive and multiply, bacteria need; water, food, correct temperatures, time, most but not all, need oxygen.
- Under these conditions, bacteria will multiply by dividing in two every 10-20 minutes. After 6 hours, 1 bacterium can multiply into 262,144 bacteria, more than enough to cause food poisoning.

How do bacteria enter a food premises?

- Food handlers (especially their hands).
- Raw foods, such as meat, poultry, shellfish and vegetables.
- Pests and animals.
- Air and dust.

- Dirt and food waste.

11.4. Causes of food poisoning

1. Food at incorrect temperatures

Under ideal conditions, bacteria multiply rapidly between 5°C and 60°C (the danger zone for food). Below 5°C, bacteria multiply slower. At freezing temperatures, bacteria stop multiplying and become dormant. Freezing does not kill bacteria; most bacteria are killed at temperatures above 60°C.

2. Cross-contamination

- It occurs when food becomes contaminated with bacteria from another source.
- Bacteria can be transported by hands, utensils, surfaces, equipment, tea towels, raw food and pests.
- Common examples of cross contamination include unclean hands; dirty knives; utensils; equipment and food contact surfaces (e.g chopping boards); blood dripping from raw foods; storing raw food with cooked foods; storing food uncovered; and using dirty cleaning cloths and tea towels.

3. Poor personal hygiene

Examples of poor personal hygiene include; Dirty hands and clothing, uncovered cuts and wounds, long dirty fingernails, Excess jewellery on hands and wrists, Coughing and sneezing over food, Handling food while ill, not washing hands after going to the toilet.

4. Unclean food premises- Dirty kitchens increase the risk of cross-contamination from pests and particles of food, grease and dirt.

5. Poor pest control - *Common pests found in food premises includes;* flies, Cockroaches, Rats and mice. These pests can carry food poisoning bacteria and may also cause physical contamination of food with their droppings, eggs, fur and dead bodies.

11.5. Actions for prevention of food poisoning

Temperature control

- Minimise the time that potentially hazardous foods spend in the danger zone; always remember to keep cold food cold at 5°C or colder and hot food hot at 60°C or hotter.
- *All food Health facilities are required to obtain and use a probe thermometer, accurate to +/- 1°C to monitor the temperature of potentially hazardous foods.*

Avoid cross-contamination – to avoid cross-contamination do the following:

- Keep food covered until use,
- Practise correct personal hygiene,
- Separate raw and cooked, and old and new food at all times,
- Use separate equipment and utensils when preparing raw meats, poultry and seafood,
- Clean and sanitise all equipment, utensils and food contact surfaces and
- Store chemicals separate from food.

Personal hygiene – the following should be considered:

- Clean hands and clothing,
- Minimise jewellery on hands and wrists,
- Tie-back or cover hair,
- Clean and short fingernails,
- Avoid unnecessary contact with food,
- Cover all cuts and sores with a brightly coloured waterproof dressing,
- Do not eat over food or on food surfaces,
- Do not prepare food when you are ill,
- Avoid touching your face and hair,
- Do not cough or sneeze over food,
- Do not taste food with your fingers or “double dip” with a spoon and
- If wearing gloves, change frequently.

Proper Hand Washing: When should you wash your hands?

- Before commencing or resuming work,

- After using the toilet,
- After smoking,
- After handling rubbish,
- After using a handkerchief or tissue,
- After touching your hair or face,
- Before and after handling raw food,
- Before handling cooked food and
- After any cleaning task.

Avail Hand washing facilities - Must be accessible to all food handlers, to be used only for the washing of hands, Provide soap and warm potable water, Provide disposable towels for drying hands, Provide a bin for the disposable towels.

Cleaning

- Must be continuous and ongoing; thoroughly clean and sanitise all food surfaces, equipment and utensils with hot water and detergent and chemicals (sanitisers). Remember that most detergents do not kill bacteria, but hot water and sanitisers do! Implement a cleaning schedule to ensure that cleaning is conducted on a regular basis (including hard reaching places).

Cleaning and sanitising with/without a dishwasher

- Wear rubber gloves to protect your hands from the hot water and chemicals.
- Remove food particles by scraping or soaking.
- Wash using hot water and detergent – change the water if it becomes cool or greasy.
- Rinse in hot water with chemical sanitiser or in very hot water (above 80°C - only if sink has heating element and rinsing baskets) and leave to soak for 30 seconds.
- Either drip-dry or use a clean tea towel to reduce the risk of cross-contamination.

Pest Control

- Keep them out – seal the food premises.
- Starve them out – keep food premises clean.
- Throw them out – conduct regular pest inspections or services.

- Don't give them a home - remove all unnecessary equipment and items.
- Report all pest sightings or evidence of pest activity to your supervisor.

Waste management

- Place waste in plastic lined bins.
- Remove all waste from the premises as required.
- Empty and clean waste bins regularly.
- Ensure all external bins are covered.
- Protect external waste bin area from pests and birds.

11.6. Water safety

Water and health

- waterborne disease like diarrhea, kills around half a million under five children each year
- Infectious diseases transmissions pathways through water supply are categorized into four:
 - **Water borne diseases:** transmit through DW contamination (eg. typhoid, cholera)
 - **Water washed diseases:** caused by the shortage of adequate water for personal hygiene (scabies, and trachoma)
 - **Water based diseases:** transmitted through aquatic vectors (such as schistosomiasis)
 - **Water related diseases:** spread by insects that depend on water (malaria and yellow fever)

Drinking water quality and safety

- Drinking-water should be suitable for human consumption as well as domestic purposes.
- Contamination and chemical introduction can occur across the water supply chain, including:
 - at the catchment areas and water sources (by human and animal feces),
 - contamination in the distribution system (through “leaking” pipes, obsolete infrastructure, and inadequate treatment and storage) and
 - Unhygienic handling of stored household water.
- Climate change can also affect the quality of DW.

Method how to make water safe if it is from unsafe source

- A. Water boiled for 1 to 5 minutes is considered safe to drink, while water boiled for 20 minutes is high-level disinfected.
- B. Alternatively, water can be disinfected and made safe for drinking by using sodium hypochlorite.

Water quality surveillance and monitoring

Drinking-water supply quality surveillance refers to “*continuous and vigilant public health assessment and review of the safety and acceptability of drinking-water supplies*” (WHO, 2011). It is a careful watching and protecting of DW from possible contamination risks.

Four components of DWQS

1. Sanitary inspection / survey – identify hazards
2. Water quality monitoring/testing
3. Data analysis, interpretation and reporting
4. Remedial action

It includes institutional inspection, sanitary survey, continuous monitoring of physico-chemical and microbiological parameters (laboratory or spot testing of water samples collected at different locations, i.e. at source, pipe line, reservoirs and delivery points) and time, data processing, evaluation followed by remedial action and preventive measures.

Monitoring the quality of water supply

- A. Know the biological quality of the source.
- B. Monitoring/inspections of the water quality used by the health care facilities including the sources, collection, and storage should be done on regular basis is very important to early detect contaminants.
- C. The microbial water quality (Total Coliform and E.coli count based on WHO guideline value or country water quality standard if available) of the source should also be monitored on quarterly basis.
- D. If it is feasible see also chemical quality.
- E. Water containers and tankers should be cleaned and disinfected regularly

Water quality parameters

There are three categories of parameters for drinking water (DW): *physical*, *chemical* and *bacteriological*. A national standard for DW quality was adapted from WHO recommendation.

Table 11-1: National Water Quality Parameters adapted from WHO

Bacteriological levels		
Organism	Maximum permissible level	Test method
Total viable organisms, colonies per ml	must not be detectable	ES ISO 4833
Faecal streptococci per 100ml	must not be detectable	ES ISO 7899-1 ES ISO 7899-2
Coliform organisms, number per 100 ml	must not be detectable	ES ISO 9308-1
E. Coli, number per 100 ml	must not be detectable	ES ISO 9308-1 ES ISO 9308-2

Source: Compulsory Ethiopia drinking water Standard, 2013

Water sampling methods

Basically there are two types of sampling methods: probability and non-probability.

1. Probability Sampling methods

Every unit of the population has an equal chance (probability) of being selected in the sample.

Method includes

- ✓ **Simple Random Sampling** :A subset of a statistical population in which each member of the subset has an equal probability of being chosen
- ✓ **Systematic Random Sampling:** Systematic sampling is a statistical method involving the selection of elements from an ordered sampling frame
- ✓ **Cluster Sampling** : is a sampling technique used when "natural" but relatively homogeneous groupings are evident in a statistical population

Stratified Random Sampling: is the process of dividing members of the population into homogeneous subgroups before sampling

2. Non-probability sampling: does not use random selection. Generalization of the findings is not possible because the sample is not representative of population.

- ✓ **Convenience Sampling:** a sample population selected because it is readily available and convenient

- ✓ **Quota Sampling:** population is first segmented into mutually exclusive sub-groups
- ✓ **Snowball Sampling:** The first respondent refers a friend. The friend also refers a friend, and so on

Table 11-2: Quantity of sample water required for testing and how to handle

Sample type	Amount required	Transport and Storage	Stability
Chlorinated water sample	100 ml	Water should be collected to sterile container with lid and transported in an insulated cold box as soon as possible to laboratory	6 hrs
Un-chlorinated water sample	105 ml	Water should be placed in an insulated cold box for transport to a water testing	

Sample De-chlorination

- When samples of chlorinated effluents are to be collected and tested, the sample must be de-chlorinated.
- Chlorine remaining in the sample can further disinfect the sample during any holding time after sample collection.
- Since sterile sampling procedures must be followed for a valid bacteriological test, the de-chlorination steps cannot be performed after the sample is collected.

Procedure for de-chlorination

- De-chlorination of bacteriological samples is as follows:
- When the water to be examined is likely to contain chlorine or chloramines, sufficient amount of sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) must be added to each bottle to neutralize this substance.
- Add 2-3 drops of sodium thiosulphate to sample collection bottle
- Gram of Chemical Required to Neutralize Residual Chlorine Concentration in 378,500 L of water is presented in **Error! Reference source not found..**

Table 11-3: Grams of sodium thiosulphate required to Neutralize Residual Chlorine Concentrations in 378,500 L of water

Residual Chlorine Conc. (mg/L)	Sodium ThiosulfatePentahydrate ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$)
0.3	181.44g
0.6	317.51g
0.9	498.95g
1	544.31g
1.3	725.75g

How to Collect Water Samples

- Samples should be collected in a non-reactive borosilicate glass plastic bottle or plastic bag that has been cleaned, rinsed and sterilized
- 105 ml for un-chlorinated and 100 ml for chlorinated water sample is the minimum volume that should be taken as a sample to obtain reliable results, especially for microbiological testing. More water should be collected than needed (i.e. 200 – 1000 ml) in case if multiple tests are required.

Table 11-4: Minimum sampling frequency for drinking water in distribution system

Population served	Sample to be taken monthly
Less than 5,000	1 sample
5,000-100,000	1 sample per 5,000 population
More than 100,000	1 sample per 10,000 population plus 10 more samples

Labeling of water Sampling

Every sample container should have a label. The sample label has information about:

- Sample location,
- Sample description (e.g. inlet water, storage bucket water),
- ID number,
- Date and time,
- Name of the person collecting the sample,
- Test to be performed (optional)

Sampling a Tap water

- Remove any external fitting from the tap carefully clean and disinfect the inside and outside of the tap.
- Clean carefully the outside nozzle of the tap ensures that any deposits in the pipes are washed out.
- Turn the tap on full for one minute
- Sterilize the tap using the flame of blow lamp or gas of cotton wool soaked in alcohol
- Allow the tap to cool by running the water to waste for few seconds
- Fill the sample bottle from the gentle flow of water, and replace the cap of bottle
- Using water proof marker number the bottle with sample code

How to Transport Water Samples

- Bacteria do not generally survive well in water due to a variety of factors. It is well known that the numbers of bacteria within a water sample rapidly decline 24 hours after it has been collected. Temperature can also affect die off within the water sample, with higher temperatures leading to greater die offs.
- Samples should be collected and placed on ice in an insulated container if they cannot be tested immediately; preferably held at <10 °C during transit. Samples should be tested the same day and refrigerated overnight if necessary.
- If the time between collection and test exceeds 6 hours, the final report should include information on the conditions and duration of sample transport. Samples exceeding 30 hours holding time (from collection to testing) should not be tested.
- Minimum sampling frequency for drinking water in distribution system (see Annex)
- The collection, transportation, storage and handling of DW: It should be done with precaution to avoid risk of contamination(i.e. use properly washed/ sanitized container to collect and store water, separate container for drinking and other purpose by clearly writing on the container which is for which).

Summary

Educate the hospitalized patients and care takers on need of hand washing during critical times (before preparing food, before eating, after toilet).

Medical Checkup of food handlers should be done quarterly.

Cleanliness of the kitchen has to be done on daily basis monitored and verified in order to avoid contamination of food during cooking.

Ensure Equipment Cleaning and Disinfection: cutting boards, Utensils for serving food and cups for drinking has to be properly washed or sanitized.

Purchase raw food from known vendors that meet local inspection standards if possible.

Foods prepared at home should not be shared with other hospitalized patients.

Transportation and Storage of Row and Cooked Food purchased row food has to be transported to the healthcare facilities with transportation free from biological and chemical contaminants. Storage of row and cooked food should be separate and done in line with the recommended temperature for each type of food to be stored

Apply Water Safety Principle Identify the quality of water source used by the healthcare facility: biological quality of the source (Total *Coliform* and *E.coli* count based on WHO guideline value or country water quality standard if available). If it is feasible, examine the chemical quality as well. Infected patients should be restricted from using communal baths

Collection, Transportation, Storage and Handling of Water healthcare facilities has to collect, transport, store and handle water with precaution to avoid risk of contamination (i.e. use properly washed/sanitized container to collect and store water, separate container for drinking and other purpose by clearly writing on the container which is for which).

Making Water Collected from Unsafe Source Safe water boiled for 1 to 5 minutes is considered safe to drink while water boiled for 20 minutes is labeled as high-level disinfected and hence even safer. Alternatively, water can be disinfected and made safe for drinking by adding 3-5 PPM Chlorine (*The formula for preparing 0.001% of Chlorine solution is given in SECTION 1CHAPTER 9 : ENVIRONMENTAL CLEANING this manual chapter*)

CHAPTER 12: TRAFFIC FLOW AND FACILITY DESIGN

Chapter objectives

The objective of this chapter is to enable participants understand the relationship between Infection prevention and Control (IPC) and the design and flow of activities in healthcare settings to minimize the level of microbial contamination in areas where patient care and instrument processing take place.



Learning objectives

By the end of this chapter, participants will be able to:

- The significance of regulating traffic flow and defining activity patterns in health facilities
- Designing traffic flow and activity patterns in procedure rooms, instrument processing and surgical areas.
- The traffic flow requirements for different areas.

Chapter Content

- 11.1. Overview
- 11.2. Designing traffic flow and activity patterns in procedure rooms, instrument processing and surgical areas.
- 11.3. The traffic flow requirements for different areas.

12.1. Overview

Regulating the flow of visitors, patients and the staff plays a central role in preventing disease transmission in healthcare facilities. This is so for the number of microorganisms in a designated area tends to be related to that of the number of people present and their activity. Microbial contamination is found to be high in areas such as waiting rooms and places where soiled surgical instruments and other equipment are initially processed. Microbial contamination is minimized by reducing the number of people coming to the area and defining the activities taking place at each place.

An important objective of infection prevention and control is to minimize the level of microbial contamination in areas where patient care and instrument processing take place. Such areas for instrument processing include: procedure areas, surgical units, and work areas (where instruments are processed).

These include dirty and clean areas where soiled instruments, equipment's and other items are first cleaned and then processed and stored. It is important to direct activity patterns and traffic flow in the above-mentioned areas to keep contaminated areas separate from areas where procedures take place. The major areas are:

- **Procedure areas** - are settings where patients are examined and procedures (e.g. pelvic examinations, wound care management, blood drawing, immunizations, IUD insertions and removals, and normal childbirth) are carried out.
- **Surgical units** - are settings where major and minor operations are performed. The surgical unit also includes preoperative and recovery rooms as well as several other areas
- **Work areas** - are settings where instruments are being processed. These include dirty and clean areas where soiled instruments, equipment and other items are first cleaned and either high-level disinfected or sterilized and then stored
- It is important to direct activity patterns and traffic flow in these areas to keep contaminated areas separate from areas where procedures take place.
- Activities such as waste disposal, instrument processing and cleaning procedure areas should be carefully planned and organized to minimize the risk of infection to patients and healthcare workers.
- Equally important, is designing and implementing traffic flow patterns that prevent soiled instruments and other items from coming across to the cleaned, high-level-disinfected or sterilized items.
- Traffic flow is also related with separating people who have or are likely to have communicable diseases from those who are at risk (susceptible). These people pose a great risk to susceptible patients and healthcare workers simply by availing themselves in the same room; therefore, it is necessary to identify and remove them quickly.

12.2. Facility design, space and equipment requirements

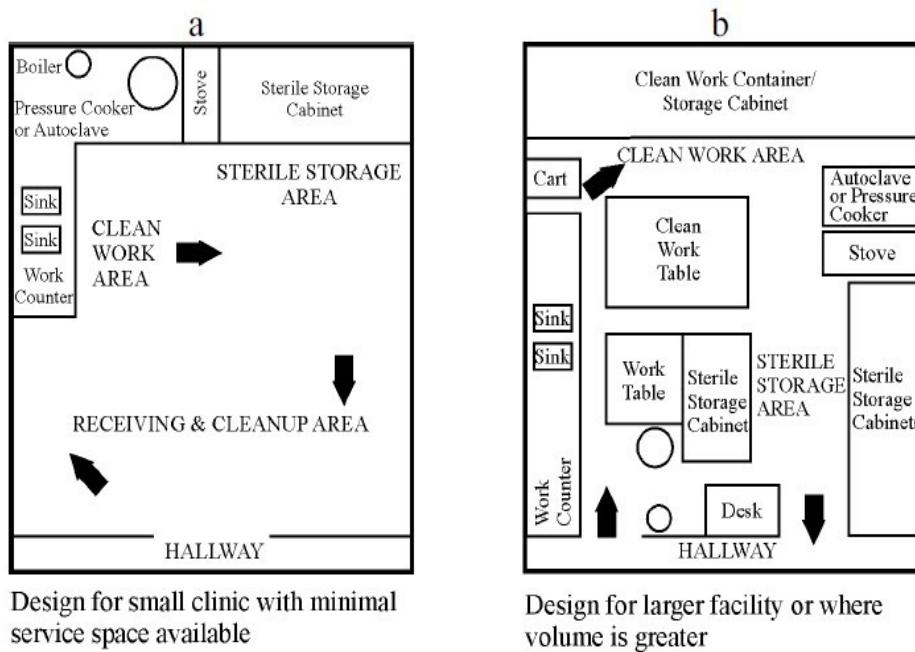
Healthcare facilities vary in the types of services they provide. For example, a rural clinic may offer only a few procedures (e.g. IUD insertion and removal, immunizations, antenatal care and minor surgery for suturing wounds). Larger facilities (including district and referral hospitals) provide major and minor general surgical procedures, child delivery services in addition to ambulatory procedures. Regardless of the size of the facility, however, the specific space and equipment requirements to perform a particular procedure do not generally vary.

- Microbial contamination can be substantial in highly trafficked areas and places where soiled surgical instruments and other equipment are initially processed. Basic principles of facility design, traffic flow, and work practices that can be applied to reduce microbial contamination include:
- Designating appropriate traffic flow for patients, health care workers (HCWs), and equipment to ensure safe separation between contaminated items and clean/sterile items.
- Developing policies and procedures that establish clear authority, responsibility, and accountability to ensure that these safe practices are adopted and practiced.
- Regulating the flow of visitors, patients, and staff using signs (e.g., authorized personnel only), reminders (e.g., red line on the floor), and physical barriers (e.g., closed doors). The amount of traffic and the number of individuals present in a designated area and their activities contribute to the number of microorganisms present in that area.
- Using work practices that prevent contaminated items from contacting clean items, such as working from dirty to clean. This is especially important if separate spaces for dirty and clean items are not available.
- Ensuring that all staff understands the policies and procedures, for example, through new staff orientation and ongoing training, to guarantee safe handling of clean and soiled items.
- Ensuring appropriate ventilation of OTs, procedure areas, CSSDs, and instrument processing areas.
- Using fans in facilities without mechanical ventilation to optimize existing ventilation. The air should be drawn into the area and should be exhausted outside using one-way

exhaust fans. Where mechanical ventilation or fans are not available, the only option is to use natural ventilation with open windows and doors fitted with mosquito nets.

Designing new facilities and renovations with these principles in mind. For example, health care facilities should have a dedicated central location where soiled instruments can be reprocessed and that is physically separated from procedure areas.

In clinics where only minor procedures are performed, a procedure room with a hand washing sink is required for examining clients and performing procedures. A separate room with at least one sink for cleaning and an area for processing instruments and other items is also desirable (Figure 12-1). Ideally, the processing area should include more than one room (e.g. a dirty room for receiving dirty instruments and a clean room for final processing and storage). If only a single room is available (Figure 12-1a), soiled equipment should be received and cleaned in an area of the room distant enough from areas where equipment are high-level disinfected or sterilized and then stored.



Source: SEARO/WHO 1988.

Figure 12-1 a and b: Floor Plans for Instrument Cleaning, High-Level Disinfecting and Sterilizing Areas in a Clinic and Larger Facility

Although the space requirements for performing various minor surgical procedures may not be different, it may still be quite different to some extent depending on the classification of the procedure (semi critical or critical), the instrument processing requirements (high-level disinfection or sterilization). Inserting or removing an IUD, for example, is classified as a semi critical procedure not normally sterile, or can be made so if necessary (Spaulding, 1968). In contrast, inserting a laparoscope into the abdomen is classified as a critical procedure because tissues that are normally sterile are being touched. For the former, either sterile or high-level disinfected instruments are acceptable, but for the latter, the preferred final processing is sterilization. To sum up, it should be noted that sterile metal instruments with laparoscopy, calls for an additional separate area for final processing (high-pressure sterilization by autoclaving). (Figure 12-1b). This is especially important if the volume of services is high (five or more procedures per day).

The space, equipment and need for well-defined traffic flow and activity patterns become progressively more complex as the type of surgical procedure changes from general surgery and obstetrics to open heart surgery.

As a guide, the space requirements for the types of surgery typically performed at district hospitals are roughly the same as that of a busy surgical center or polyclinic. These include:

- Changing room and scrub area for the clinic staff.
- Preoperative area where clients are examined and evaluated prior to surgery.
- Operating room
- Recovery area for observation of patients after surgery (may be combined with the preoperative area).
- Processing area for cleaning and sterilizing or high-level disinfecting instruments and other items.
- Space for storing sterile packs and/or high-level disinfected containers of instruments and other items.

12.3. Traffic flow and activity patterns

The recommended infection prevention practices for minimizing microbial contamination of specific areas in healthcare facilities are briefly described below.

ICU and Isolation room

- Limit traffic to authorized staff and patients at all times.
- Permit only the patient and staff (performing and assisting) Only two family members should be limited at a time in one room for limited period of time in a day (wearing clean attire and head-cover).
- Patients can wear their own clean clothing.
- Staff should wear attire and personal protective equipment (PPE) according to procedures performed. Family member who allowed to inter should wear head cover, face mask, gown and shoe cover above their clean close and shoe.
- Family member who reported to have acute URTI should not be allowed to inter

Procedure area

- Limit traffic to authorized staff and patients at all times.
- Permit only the patient and staff (performing and assisting) in the procedure room (family members should be limited with obstetrical procedures).
- Staff should wear attire and personal protective equipment (PPE) according to procedures performed.
- Place a clean container filled with clean water mixed with enzymatic detergent solution(if available) for immediately immersing of instruments and other items once they are no longer needed.
- Have a leak proof and covered waste container for disposal of contaminated waste items (cotton, gauze, dressings) right after use.
- Have a puncture-resistant container for safe disposal of sharps (e.g. used suture needles, hypodermic needles and syringes, and disposable scalpel blades) right after use.

- Have storage space in procedure rooms for clean, high-level disinfected and sterile supplies (Storage shelves should be enclosed to minimize dust and debris collecting on stored items).

Surgical unit

The surgical unit is often divided into four designated areas defined by the activities performed in each unrestricted area: **transition zone**, **semi restricted** and **restricted area**. Environmental controls and use of surgical attire increase as one move from unrestricted to restricted areas. Moreover, staff with respiratory or skin infections and/uncovered open sores should not be allowed in the surgical unit.

Different Areas in Surgical Unit

Post signs in each area to clearly indicate the appropriate environmental control and surgical attire required.

A. Unrestricted Area Note

This area is the entrance from the main corridor and is isolated from other areas of the surgical unit. This is the point through which the staff, patients and materials enter the surgical unit.

B. Transition Zone

This area consists primarily of dressing rooms and lockers. It is where the staff put on surgical attire that allows them to move from unrestricted to semi-restricted or restricted areas in the surgical unit. Thus, only authorized staff should enter this area.

C. Semi-Restricted Area

This is the peripheral support area of the surgical unit and includes preoperative and recovery rooms; storage space for sterile and high-level disinfected items; and corridors leading to the restricted area. This is an area where support activities (e.g. instrument processing and storage) for the operating room are carried out. So,

- Limit traffic to authorized staff and patients every time.
- Have a work area for processing of clean instruments.

- Have storage space for clean, sterile or high-level disinfected supplies with enclosed shelves to minimize dust and debris collecting on stored items.

Flip flops or sandals should not be worn as they provide no protection from dropped sharps.

- Have doors limiting access to the restricted area of the surgical unit.
- Staff working in this area should wear surgical attire and a cap.
- Staff should wear clean and closed shoes that will protect their feet from fluids and dropped items.

D. Restricted Area

This designated area consists of the operating room(s) and scrub sink areas.

Never store instruments and other items in the operating room

- Limit traffic to authorized staff and patients at all times.
- Keep the door closed at all times, except during movement of the staff, patients, supplies and equipment.
- Scrubbed staff must wear full surgical attire and cover head and facial hair with a cap and mask.
- Staff should wear clean and closed shoes that will protect their feet from fluids and dropped items.
- Masks are required when sterile supplies are open and when the scrubbed staffs are operating.
- Patients entering the surgical unit should wear clean gowns or be covered with clean linen and have their hair covered.
- Patients do not need to wear masks during transport (unless they seek airborne precautions).

E. Operating Room(s)

- The operating room should be enclosed to minimize dust and eliminate flies; however, central air conditioning is necessary (If windows are the only ventilation, provide tight-fitting screens).
- The operating room should be located away from areas of the hospital or healthcare facility that are heavily staffed with frequent movements of the staff and patients.

F. Work Area

- According to the size and type of the healthcare facility, the work area for processing instruments (e.g. the Central Sterile Supply Department or CSSD) may be: part of the surgical unit; or just connected to it; or an independent area somewhere away from it.
- This is the area where instruments, surgical gloves and equipment are processed and where the staff should be specially trained in handling, processing and storing instruments, equipment and other clean, sterile or high-level disinfected items. The CSSD is considered a semi-restricted area; hence all the recommendations for traffic patterns and proper attire described above should be followed.

Permit only authorized personnel to enter this area.

How to Conduct Activities at Surgical Unit

Before surgical procedures

- Place a plastic bag or leak proof-covered waste container for contaminated waste items (cotton gauze and old dressings).
- Place a puncture-resistant container for the safe disposal of sharps (e.g. suture needles, hypodermic needles and syringes, and disposable scalpel blades) at the point of use but without contaminating the sterile field.
- Place a leak proof and covered waste container for soiled linen away from sterile items.
- Organize tables, Mayo and ring stands side by side in an area away from the traffic patterns and at least 45cm (18 inches) from walls, cabinets and other non-sterile surfaces.

- Place a clean sheet, a lift sheet and arm board covers on the operating room bed.
- Check and set up suction, oxygen and anesthesia equipment.
- Place supplies and packages those are ready to open on the tables, not on the floor.
- Mayo stand and other non-sterile surfaces that are to be used during the procedure should be covered with a sterile towel or cloth.

During surgical procedures

- Limit the number of staff entering the operating room only to those necessary to perform procedures and to patients (family members as deemed necessary). Make the surgical team self-sufficient so that outside help is not required.
- Keep the doors closed at all times, except during movement of the staff, patients, supplies and equipment.
- Keep the number of people and their movement to a minimum; because, the numbers of microorganisms is directly proportional to an increase with people's activity.
- Keep talking to the minimum in the presence of a sterile field.
- Scrubbed staff should wear full surgical attire including:
 - A clean scrub suit covering the bare arm (one or two pieces); if a two piece pantsuit is worn, the top of the scrub suit should be tucked into the pants;
 - A clean surgical cap that covers the head;
 - Clean, closed shoes that protect the feet from fluids or dropped items; and
 - Sterile (or high-level disinfected) surgical gloves, protective eyewear and a mask covering the mouth, nose and any facial hair.
- Scrubbed staff should keep their arms and hands within the operative field at all times and touch only sterile items or areas. Non-scrubbed staff should wear surgical attire including:
 - Long sleeved jackets banded at the wrist and that are closed during use;
 - A clean surgical cap that covers the head;
 - Clean, closed shoes that protect the feet from fluids or dropped items; and
 - A mask covering the mouth, nose and any facial hair.
- Non-scrubbed staff should stay at the periphery of the operating room, keeping their distance from sterile areas. They should not lean or reach over the operative field.

- Clean accidental spills or contaminated debris in areas outside the surgical field with a 0.5% Chlorine solution as promptly as possible (a non-scrubbed staff member wearing utility gloves should do this).

After surgical procedures:

Non-scrubbed staff wearing utility gloves should:

- Collect all waste and remove it from the room in closed leak proof containers.
- Close and remove puncture-resistant containers when they are three quarters full.
- Remove covered containers with a 0.5% chlorine solution with instruments and surgical gloves from the room.
- Remove soiled linen in closed leak proof containers.
- Remove waste, soiled linen, soiled instruments and equipment and supplies that have been opened but not used, in an enclosed cart or in a leak proof and covered waste container. (Be sure that these items do not reenter the restricted area).

Central sterile supply and storage

A CSSD consists of four areas, as shown in Figure 12-2. These areas are:

1. The “dirty” receiving/cleanup area,
2. The “clean” work area,
3. The cleaning equipment storage area, and
4. The sterile or high-level disinfected storage area.

Following surgery, Place soiled instruments in their original sterile wrap and transport them to the CSSD where they can be immediately cleaned before further processing.

Separate the “dirty” receiving/cleanup area (1) from the “clean” work area (2) with a physical barrier (wall and door). If this is not possible, use a screen or paint a red line on the floor to designate separation between areas.

Note: Develop flow patterns to help ensure that contaminated items never come in contact with clean, disinfected or sterile items.

The function and equipment requirements for the four areas of a typical CSSD are summarized below.

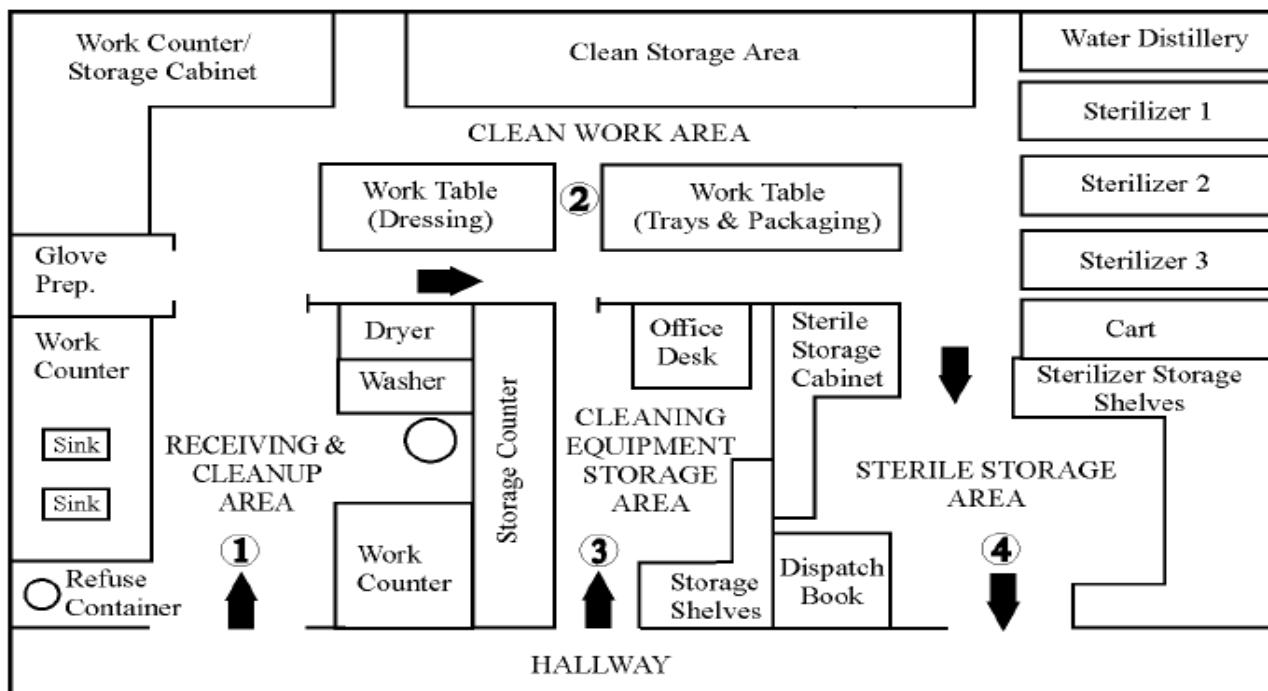


Figure 12-2: Floor Plan for a Central Sterile Supply Department in a Hospital

1. Dirty Receiving/Cleanup Area

In this area, soiled items are received, disassembled, washed, rinsed and dried. Congruently, the Staff in the receiving/cleanup area should wear plastic aprons, utility gloves and safety goggles or face shields to protect themselves from spills and splashes. The “dirty” receiving/cleanup area should have:

- Two sinks if possible (one for cleaning with detergent and one for rinsing) with a clean water supply; and
- A clean equipment counter for drying.

2. Clean Work Area

In the clean work area, cleaned items are;

- Inspected for flaws or damage;
- Packaged (if indicated) and either sterilized or high-level disinfected; and

- Sent for storage as packaged or air dried and placed in a sterile or high level disinfected container.

The clean work area should have

- A large work table;
- Shelves for holding clean and packaged items; and
- A high-pressure steam sterilizer, a dry-heat oven, a steamer or a boiler.

Staff entering the clean work area should wear clean cover gowns

2. Clean Equipment Storage Area

Store: Clean the equipment in this area. The staff of CSSD should also enter the department through this area. Equip the area with:

- Shelves (preferably enclosed) for storing clean equipment, and
- An office or desk for record keeping.

3. Sterile or High-Level Disinfected Storage Area

Store sterilized packs and covered sterile or high-level disinfected containers in this area. This area should be separated from the central sterile supply area:

- Limit access to the storage area and/or store items in closed cabinets or shelves. (Shelves or cabinets had better be closed as they protect packs and containers from dust and debris. Open shelves are acceptable only if the area has limited access and if housekeeping and ventilation practices are controlled).
- Keep the storage area clean, dry, dust-free and lint-free by following a regular housekeeping schedule.
- Packs and containers with sterile or high-level disinfected items should be stored 20 to 25 cm (8 to 10 inches) off the floor, 45 to 50cm (18 to 20 inches) from the ceiling and 15 to 20cm (6 to 8 inches) from an outside wall.
- Do not use cardboard boxes for storage. (Cardboard boxes shed dust and debris and may harbor insects).

- Date and rotate the supplies (first in, first out). This process serves as a reminder that the package is susceptible to contamination and conserves storage space, but it does not guarantee sterility.
- Packs will remain sterile as long as the integrity of the package is maintained.
- Sterile or high-level disinfected containers remain so up until they are opened.
- Dispense sterile and high-level disinfected articles from this area.

Shelf Life of Sterile Items (Belkin, 1997a; Belkin, 1997b)

- The shelf life of a packaged sterile item is event-related and not time related.
- An event can compromise the integrity and effectiveness of the package.
- Events that can compromise or destroy package sterility include multiple handling, loss of package integrity, moisture penetration and airborne contamination.
- Sterility is lost when the package has tears in the wrapper, has become wet, has been dropped on the floor, has dust on it or is not sealed.
- The shelf life of a sterile package will depend on: the quality of packing; conditions during storage and transport; and the amount of handling prior to use.
- Sealing sterile packs in plastic bags can help prevent damage and contamination.
- Most contaminating events are related to excessive or improper handling of the packages.

The ideal number of times an item should be handled is three:

1. When removing it from the sterilizer cart and placing on a storage shelf,
2. When transporting it to the place where it is to be used, and
3. When selecting it to be opened for use.

Handling and Transporting Instruments and Other Items

- Keep clean and high-level disinfected or sterile instruments and other items separate from soiled equipment and waste items. Do not transport or store these items together.
- Transport high-level disinfected and sterile instruments and other items to the procedure or operating room in a closed cart or container with a cover to prevent contamination.

- Remove supplies from all shipping cartons and boxes before bringing such supplies into the procedure room, the operating room or the clean work area of the CSSD. (Shipping boxes shed dust and harbor insects that may contaminate these areas).
- Transport soiled supplies and instruments to the receiving/cleanup area of the CSSD in leak proof and covered waste containers.
- Transport contaminated waste to the disposal site in leak proof and covered waste containers.

Note:

If supplies are being delivered to the surgical area; one person standing outside should pass them through the door to a person inside the operating room.

Summary

Irrespective of the existing layout of the facility, design traffic flow and work practices in such a way that keeps soiled/contaminated instruments, equipment, and textiles separate from the clean and sterile instruments, equipment, and textiles, whether in the OT or in the CSSD. Appropriate traffic flow and work practices prevent accidental contamination of clean items and reduce the risk of infections to patients, HCWs, and visitors.

CHAPTER 13: INFECTION PREVENTION AND CONTROL ASPECTS OF OCCUPATIONAL HEALTH IN HEALTH CARE SETTINGS

Chapter objectives

The objective of this chapter is to enable participants understand the role of occupational health and safety in infection prevention control activities in health care facilities.



Learning objectives

By the end of this chapter, participants will be able to:

- Identify infectious hazards and risks in health care facility
- Explain role occupational health activities for the prevention and management of infections in HCWs
- Describe occupational health activities for management of job-related illnesses and occupational exposures
- Describe prevention strategies for infections relevant to occupational health in health care facilities
- Elucidate post exposure prophylaxis for HIV and HBV
- Explain monitoring of occupational health activities

Chapter Content

- 13.1. Overview
- 13.2. Hazard Identification, Risk Assessment and Risk Control
- 13.3. Occupational health activities for the prevention and management of infections in HCWs
- 13.4. Occupational Health Activities for Management of Job-Related Illnesses and Occupational Exposures
- 13.5. Prevention Strategies for Infections Relevant to Occupational Health in Health Care Facilities
- 13.6. Occupational Health Activities for specific groups of health care workers

13.7. Post Exposure Prophylaxis for HIV and HBV

13.8. Monitoring of occupational health activities

13.1. Overview

Occupational exposures to sharps injuries are an example of the substantial impact of occupational infections among HCWs. It is estimated that 39% of hepatitis C virus (HCV), 37% of Hepatitis B virus (HBV), and 4.4% of HIV infections among HCWs worldwide are attributable to occupational exposure due to sharps injuries. This amounts to an estimate of 16,000 HCV, 66,000 HBV, and 1,000 HIV occupational infections annually (Prüss-Üstün *et al.* 2005). It is thought that more than 90% of these are in limited-resource countries. (IFIC 2003)

Occupational Health deals with all aspects of work-related health and safety and has a strong focus on prevention, especially for infectious (such as disease exposures) and non-infectious risks (such as injury). The goals of infection prevention and control (IPC) intersect with those of occupational health in preventing and addressing infectious hazards at health care facilities. Therefore, a large portion of occupational health activities at a health care facility are also IPC activities. (APIC 2014a)

13.2. Hazard Identification, Risk Assessment and Risk Control

Hazard Identification: This is the process of examining each work area and work task for the purpose of identifying all the hazards which are “inherent in the job”. Work areas include but are not limited to machine workshops, laboratories, office areas, agricultural and horticultural environments, stores and transport, maintenance and grounds, reprographics, and lecture theatres and teaching spaces.

Risk Assessment: Is defined as the process of assessing the risks associated with each of the hazards identified so the nature of the risk can be understood. This includes the nature of the harm that may result from the hazard, the severity of that harm and the likelihood of this occurring.

Risk Control: Taking actions to eliminate health and safety risks so far as is reasonably practicable. Where risks cannot be eliminated, then implementation of control measures is

required, to minimize risks so far as is reasonably practicable. A hierarchy of controls has been developed and is described below to assist in selection of the most appropriate risk control measure/s.

13.3. Occupational health activities for the prevention and management of infections in HCWs

The goal of occupational health activities is to protect HCWs—and thereby their patients—from acquiring an infection or any other hazard while working in a health care facility. This goal is achieved by:

- Identifying work-related infection risks and hazards and preventing them
- Ensuring prompt and appropriate management of any occupational exposures to infections or other hazards
- Training all HCWs on IPC and patient safety practices and how to protect themselves against the risks of occupational exposures to infections and other hazards
- Monitoring and investigating potentially harmful exposures and outbreaks among HCWs
- Preventing infections by carrying out occupational health activities (APIC 2014a; CDC 1998; WHO 2016c)

13.4. Occupational Health Activities for Management of Job-Related Illnesses and Occupational Exposures

The occupational health team should respond to all potential and confirmed exposures to blood-borne pathogens and other infectious diseases immediately and collaborate with IPC staff for follow-up as necessary. Health care facilities should have systems in place for HCWs to report sharps injuries and blood borne pathogen exposures with prompt evaluation and follow-up.

Summary of Key Elements of Occupational Health Activities

The following are the key elements for occupational health programs in health care facilities:

- Oversight by a qualified health care professional or team
- Coordination among multiple hospital departments
- Medical evaluation at the start of employment

- Health and safety education and training of all staff
 - Immunization programs
 - Management of work restrictions and post-exposure treatment for occupational illnesses and exposures
 - Counseling on protection from and management of accidental exposure to blood borne and other infectious pathogens
 - Maintenance of personnel health records
- (APIC 2014a; CDC 1998; WHO 2002)

13.5. Prevention Strategies for Infections Relevant to Occupational Health in Health Care Facilities

- **Prevent occupational exposure** of HCWs by the application of Standard Precautions for all patients, at all times, as well as disease- or syndrome-specific Transmission-Based Precautions, to prevent exposures to infectious agents.
- **Protect against vaccine-preventable diseases:** Having a mandatory program that requires all HCWs to receive vaccines to protect themselves against vaccine-preventable diseases has been found to be more effective than a voluntary program in ensuring that all susceptible staff are vaccinated. In settings with limited resources, priority should be given to staff who are at high risk of exposure and those without any existing immunity. Select the vaccines that may provide the most protective effects, such as hepatitis B or influenza.
- **Manage occupational exposures** following the national guidelines (e.g., national guidelines for management of occupational exposure to blood and body fluids) (Refer to Chapter 6, Sharps Injuries and Management of Exposure to Blood borne Pathogens, in this volume for post-exposure management of HBV, HCV, and HIV).
- **Keep up to date** by seeking additional information on specific diseases and local epidemiology:

13.6. Occupational Health Activities for specific groups of health care workers

Certain groups of workers at a health care facility may require special attention related to occupational health activities. They include pregnant staff, laboratory staff, emergency response staff, and HCWs infected with HIV, HBV, or HCV.

Pregnant Health Care Workers

Pregnancy does not increase the risk of acquisition of infection for most occupationally acquired infections, and clinical manifestations are no more severe in pregnant women than in others (APIC 2014b). However, pregnant HCWs may be anxious about potential infection and possible harm to their babies.

Laboratory Staff

HCWs in laboratories may be at increased risk of occupational exposure to the pathogens with which they work. Laboratory staff should receive specific training on the risks and how to avoid them (such as working under a bio-containment hood, using a closed centrifuge, avoiding mouth pipetting) and have access to PPE, as required, according to the procedures they perform and the pathogens with which they have contact.

Emergency Response Staff

HCWs who respond to emergencies and transport patients should not be overlooked during occupational health activities. These HCWs are at a high risk of exposure to blood borne pathogens and should have access to HBV vaccination, have adequate PPE and thorough instruction on proper PPE use, and be taught to apply Standard Precautions for all patients at all times.

Health Care Workers exposed TO HIV and/or Hepatitis B or C

HIV, HBV and HCV are the primary infectious agents that can be transmitted via exposure to bodily fluids. In addition to percutaneous injury, contact of mucous membranes or non-intact skin with blood, fluids containing blood, tissue or other potentially infectious bodily fluids pose an infectious risk. Potentially infectious body fluids include semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, pericardial fluid, amniotic fluid,

pus, etc. In this case, body fluids like faeces, nasal secretions, saliva, sputum, sweat, tears, urine, and vomits are not considered infectious unless they contain blood.

13.7. Post Exposure Prophylaxis for HIV and HBV

PEP for Occupational Exposure to HIV

PEP is effective when initiated within 72 hours of exposure. Taking the evidences mentioned above into consideration, most international guidelines recommend PEP drugs to be started for exposed persons (based on the indication) as early as possible preferably within 2 hours of exposure but giving PEP drugs after 72 hours of exposure is not generally advisable.

Exposure to Hepatitis B Virus

HBV infection is a well-recognized occupational risk for HCP (Mast EE et al., 1993). The risk of HBV infection is primarily related to the degree of contact with blood in the work place and also to hepatitis B e antigen (HBeAg) status of the source person. In studies of HCP who sustained injuries from needles contaminated with blood containing HBV, the risk of developing clinical hepatitis, if the blood was both hepatitis B surface antigen (HBsAg) and HBeAg-positive was 22% to 31%; the risk of developing serologic evidence of HBV infection was 37% to 62%.

Exposure to Hepatitis C Virus

The CDC recommends follow-up testing for an exposure to HCV with anti-HCV antibody testing within 4 to 6 months. So it is resolved that a positive antibody test should prompt HCV viral load and liver function tests. Once exposure is confirmed, the management and follow up of non-occupational HCV exposure is similar to that of the occupational exposure.

13.8. Post-Exposure Management Steps (HBV, HCV and HIV)

STEP 1 Time frame – immediately, within 30 minutes. Person responsible: Exposed HCW.

- Provide immediate care to the exposure site:
- Wash the exposed skin and any wound with soap and water.
- Mucous membranes with water for 15 minutes.
- DO NOT use any antiseptic or caustic agents such as bleach.

STEP 2 Timeframe – immediately after reporting. Person responsible: Physician, in-Charge of PEP management determines the risk associated with exposure

STEP 3 Time frames – as soon as possible, preferably within 24 hours. Person responsible: Physician, in-Charge of PEP management, HCW.

Evaluate the exposed HCW:

- Check history of hepatitis B vaccination (currently there is no vaccine for hepatitis C or HIV).
- Determine immune and infection status of the exposed HCW.

STEP 4 Timeframe – as soon as possible, preferably within 24 hours, simultaneously with Step 3 above. Person responsible: In-Charge of PEP management, patient's treating physician.

Evaluate the exposure source:

- Obtain detailed information on clinical status of the source person.
- Determine vaccination and immune status of the source person:

STEP 5 Timeframe – as soon as test results return (if any), must be within 72 hours from exposure. Person responsible: Physician, In-Charge of PEP management, HCW.

Establish eligibility for PEP: PEP is not indicated if:

- The exposed HCW is known to be HIV-positive.
- The source person is HIV-negative.
- Exposure is limited to intact skin.

STEP 6 Prescribe PEP: Time frame initiate PEP as early as possible but within 72 hours

- Continue ARVs for HIV for 28 days.
- Continue HBV vaccine schedule over 6 months
- Provide adherence counseling and address any drug interactions.
- Follow national guidelines or WHO recommendations for PEP

STEP 7 Timeframe - 72 hours – 6 months after exposure. Person responsible: Physician, In Charge of PEP Management, HCW.

Follow-up:

- Provide follow-up for adherence and any side effects of ARVs and address questions that the individual may have.
- Arrange for an HIV test at 3 months after the exposure.
- Arrange for HBV vaccine at 1 and 6 months, if indicated.
- Link HIV care and treatment, including prevention measure for protecting others, in case the HIV test results are positive.
- Provide additional counseling and other preventive interventions, as needed, and if test results are negative.
- Document all PEP provided, following facility and national guidelines.
- Monitor PEP provision in the facility.

13.9. Monitoring of occupational health activities

Health care facilities should evaluate the effectiveness of occupational health interventions and practices on a routine basis. They should conduct surveillance to collect, analyze, and disseminate data on risks to HCWs. There should be a system to report any occupational exposure and injury, which should be supported by prompt management and PEP. The rates of injuries or exposures among HCWs should be routinely reviewed and reported back to the staff and strategies and action plans to prevent future injuries should be developed and updated.

Surveillance activities can be conducted by the staff organizing occupational health activities at the facility and/or with the assistance of IPC staff.

Summary

In the course of their duties, millions of HCWs around the world are routinely exposed to a variety of health and safety hazards, including infectious agents. Infections can be transmitted to HCWs, who can in turn transmit the infections to patients and others. The goals of IPC intersect with those of occupational health activities in preventing and addressing infectious hazards at health care facilities. Therefore, IPC staff should be involved in occupational health activities at the facility, and occupational health staff should be knowledgeable about IPC.

CHAPTER 14: CLIENT EDUCATION ON INFECTION PREVENTION AND CONTROL (IPC)

Chapter objectives

The objective of this chapter is to enable participants understand the importance of educating clients on infection prevention control for effectiveness of health facility IPC program. And to empower health professionals on the techniques for educating clients in health care facility.



Learning objectives

By the end of this chapter, participants will be able to:

- Explain the significance of client education on IPC
- Describe components of effective client Education Program
- List steps in client's education on IPC
- Explain models of client Education

Chapter Content

- 14.1. Overview
- 14.2. Components of Effective client Education Program
- 14.3. Good Examples of Patient Education Program
- 14.4. Steps in client's education on IPC
- 14.5. Models of Client Education

14.1. Overview

Educating and empowering patients and clients to actively participate in their care help reduce a patient's risk of hospital acquired infections. Creating an open dialogue, however, can be a challenge in today's healthcare system

Four components have been reported as being fundamental to the process of patient/client empowerment:

1. Patient understands of his/her own role;

2. Patient's acquisition of sufficient knowledge on their ability to collaborate or involve with their healthcare provider;
3. Patient's knowledge and skills; and
4. The presence of facilitating environment

14.2. Components of Effective client Education Program

1. Have clear policies and procedures in place that guide proper implementation of patient education and empowerment.
2. Have a clear assignment of roles and responsibilities for all steps in patient education process to qualified individuals within a context of shared responsibility and accountability. The list is inclusive of the patient's primary care provider, other physicians, nurses, pharmacists and other clinicians. The qualifications of the responsible individuals should be determined by the healthcare organization within the limits of applicable law and regulation.
3. Incorporate training on procedures and basic principle for patient education into the educational curricula, orientation and continuing professional development activities for healthcare professionals.
4. Develop and include an evaluation component that includes using both qualitative and quantitative measures to determine not only what works, but under what conditions and within which organizational context the program works.
5. Background of evidences on effective patient/client education program

14.3. Steps in client's education on IPC

1. Make the patient comfortable

The general standard on patient education also requires that the hospital provide the patient with education on how to communicate concerns about patient safety issues. Patients may feel cautious or apprehensive about asking questions because they do not want to be considered a tough patient but encouraging them to speak up can go a long way in preventing infections.

2. Help the patient become an active participant

Talk to the patient about what he or she can do to optimize care, instead of focusing solely on what the healthcare provider is going to do for the patient. Patients want to be involved in their care. They want to be an active participant. And family members want to be involved in any way they can.

4. Let patients know what their care should look like as well

Educate the patient on what dressings or catheters need to be changed on a daily basis and what the process looks like. Showing the patient what to expect and what techniques help prevent infections empowers him or her to look out for potential risks when shifts change and someone else begins changing his or her dressings.

5. Don't forget about high-risk patients.

For patients at a higher risk of infection, such as those who are diabetic, taking immune suppressive drugs, overweight or smokers, healthcare providers need to discuss how these issues heighten their risk for infection. Patients in the intensive care unit are also considered high risk. Healthcare providers should encourage ICU patients to get up and out of bed.

6. Understand the patient's rights of education

According to EFDA standards, the patient possesses the right to receive information in a manner in which the patient understands. In certain cases the hospital may need to provide interpreting or translation services to accommodate the patient's communication needs. These needs should be determined during the initial learning needs assessment.

14.4. Models of Client Education

Reminders and Motivational Messages

Patient empowerment models often include visual reminders for both the HCW and the patient. These visual reminders usually include small badges or stickers worn by patients with a message such as "did you wash/sanitize your hands?" If the message is framed correctly, posters can serve as a visual reminder and encouragement for both the patient and the HCW to participate in hygiene practices of the hands.

Role modeling

Role modelling in which the HCW's behaviour towards Hand hygiene or other positive behavior is influenced by either peers or superiors has been observed to influence compliance and motivation of the patient to be empowered.

Graphic illustrations (pictures, pictographs, models)

Research has shown that using pictures including cartoons or pictographs with verbal explanations and use of models can greatly increase patient's understanding and retention of information.

Summary

Educating and empowering patients and clients to actively participate in their care help reduce a patient's risk of hospital acquired infections. Actionable strategies are being developed with a strong emphasis on working in partnership with healthcare authorities, partners and professionals.

They are the basis of infection control precautions which are to be used as a minimal expectation in the care of all patients. For example, Hand hygiene is a major component of standard precautions and one of the most effective methods to prevent transmission of pathogens associated with healthcare. In addition to that, the use of personal protective equipment should be guided by risk assessment and the extent of contact anticipated with blood and body fluids, or pathogens. Supplementary to the practices carried out by health workers when providing care, all individuals (including patients and visitors) should comply with infection control practices in health care settings.

VOLUME 2: ADVANCED AND SPECIAL INFECTION PREVENTION AND CONTROL PRACTICES

Section 1: Prevention of AMR:

Chapter 1: Rational use of antibiotics

Chapter 2: Antimicrobial Stewardship Program.

Section 2: Prevention of Common Health care Associated Infections:

Chapter 1: Surgical Site Infection (SSI)

Chapter 2: Catheter Associated Urinary Tract Infection (CAUTI)

Chapter 3: Intravascular Catheter Associated Blood Stream Infection
(ICABSI/CLABSI)

Chapter 4: Health Care Associated Pneumonia (Including Ventilator Associated
Pneumonia),

Chapter 5: Preventing Health Care-Associated Infectious Diarrhea

Section 3: Surveillance of HAI

Chapter 1: Introduction to Surveillance of HAI

Chapter 2: Basic Epidemiology and Biostatistics for IPC

Section 4: IPC in Special Settings:

Chapter 1: IPC in Operating Theater

Chapter 2: IPC in Intensive (Critical care) Unit

Chapter 3: IPC in Laboratory

Chapter 4: IPC in Blood Bank and Transfusion Services

Chapter 5: IPC in Maternal and Neonatal unit

Chapter 6: IPC in Mortuary

Section 5: IPC Programme Management and Governance:

Chapter 1: Infection Prevention and Control in Public Health Emergency and
Outbreak management.

Chapter 2: Managing IPC Program.

SECTION 1: PREVENTION OF AMR

CHAPTER 1: RATIONAL USE OF ANTIBIOTICS

Chapter objective

This Objective of the chapter is to enable participants understand the basic concept of antimicrobial resistance to minimize the emergence and transmission of resistance to drugs used in infection prevention and control.



Learning objectives

By the end of this chapter participants will be able to:

- Explain Consequences and magnitude of antibiotic resistance
- Identify the Causes of antibiotic resistance
- Describe Rational use of antibiotics
- Explain promotion of rational use of antibiotics

Chapter content

- 1.1. Overview of the rational use of antibiotics
- 1.2. Consequences and magnitude of antibiotic resistance
- 1.3. Causes of antibiotic resistance
- 1.4. Rational use of antibiotics
- 1.5. Promotion of rational use of antibiotics

1.1. Overview of the rational use of antibiotics

Critical aspects of the broader global response to antimicrobial resistance 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 persistent expansion of antimicrobial resistance, 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, while 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 HCWs to treat infectious diseases and has increased health care costs. It is critical that necessary measures to respond to the resistance crisis be taken at all levels (by institutions as well as local and national governments). Measures should include rational use of antimicrobials through the incorporation of careful antimicrobial stewardship activities and programs. Ultimately, improving antimicrobial use involves actions at the national level to guide treatment decisions made by informed HCWs as well as the awareness and cooperation from patients. While this chapter focuses on antibiotics, its recommendations can be applied to all antimicrobials (WHO 2015; WHO 2016).

1.2. Consequences of Antibiotic Resistance

Antibiotic resistance makes it harder to treat infections were effectively treated a few decades ago. Leads to increased medical costs, extended hospital stay, increased toxicity, adverse effects, and mortality. 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 2016). Infections such as pneumonia, tuberculosis, bloodstream infections (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 (see **Error! Reference source not found.**).

Table 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	<i>Enterococcus faecium</i> , vancomycin-resistant	<i>Streptococcus pneumoniae</i> , penicillin-non-susceptible
<i>Pseudomonas aeruginosa</i> , carbapenem-resistant	<i>Staphylococcus aureus</i> , methicillin-resistant, vancomycin-intermediate and resistant	<i>Haemophilus influenzae</i> , ampicillin-resistant
<i>Enterobacteriaceae</i> , carbapenem-resistant, Extended Spectrum Beta	<i>Helicobacter pylori</i> ,	<i>Shigella</i> spp., fluoroquinolone-resistant

Lactamase-producing	clarithromycin-resistant <i>Campylobacter</i> spp., fluoroquinolone-resistant <i>Salmonellae</i> , fluoroquinolone-resistant <i>Neisseria gonorrhoeae</i> , cephalosporin-resistant, fluoroquinolone-resistant	
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Adapted from: WHO 2017c.

1.3. 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. Thus in the presence of an antibiotic, only the resistance microbes will continue to survive and grow and become the dominant population. This phenomenon is called “selective pressure” and results in growth of resistant bacteria that will replace the susceptible bacteria (see **Figure 2-1-1-1 from Reference Manual**).

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.

- Poor compliance with recommended infection prevention and control (IPC) practices.

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 misuse of antibiotics are not available. This results in antibiotics being available without a prescription from a clinician authorized to prescribe, which increases inappropriate use of antibiotics.

Commonly Available Antibiotics

When bacteria develop resistance to an antibiotic, resistance to other members within the same class is possible. **Figure 2-2-2-2** from your reference manual Provides examples of the classes and the individual antibiotics within each class those are commonly available.

2. 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 health care provider.

Determinants of Irrational Use of Antibiotics

There are several determinants of irrational use of antibiotics:

- Lack of provider knowledge, particularly 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 and Haak 2003; Rowe et al. 2005; Sketris et al. 2009; WHO 2002)

1.4. Promoting Rational Use of Antibiotics

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

WHO recommends the following core interventions to promote 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 standard treatment guidelines
- Drugs and therapeutics committees to oversee antibiotic use in districts and health care 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 in order to prevent over-prescribing
- Public education about rational use of medicines
- Appropriate and enforced regulation
- Sufficient government expenditure to ensure availability of medicines and trained staff.

(Refer reference manual of IPC page #00)

Summary:

Antibiotics have become major components of healthcare interventions. The use and misuse of antibiotics have led to the emergence of multi-resistant strains. 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.

CHAPTER 2: ANTIBIOTIC STEWARDSHIP PROGRAMS

Chapter Objective

The objective of this chapter is to enable participant understand the importance, practice and implementation of antibiotic stewardship programs and coordinated interventions at the health care facility level.



Learning objectives

By the end of this chapter participants will be able to:

- Understand the general overview of Antimicrobial Stewardship Programme
- Describe the Goals of an Antimicrobial Stewardship Programme
- Identify the core elements of an Antibiotic Stewardship Program
- Describe the Intervention Modalities for Implementing AMS programme

Chapter content

- 2.1. Overview
- 2.2. Goals of an Antimicrobial Stewardship Program
- 2.3. Core Elements of an Antibiotic Stewardship Program
- 2.4. Intervention Modalities for Implementing AMS program

2.1. Over view of antibiotic stewardship programs

Antibiotic stewardship programs are coordinated interventions at the health care 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 health care costs
- Reduce antibiotic resistance

- Prevent the creation of antibiotic-resistant strains (Barlam et al.2016;CDC 2015a).

2.2. The goals of an antibiotic stewardship program should include:

- 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 health care costs without an adverse impact on quality of care

2.3. Core Elements of an Antibiotic Stewardship Program

- Leadership commitment
- Accountability and drug expertise
- Implementation of policies and interventions
- Tracking and reporting antibiotic use and outcomes
- Education

1. Leadership commitment

Leadership support is an important component of successful stewardship programs. Leadership should support creating 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 facility level.

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

2. Accountability and drug expertise

Designated leadership of the program helps to 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 qualified clinical professional or 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 health care facility who can assist with and support the program activities. At large hospitals these may include clinical microbiologists, laboratory staff, information system staff, quality improvement staff, IPC staff, hospital epidemiologists, department heads, clinicians, and nursing staff (for details see [Figure 2-1-2-2-1 from reference manual](#)). 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 (CDC 2015a).

3. Implementation of policies and interventions

Key activities would fall under implementing policies that support optimal antibiotic use and identifying interventions 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 to 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, urinary tract infections, and surgical prophylaxis. Adapt national guidelines to local conditions if indicated.

- Implement broad, pharmacy-driven, infection- and syndrome-specific interventions (see details in SECTION 1CHAPTER 2: MANAGING INFECTION PREVENTION AND CONTROL PROGRAM, in the Facility-Level Recommendations and Strategies section).

4. Tracking and reporting antibiotic use and outcomes

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:

Qualitative assessment of antibiotic prescribing patterns in the health care 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, right duration, and 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 change.

Antibiotic use measure: Health care facilities implementing antibiotic stewardship programs measure antibiotic use either as days of therapy or defined daily dose. (See [Appendix 2-1-2-1](#) for more information on antibiotic use measures.)

Management of information on drug utilization requires dedicated training of pharmacy staff. Health care facilities embarking upon such activities should ensure that the pharmacy staff are appropriately trained.

5. 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.

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.

**SECTION 2: PREVENTION OF HEALTHCARE ASSOCIATED
INFECTIONS**

CHAPTER 1: PREVENTION OF SURGICAL SITE INFECTION (SSI)

Chapter Objective:

The objective of the chapter is to enable participants understand how to prevent surgical site infection (SSI).

Learning objectives

By the end of this chapter, participants will be able to

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

Chapter content:

- 1.1. Over view
- 1.2. Risk factors for SSI
- 1.3. Prevention of SSI
- 1.4. Commonly used antiseptics for infection prevention and control
- 1.5. Monitoring and surveillance of SSIs
- 1.6. Quality improvement for prevention of SSIs

1.1. Overview

Considerable progress has been made in understanding the cause and prevention of SSIs in the past 100 years. Postoperative wound infections, however, remain a leading cause of HAI, 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 increase hospital lengths of stay by up to 21 additional days. (WHO 2011)

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 health care facility or the duration of the surgery (more than 4 hours)

The majority of 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

The array of microorganisms that cause SSIs is similar in many countries throughout the world (see Box 1-1: The Most Common Pathogens Associated with Surgical Site Infections).

Box 1-1: The Most Common Pathogens Associated with Surgical Site Infections

Staphylococcus aureus

Coagulase-negative staphylococci

Enterococcus species

Escherichia coli

Pseudomonas aeruginosa

Enterobacter species

Klebsiella pneumoniae

Candida species

Klebsiella oxytoca

Acinetobacter baumannii

Adapted from: Hidron et al. 2008.

1.2. Risk factors for SSI

Risk factors for developing SSI can occur before, during, and after surgery. The Risk factors can be Patient Related or Procedure/practice related See Box 1-2: Patient Characteristics and Perioperative Practices That May Influence the Risk of Developing an SSI. 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 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 methicillin-resistant *S. aureus* [MRSA])
- Age (e.g., elderly or < 5 years)
- Poor nutritional status
- Uncontrolled diabetes
- Smoking or use of other tobacco products
- Obesity (body mass index $\geq 30 \text{ kg/m}^2$)
- 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: World Health Organization. 2009. Guidelines for Safe Surgery 2009: Safe Surgery Saves Lives, page 49.

http://whqlibdoc.who.int/publications/2009/9789241598552_eng.pdf

1.3. Prevention of Surgical Site Infections

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.

General Measures to Prevent SSI

A. Patient preparations

Complete preoperative evaluations for scheduled elective surgeries and identify underlying conditions that should be managed at least 30 days before scheduling surgery. These 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.
- 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.
- 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 antimicrobial resistance

B. Skin Preparation Prior to 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, 1991; 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 it 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-metaxylenol or PCMX) various concentrations (Dettol®).

STEP 4 Using 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 to prevent recontamination of the operative site with local skin bacteria).

Do not allow the antiseptic to pool underneath the client's body for 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 for fear that it can irritate the skin.

C. Operating theater 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.

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 (see SECTION 1CHAPTER 9: ENVIRONMENTAL CLEANING).

Sterile instruments: Sterile sets of surgical instruments and equipment should be available for surgery, and sterility should be carefully maintained (see, SECTION 1CHAPTER 7: DECONTAMINATION AND REPROCESSING OF MEDICAL DEVICES (INSTRUMENT PROCESSING)).

Preoperative Measures to Prevent SSIs

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

Decolonization with mupirocin ointment with or without chlorhexidine gluconate (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 surgical antibiotic prophylaxis (SAP): SAP should be administered prior to 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 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 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 SSI.
- Handle soft tissue gently to avoid crushing, which can result in tissue death (i.e., necrosis).
- Limit the use of electro-cautery 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 drains¹), 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 2–6 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 patients with blankets.

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

¹ 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.

Maintaining adequate circulating fluid volume: Use goal-directed fluid therapy intraoperatively 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.

Drapes and gowns: Use either sterile disposable non-woven or sterile reusable woven drapes and surgical gowns during surgical operations for the purpose of preventing SSIs. (See Appendix 2-2-1-2 for detailed information on using drapes during surgery.)

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 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 on 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 1–7 days postoperatively are recommended.

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

Intraoperative and Postoperative Incision Care to Prevent SSIs

A. 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 24–48 hours. Beyond 48 hours, there is no need to cover an incision for preventing SSIs.

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

B. Other than Primarily Closed Wounds

- Incisions that are left open at skin level for a few days (usually 4–5 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.
- 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 (24–48 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 the tube-feeding is discontinued.
- Cover the dressing and surrounding area to keep them dry while bathing. 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 health care 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 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 prior to 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 blood borne 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 prior to surgery will depend on the microorganism responsible for causing SSI, efficacy of the antibiotic in killing these microorganisms, the age of the patient, and the duration of effect of the microbial agent. See [Appendix 2-2-1-3](#) 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 et al. 2013)

In most instances, a single IV dose of an antibiotic completed within 60 minutes before the procedure is recommended. (See [Appendix 2-2-1-4](#). 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 60–120 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 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 1-1: Prevention of Bacterial

Endocarditis before Dental Procedures provides a list of recommendations for the prevention of infective endocarditis before dental procedures. (AHA 2015; Nishimura et al. 2008).

Although there is no conclusive evidence of high-quality outcomes with prophylactic antibiotics to prevent infective endocarditis, the American Heart Association 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 1-1: Prevention of Bacterial Endocarditis before Dental Procedures

Situation	Agent	Regimen—Single Dose	
		Adults	Children
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin <u>or</u>	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 ^{1,2} 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 ³	1 g IM or IV	50 mg/kg IM or IV
	<u>Or</u>	600 mg IM or IV	20 mg/kg IM or IV
	Clindamycin		

Adapted from: Wilson et al. 2007.

¹ This can include other first- or second-generation oral cephalosporin in equivalent adult or pediatric dosage.

² Cephalosporins should not be used on patients with a history of anaphylaxis, angioedema, or urticaria with penicillin or ampicillin.

³ Cephalosporins should not be used on patients with a history of anaphylaxis, angioedema, or urticaria with penicillin or ampicillin.

Surgical site Infection Prevention and Control Practice Bundle

The Institute of Healthcare Improvement in the United States developed the concept of a “bundle” to help HCWs care for patients during particular 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 that, when performed collectively and reliably, have proven to improve patient outcomes. Box 1-3: Bundle for Prevention of SSIs Sourceis an example of the components of a bundle of practices for prevention of SSIs that are easily applicable in low-resource settings.

Box 1-3: Bundle for Prevention of SSIs Source

- 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

Allegranzi et al. 2018.

1.4. Commonly used antiseptics for infection prevention and control

Alcohol Solution (Ethyl or Isopropyl)

Ethyl and Isopropyl alcohol (60 to 90%) are relatively cheaper, easily available and at times, excellent antiseptics. However, they should not be used on mucous membranes (e.g. for vaginal preparation) for Alcohols dry and irritate them even to further promote the growth of microorganisms. 60 to 70% solutions of Ethyl or Isopropyl alcohol are effective, less drying to the skin and less costly than those with higher concentrations and are among the safest known antiseptics.

Chlorhexidine Gluconate (CHG)

Chlorhexidine gluconate (CHG) is an excellent antiseptic. It remains active against microorganisms on the skin many hours after use (referred as residual effect) and is safe even for use on newborn infants. Due to the threat of inactivation by a concomitant use of soaps, CHG's residual antimicrobial activity is dependent upon its concentration availed in the market. Chlorhexidine with 2 to 4 % of concentration is the recommended. The new 2% aqueous formulations and 1% Chlorhexidine in a waterless, alcohol-based antiseptic hand rub are also effective (Larson, 1995).

Iodine and Iodophor Solution

Iodine solutions with 3% concentration are very effective and are available both as an aqueous (Lugol) and tincture solutions (Iodine in 70% alcohol). Iodophors with 7.5 to 10% are solutions of iodine mixed with a carrier a complexing agent like Polyvinyl pyrrolidone (Povidone) that releases a small amount of iodine. Povidone-iodine is the most common Iodophor available globally.

Iodophors have a broad spectrum of activity. Thus they kill vegetative bacteria, mycobacterium, viruses and fungi. For an optimal effect, however, they require up to 2 minutes of contact time to release free iodine which is chemically active form. Once the free iodine is released, it elicits a rapid killing action. Besides, Iodophors are generally nontoxic and nonirritating to skin and mucous membranes unless there is some allergy to it (Larson, 1995). Commercially available Iodophors manufactured for antisepsis should not be diluted (Betadine or Wescodyne) as this increases the concentration of free iodine that can be released and increase the degree of skin irritation.

Chlorhexylenol

Chlorhexylenol (para-chloro-metaxylenol or PCMX) is a halogenated derivative of Xylenol widely available in concentration of 0.5 to 4%. Chlorhexylenol destroys microorganisms by breaking down the cell wall. It has low germicidal action (Favero, 1985) compared to alcohols, Iodine or Iodophors and is less effective in decreasing skin flora than both CHG and Iodophors (Sheena & Stiles, 1982). Because of its capacity to penetrate the skin and possibility of turning

to be toxic on its application to some areas of the body, it should not be used on newborns. To avoid some harm, therefore, one should avoid using commercial products with Chlorohexylenol concentrations above 4%.

Triclosan

Triclosan is a colorless substance often serving as an ingredient in soaps which are considered antimicrobial agents. Concentrations from 0.2 to 2.0% have moderate antimicrobial activity against gram-positive cocci, mycobacteria and yeast but not gram-negative bacilli, especially *P. aeruginosa* (Larson, 1995). Although there are growing concerns of the resistance to this agent is developing more readily than to other antiseptic agents, resistance to skin flora has not so far been observed in long-term clinical studies.

1.5. Monitoring and surveillance of SSIs

Surveillance of Surgical Site Infections

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 health care facility should develop its own surveillance program, which can maximize 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 health care facility's overall objectives (APIC 2014; Lee et al. 2007). A facility IPC Risk Assessment can help guide these decisions (see SECTION 1CHAPTER 2: MANAGING INFECTION PREVENTION AND CONTROL PROGRAM).

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 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 out-patient 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 SECTION 1CHAPTER 1: INTRODUCTION TO SURVEILLANCE OF HEALTHCARE ASSOCIATED INFECTIONS.

1.6. 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 facilities' 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, nurse, health care facility administrators, health care facility leadership, IPC staff, cleaning staff, CSSD staff).has been shown to be an effective method to support quality improvement efforts. (Wick et al. 2012) To be effective, teams should Within 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

Surgical site infections 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 health care system.

CHAPTER 2: PREVENTING CATHETER-ASSOCIATED URINARY TRACT INFECTIONS (CAUTIS)

Chapter Objective

The objective of this chapter is to provide healthcare workers evidence-based practices know to reduce the incidence to urinary tract infections (UTIs) associated with urinary catheters which can be applied in limited resource settings.



Learning objectives

By the end of this chapter, participants will be able to:

- Define catheter associated urinary tract infection (CAUTs).
- Describe the burden of CAUTs.
- Explain the risk factors for CAUTs.
- Identify the recommended IPC activities to prevent CAUTs.
- Elucidate the role of surveillance and monitoring in improving IPC and reduction of CAUTs.

Chapter Content

- 2.1. Overview
- 2.2. Risk factors for acquiring health care-associated urinary tract infections (UTIs), including CAUTIs
- 2.3. Prevention strategies for health care-associated UTIs and CAUTIs
- 2.4. Monitoring and surveillance of CAUTIs
- 2.5. Quality improvement for prevention of CAUTI

2.1. Overview

Urinary tract infection is one of the most common HAIs. The majority (70–97%) of health care-associated UTIs are caused by indwelling urinary catheters, known as catheter-associated urinary tract infection (CAUTI).

In low- and middle-income countries (LMICs), 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 LMICs, where patients have at least twice the risk of acquiring UTIs than in high-income countries, based on indwelling urinary catheter use.

For these reasons and because a high percentage of hospitalized patients are catheterized, prevention of CAUTIs is an important aspect of reducing HAIs.

Urinary catheters are indicated in health care to:

- Monitor urine output during certain types of surgery and with critically ill patients,
- manage urinary retention and obstruction
- 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.

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.

2.2. Risk factors for Acquiring Catheter Associated Urinary Tract Infection (CAUTs)

Most microorganisms causing CAUTIs are derived from the patient's intestinal and perineal area. The hands of health care workers (HCWs) during catheter insertion or manipulation of the collection system. Organisms gain access to bladder in one of two ways (See Figure 2-1: Intra- and Extra Luminal Sources of Infection).

- **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.

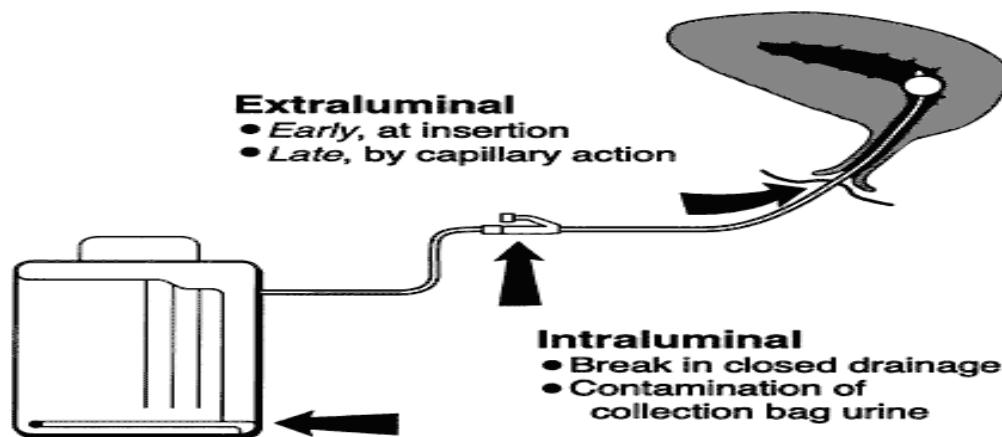


Figure 2-1: Intra- and Extra Luminal Sources of Infection

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.

Excessive use of quinolones (e.g., ciprofloxacin for treatment of UTI) has increased the rate of *E. coli*-resistant isolates in most countries.

Additionally, there is a category of multidrug-resistant *Enterobacteriaceae*, including *E. coli* that produce enzymes, known as extended-spectrum beta-lactamase, that inactivate antibiotics. A small proportion of CAUTI are caused by *Staphylococcus* spp.

Biofilm

Microorganisms form biofilms (Figure 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 defences.

Following recommended IPC practices (hand hygiene and glove use) when handling catheters can prevent CAUTI.

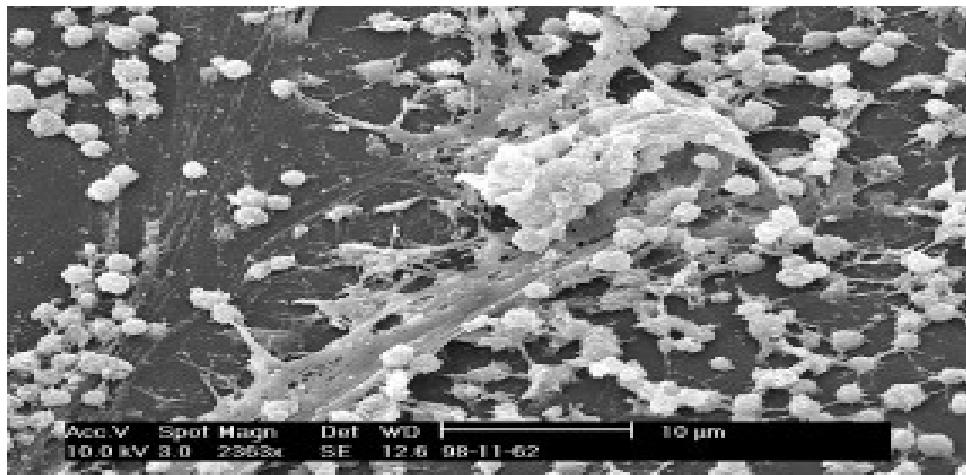


Figure 2-2: Scanning Electron Micrograph of the Bacteria *S. aureus* (spheres) on the Interior Surface of an Indwelling Catheter with a Biofilm (thread-like material).

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

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.

- **Patient-related factors:** Compromised immune system, Diabetes mellitus, Renal dysfunction, Fecal incontinence, Female sex and Elderly age

2.3. Prevention Strategies of Catheter-Associated Urinary Tract Infection

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 CAUTI.
- Remove the catheter as soon as possible.

Acceptable indications for catheterization

- For hemodynamically unstable patients that require accurate urinary output every 1–2 hours.
- 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).

Indications that do not require an indwelling urinary catheter

- Management of incontinence, collection of lab specimens in patients who can void spontaneously.

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.
- 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).

Strategies to limit the use of urinary catheters

- Provide written guidelines for HCWs, stating appropriate indications for inserting urinary catheters.
- Require an in-charge clinician’s order in the chart before an indwelling catheter is placed.
- Develop tools/job aids to remind HCWs, including clinicians, to remove the catheter when it is no longer needed (See Box 2-1: Urinary Catheter Reminder to Prevent CAUTIs).
- 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.

- Use daily order renewals requiring a reason to be given each day for continuation of the catheter.

Infection Prevention and Control (IPC) Principles during Insertion and Maintenance of Indwelling Urinary Catheters

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

Box 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: _____

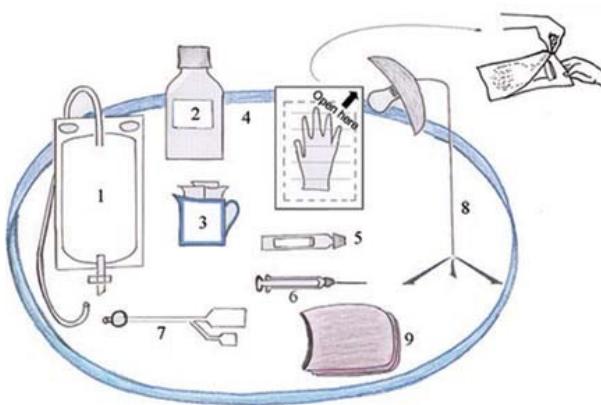
Procedures for Insertion, Removal, and Replacement of Indwelling Urinary Catheters Using Infection Prevention and Control Techniques

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 (see Figure 2-4):
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)
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 sheets
13. A plastic bag or leak-proof, covered waste container for disposal of contaminated items



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

Figure 2-3: Urinary Catheter Equipment

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: Prior to 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.

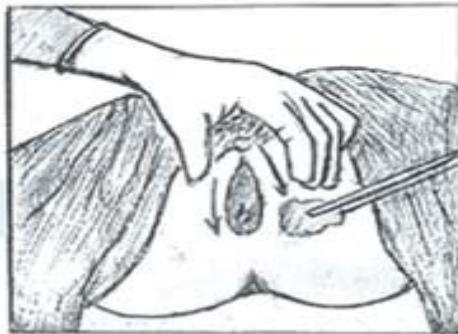
STEP 7: Put non-sterile gloves on both hands.

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 (see Figure 2-4 A and B: Cleaning Female and Male Genital Areas before Insertion of an Indwelling Catheter).

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 2-4 A and B: 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.

A. Female



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.

B. Male

Figure 2-4 A and B: Cleaning Female and Male Genital Areas before Insertion of an Indwelling Catheter

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.**

Note: 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 2-5 A and B: Catheterization

Techniques for Female and Male Patients, 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 2-5 A and B: Catheterization Techniques for Female and Male Patients, 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).

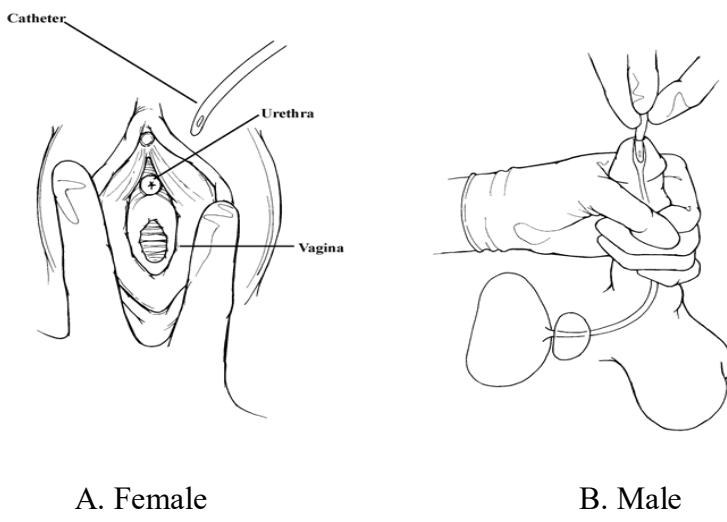


Figure 2-5 A and B: Catheterization Techniques for Female and Male Patients

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) (see Figure 2-6: Securing a Female Indwelling Catheter).

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.

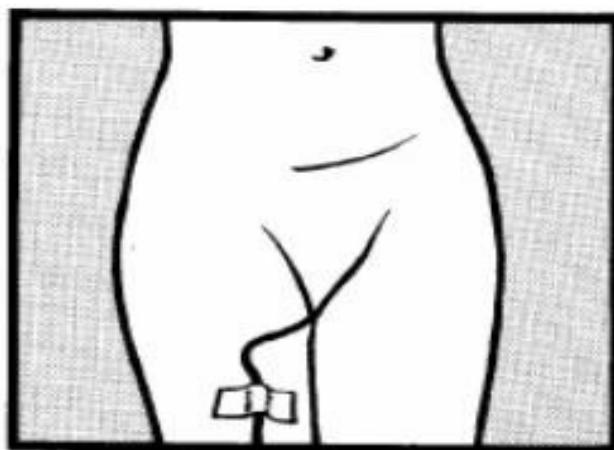


Figure 2-6: Securing a Female Indwelling Catheter

Removal or Replacement of a Urinary Catheter

STEP 1: Make sure that all items are available if replacing an indwelling catheter, 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 procedures.

STEP 8: If you are replacing the indwelling catheter, follow Steps 4 through 21 of the insertion procedures.

Recommended Catheter Maintenance Practices

- Educate HCWs on the insertion, care, and maintenance of urinary catheters and about prevention of CAUTIs.
- 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 SECTION 1CHAPTER 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 the WHO “My 5 Moments for Hand Hygiene” See SECTION 1CHAPTER 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 (see Figure 2-6). Always secure the collection bag below the level of the bladder, including during transport.
- **Never** rest the bag on the floor (even atop a clean/sterile towel).

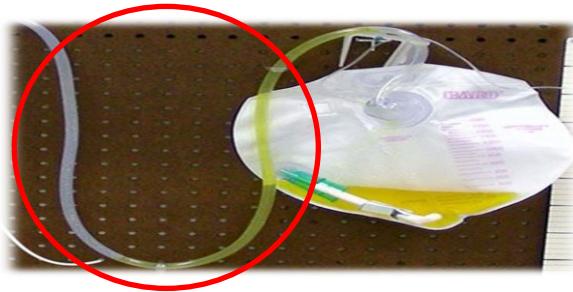


Figure 2-7: Dependent loops (inside red circle) create a back pressure and obstruct urine flow from the bladder

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 2/3 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 meatal 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 *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 *et al.* 2009)
- Do **not** re-use 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 2006)

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 2 hours, place it in a refrigerator until it can be delivered to the laboratory.

STEP 9: Discard needle/syringes into a sharp’s container.

STEP 10: Perform hand hygiene.

Catheter-Associated Urinary Tract Infection Prevention and Control Practice Bundles and Initiatives

Box 2-2: 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.

2.4. Monitoring and Surveillance of CAUTI

- Surveillance can be used to identify areas in which IPC practices can be improved to decrease CAUTIs.
- It can, however, be labor-intensive and consume precious resources.
- However, because CAUTI is one the most common HAI in low resource settings, CAUTI surveillance in areas with high use of indwelling urinary catheter should be considered.
- It is important to have a thoughtful approach when developing a CAUTI surveillance plan.
- Each health care facility should develop its own surveillance program, which should maximize use of resources by focusing CAUTI surveillance according to the use of indwelling urinary catheters, the outcomes experienced, and the health care facility's overall objectives.

A facility IPC risk assessment can help guide these decisions (see SECTION 1CHAPTER 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 CAUTI and the denominator is the number of urinary-catheter days during the same time period

(for example, numerator: the total number of CAUTI in the surgical ICU in a month/denominator: the total number of urinary-catheter days during that month).

- Use definition from 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 and Chapter 1 Introduction to Surveillance of Health Care-Associated Infections).

2.5. Quality Improvement for CAUTI

- Once CAUTI rates are known, efforts should be made to reducing CAUTI, which can improve patient outcomes and reduce facilities' cost of providing care.
- Multidisciplinary teams with representatives from the various disciplines can help prevent CAUTI, (e.g., all levels of HCWs, including clinician, nurses, health care facility administrators, health care 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 upon the team's consensus, the improvement process should include ongoing quantitative measurement of improvements and timely feedback of results and successes.

Summary

- Health care workers can prevent CAUTIs by limiting use of indwelling urinary catheters, daily reviews of indications for 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.

CHAPTER 3: PREVENTING INTRAVASCULAR CATHETER ASSOCIATED BLOODSTREAM INFECTIONS

Chapter Objective:

The objective of the chapter is to enable participants understand how to prevent Intravascular Catheter Associated Bloodstream Infections



Learning objectives

By the end of this module, participants will be able to:

- Understand Epidemiology and microbiology of intravascular catheter-associated bloodstream infection
- Identify Commonly used intravascular catheters and their potential side effects
- Identify Intravascular catheter-related bloodstream infection risk factors
- Understand how to Prevent the risk of bloodstream infection related to intravascular catheters
- Understand how to monitor and conduct surveillance of central line-associated bloodstream infections (CLABSI) other intravascular catheter-associated bloodstream infections
- Understand Quality improvement for prevention of intravascular catheter-associated bloodstream infections

Chapter content

- 3.1. Overview
- 3.2. Intravascular catheter-related bloodstream infection risk factors
- 3.3. Prevention the risk of bloodstream infection related to intravascular catheters
- 3.4. Monitoring and surveillance of central line-associated bloodstream infections (CLABSI) other intravascular catheter-associated bloodstream infections
- 3.5. Quality improvement for prevention of intravascular catheter-associated bloodstream infections

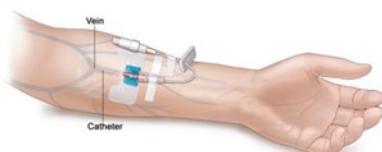
3.1. Overview

Intravascular catheters (central lines, arterial lines, and peripheral IV lines) and **Error! Reference source not found.** are often necessary for administering fluids, medications, and nutritional products to patients. While intravascular catheters can be essential for patient care, they put patients at risk for infection by interrupting the protective barrier that intact skin provides. In addition, they provide a direct route of entry for microorganisms into the bloodstream and can easily become contaminated during use.

Studies have found that up to 90% of health care-associated bloodstream infections are caused by some form of vascular access (Esposito et al. 2013). Bloodstream infections represent about 19% of all reported HAIs in low- and middle-income countries (LMIC), (WHO 2011). In low-income settings, health care-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).

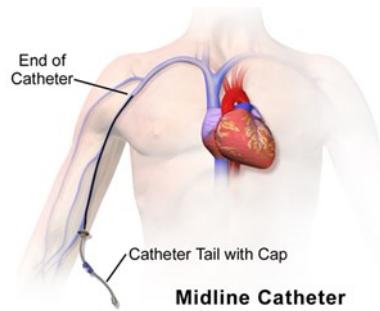
Table 3-1: Common Types of Intravascular Catheters for Venous and Arterial Access and Potential Side Effects

Catheter Type	Entry Site	Length	Potential Side Effects
Peripheral Catheters			
Peripheral venous catheter (IV line)	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	8 cm (3 in.)	Low infection risk; rarely associated



	femoral, axillary, brachial arteries		with bloodstream infections
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Midline catheter (a type of IV line)



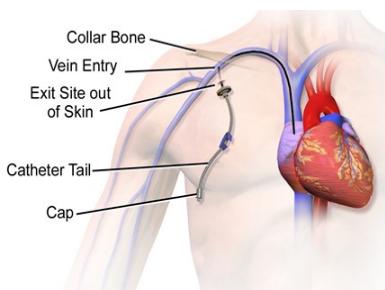
Inserted via antecubital fossa (forearm) into the proximal basilic or cephalic veins; does not enter central veins

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

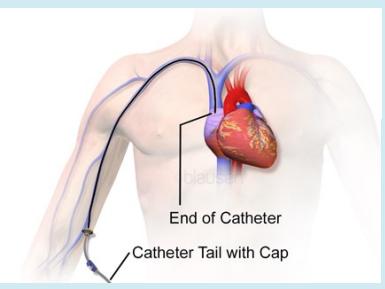


Inserted via skin into central veins (subclavian, internal jugular, or femoral)

≥ 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)



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

Tunneled central venous catheter	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
Umbilical catheter	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

3.2. Infection Risk Factors Related to Intravascular Catheters

While intravascular catheters can be essential for patient care, they put patients at risk for infection by interrupting the skin barrier and providing a direct route of entry for microorganisms into the bloodstream (see Figure 3-1: Risk Factors for Intravascular Catheter-Associated Infections). Health care workers (HCWs) should be aware that intravascular catheters (both central lines and IV lines) can become contaminated by:

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

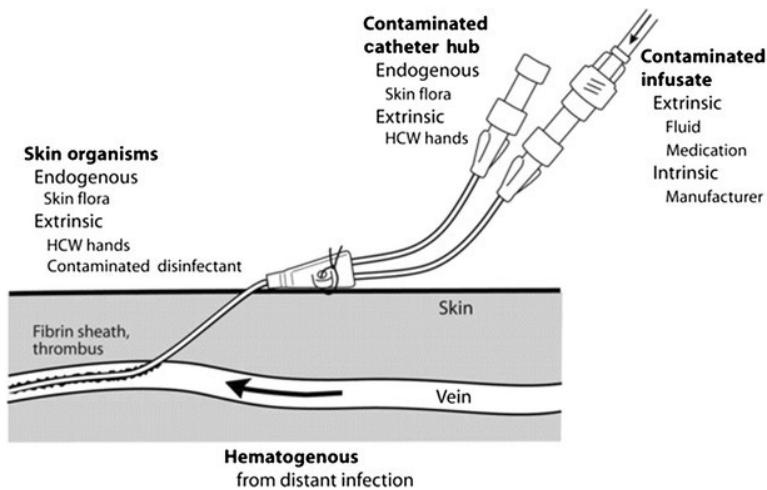


Figure 3-1: Risk Factors for Intravascular Catheter-Associated Infections

Peripheral venous catheters—IV lines

IVs lines are thought to rarely cause systemic bloodstream infections. However, in most settings these infections are often under-evaluated and may have a higher incidence of infection than what is reported. 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 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, particularly in LMIC. CLABSI rates 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 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). CLABSI can also occur outside of the ICU (e.g., dialysis, general medical, and others settings where patients have central lines).

Intravascular Catheter-Related Bloodstream Infection Risk Factors

A number of factors increase the risk of infection from intravascular catheters (see Figure 2-2-3-3-3 from reference manual) 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 as well as the proper maintenance of the intravascular catheters

3.3. 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.

3.4. Monitoring and Surveillance of Infections Related to Intravascular Catheter Use (including CLABSI).

Surveillance is an effective tool that can be used to improve IPC practices and decrease HAIs. It can, however, be labor-intensive and consume precious resources; therefore, it is important to have a thoughtful approach when developing a surveillance plan. Each health care facility should develop its own surveillance program based on the facility risk IPC assessment (see SECTION 1CHAPTER 2: MANAGING INFECTION PREVENTION AND CONTROL PROGRAM), which should maximize use of resources by focusing on the areas where the most serious infections related to intravascular catheters are likely to occur, and the health care facility's overall objectives (APIC 2014; Lee 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 could be on this area.

Steps in the CLABSI Surveillance Process

- Decide which procedures to monitor (consider areas with 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 CLABSI and the denominator the number of central-line days during the same time period. For example, numerator: the total number of CLABSI 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 an CLABSI surveillance program refer to SECTION 1CHAPTER 1: INTRODUCTION TO SURVEILLANCE OF HEALTHCARE ASSOCIATED INFECTIONS.

3.5. Quality Improvement for Infections Related to Intravascular Catheter Use (including CLABSI).

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 blood stream infection, the formation of multidisciplinary teams has been shown to be an effective method to support quality improvement efforts (Rosenthal et al. 2013; Geldenhuys 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, health care facility administrators, health care facility leadership, IPC staff, cleaning staff, and others). Within 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 upon the team's consensus, the improvement process should include on-going 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 health care 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 to identify risks and areas for performance improvement, but are not essential for implementing evidence-based procedures to prevent intravascular infections.

CHAPTER 4: HEALTH CARE ASSOCIATED PNEUMONIA (INCLUDING VENTILATOR ASSOCIATED PNEUMONIA)

Chapter objective:

To introduce participants to the basic concepts of preventing Health Care Associated Pneumonia



Learning objectives

- Understand Epidemiology and mechanisms of hospital-acquired pneumonia
- Identify Risk factors for hospital-acquired pneumonia
- Identify Strategies for preventing ventilator-associated pneumonia and other hospital-acquired pneumonias in adults, children, and infants
- Understand Monitoring and surveillance of ventilator-associated pneumonia

Chapter contents:

- 4.1. Overview
- 4.2. Risk factors for hospital-acquired pneumonia
- 4.3. Strategies for preventing health care associated pneumonia (including VAP).
- 4.4. Monitoring, surveillance of health care associated pneumonia (including VAP).

4.1. Overview

Health care associated pneumonia (HAP), which includes non-ventilator-associated pneumonia 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 intensive care units (ICUs) (WHO 2011). The presence of HAP increases hospital stay by an average of 7–9 days per patient and carries a high risk of morbidity and mortality (American Thoracic Society and Infectious Diseases Society of America 2005).

90% of health care-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-ventilator-associated pneumonia 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).

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 defence 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 (see Figure 4-1: Pooling of Secretions in Subglottic Area)
- Reduce oral immunity leading to accumulation of dental plaques, which may then be colonized by oral microorganisms
- Provide a direct pathway for microorganisms to get into the lung

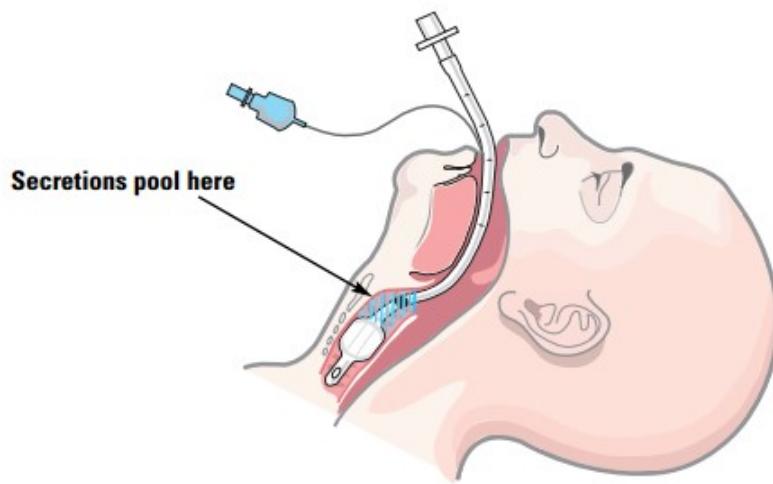


Figure 4-1: Pooling of Secretions in Subglottic Area

4.2. Risk Factors For Health Care 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).

4.3. Strategies For Preventing Health Care 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.

- 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 SECTION 1CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S).
- 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 SECTION 1CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S).
- Use single-use respiratory care items where possible (e.g., oxygen masks, nebulizer sets); when not possible, meticulously reprocess respiratory care items (see SECTION 1CHAPTER 7: DECONTAMINATION AND REPROCESSING OF MEDICAL DEVICES (INSTRUMENT PROCESSING)).
- 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.
 - Use empiric isolation
 - Use source control (have them wear a mask as soon as possible upon entering a health care 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 health care facilities

- Clean hard surfaces that are frequently touched (e.g., countertops, phones, doorknobs, light switches) regularly with a disinfectant (see Volume2, Chapter 9, Environmental Cleaning in health care setting).

Note: refer the management of health care associated pneumonia among surgery patients from your reference manual.

Strategies for Preventing Health Care Associated Pneumonia (Including VAP)

Many aspects of VAP prevention differ according to the age of the patient; however, there are infection prevention and control (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 of Instruments and 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 alcohol-based hand rub before putting on gloves
- Wear clean, non-sterile gloves and 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 alcohol-based hand rub 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. In addition, 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. While 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 SECTION 1CHAPTER 7: DECONTAMINATION AND REPROCESSING OF MEDICAL DEVICES (INSTRUMENT PROCESSING)).
- Ensure that resuscitation devices (e.g., Ambu bags), which are difficult to clean and disinfect, are completely dry before reuse as fluids containing infectious materials left inside the bag or face piece 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 SECTION 1CHAPTER 7: DECONTAMINATION AND REPROCESSING OF MEDICAL DEVICES (INSTRUMENT PROCESSING)).

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 duration of mechanical ventilation, length of stay, and cost) (Klompas et al. 2014).

Avoid intubation if possible:

- Use non-invasive 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°.
 - 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
- Source:* Klompas 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 some data that they VAP) (Klompas 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 2 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 2 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 *Source: Klompas 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 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 particular treatments. A bundle is a structured way of improving care and patient outcomes—they are a small, straightforward set of evidence-based interventions that, 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 et al. 2005). (*See all the bundles from reference manual Box 2-2-4-4-1, 2 and 3*).

4.4. Monitoring And Surveillance Of Infections Related To Health Care-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* SECTION 1CHAPTER 1: INTRODUCTION TO SURVEILLANCE OF HEALTHCARE ASSOCIATED INFECTIONS).

Summary

The use of mechanical ventilators is increasing among new born, pediatric, and adult patients in low- and middle-income countries. VAP is one of the most common HAIs, resulting in increased health care costs as well as 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.

CHAPTER 5: PREVENTING HEALTH CARE-ASSOCIATED INFECTIOUS DIARRHEA

Chapter Objective

The objective of this chapter is to provide healthcare workers evidence-based practices know to reduce the incidence to urinary tract infections (UTIs) associated with urinary catheters which can be applied in limited resource settings.



Learning objectives

By the end of this chapter, participants will be able to:

- Understand the epidemiology, common risk factors and causes of health care-associated infectious diarrhea
- Understanding practices in preventing transmission of health care-associated diarrhea.
- Describe the basic management of outbreaks of diarrheal illness.

Chapter Content

- 1.1. Overview
- 1.2. Common risk factors and causes of health care-associated infectious diarrhea
- 1.3. Preventing transmission of health care-associated diarrhea
- 1.4. Introduction to management of outbreaks of diarrheal illness

5.1. Overview

Diarrhea is a common symptom of 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 intravenous fluids.

Controlling the spread of health care-associated infectious diarrhea should be a key area of focus for infection prevention and control (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

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

Health care-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 “health care-associated diarrhea” used in this chapter refers to infectious diarrhea.

Health care-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 et al. 2012; WHO 2002)

Organisms causing diarrhea are often transferred to susceptible people via hands contaminated from direct contact with faeces 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 feco-oral route in health care facilities include:

- Person-to-person contact by health care workers (HCWs) (such as caring for a patient with diarrhea, not washing hands, and then helping a patient to 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

Health care-associated infectious diarrhea is common in low- and middle-income health care facilities. Common pathogens implicated include *Shigella* sp, *Salmonella* spp, *E. coli*, rota virus as well as 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 et al. 1998; Lopman et al. 2004; Polage 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*).

Rotavirus

Rotaviruses are the most common community causes of diarrhoea in children under 5, making up 15–25% of diarrheal disease cases identified in children at treatment centers in low- and middle-income countries (LMIC). The virus can survive on inanimate surfaces, is easily spread, and may become endemic in health care 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 immune-competent and immune-compromised 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 et al. 2011).

Noroviruses may be easily aerosolized and may be inhaled from areas heavily contaminated with feces or vomit.

Clostridium difficile

The use of antibiotics is associated with some types of health care-associated diarrhea, especially *C. difficile* (see Figure 5-1: How *C. difficile* is). In high-income countries, *C. difficile* is the most common cause of health care-associated infectious diarrhea (Polage et al. 2012). *C. difficile* is a spore-forming, toxin-producing bacterium. The illness was previously known as “antibiotic-resistant diarrhoea” or “pseudomembranous colitis.” It is now being increasingly reported in LMIC. (Alrifai et al. 2009; Garcia et al. 2007)

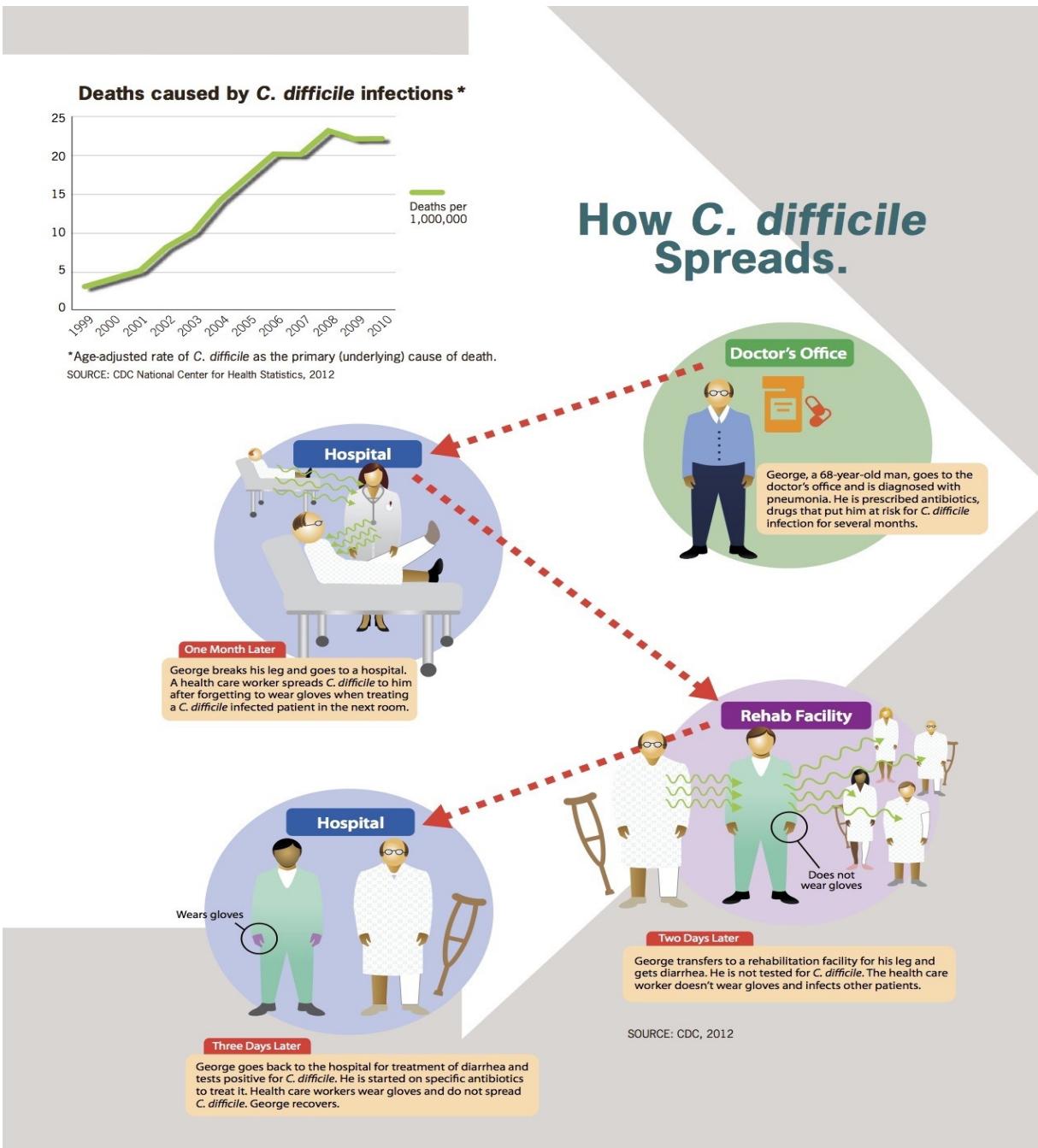


Figure 5-1: How *C. difficile* is spread

5.2. Common Risk Factors for Health Care Associated Infectious Diarrhea

Patient risk factors for health care-associated diarrhoea include extremes of age (new born 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 diarrhoea.

Outbreaks in health care 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 diarrhoea may present in unexpected ways, such as by becoming prolonged or more severe, due to decreased immunity or other risk factors. Immuno-compromised patients may shed the viruses or bacteria in stool for prolonged periods.

5.3. Prevention of Health Care-Associated Infectious Diarrhea

Preventing Transmission of Health Care-Associated Diarrhea from Patients

Prevention and control of health care-associated diarrhea includes breaking the disease transmission cycle typical for GI infections (fecal-oral route) (see SECTION 1CHAPTER 3: STANDARD AND TRANSMISSION BASED PRECAUTIONS). These include:

- Performing hand hygiene at the recommended World Health Organization (WHO) “5 Moments” with 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 and 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 personal protective equipment for situations when contact with vomit, stool, or items contaminated with these is 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 health care-associated diarrhoea.

- 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 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 recommended methods for laundering health care textiles.
- Following recommended waste management practices.

Preventing Transmission of Health Care-Associated Diarrhea from Health Care Facility Staff

Clinical staff

Clinical staff with symptoms of diarrhea, with or without fever, nausea, vomiting, abdominal pain, and, 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 as they may continue to shed the bacteria or virus in their stool and thus spread infection even after symptomatic recovery (see SECTION 1CHAPTER 14: CLIENT EDUCATION ON INFECTION PREVENTION AND CONTROL (IPC)).

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 et al. 1998; WHO 2008).

Food Service Personnel

Food service staff with diarrhea symptoms of, with and without fever, nausea, vomiting, 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 in accordance with local laws and regulations (WHO 2008). Systems for identifying symptomatic foodservice personnel should be in place to prevent ill persons from working in the foodservices area (See SECTION 1CHAPTER 11: FOOD AND WATER SAFETY; for the Prevention of Health Care-Associated Infections).

5.4. Introduction to Management of an Outbreak of Diarrheal Illness in a Health Care 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 diarrhoea in health care facilities usually requires several simultaneous actions (see SECTION 1CHAPTER 1: PRINCIPLES OF PUBLIC HEALTH EMERGENCY PREPAREDNESS AND OUTBREAK MANAGEMENT FOR HEALTH CARE FACILITIES; Investigation of Outbreaks of Health-Care Associated Infections). 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 health care 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 to 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 2-2-5-1 Diarrheal 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 SECTION 1CHAPTER 9: ENVIRONMENTAL CLEANING) are 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 personal protective equipment (see SECTION 1CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S) for staff caring for patients with diarrhoea
- Ensure correct disposal or decontamination of contaminated materials (such as linens, equipment, and medical devices)
- Ensure that staff with diarrhoea do not work
- Ensure that correct food-handling practices are performed (see SECTION 1CHAPTER 11: FOOD AND WATER SAFETY)
- Eliminate potential contaminates to the hospital water supply (see SECTION 1CHAPTER 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 neonatal intensive care unit during outbreaks (see SECTION 1CHAPTER 5: PREVENTING MATERNAL AND NEWBORN INFECTIONS IN HEALTH CARE 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

Health care-associated diarrhea is a commonly experienced health care-associated infection in all health care 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.

SECTION 3: SURVEILLANCE OF HEALTHCARE ASSOCIATED INFECTION

CHAPTER 1: INTRODUCTION TO SURVEILLANCE OF HEALTHCARE ASSOCIATED INFECTIONS

Chapter Objective

The objective of this chapter is to enable participant understand the introduction of surveillance of health Care-Associated Infection.



Learning objectives

By the end of this chapter participants will be able to:

- Identify the characteristics and types of surveillance for health care-associated infections (HAIs)
- Describe the purposes of conducting surveillance
- Identify how to Prioritizing surveillance for HAIs
- Describe the designing of HAI surveillance program
- Explain program implementation
- Describe data analysis and feedback
- Identify Performance improvement

Chapter Content:

- 1.1. Overview of Surveillance of Health Care-Associated Infections
- 1.2. Characteristics and types of surveillance
- 1.3. Purposes of conducting surveillance
- 1.4. Steps for Conducting Surveillance in a Health Care Facility
- 1.5. Designing surveillance program
- 1.6. Implementing Program
- 1.7. Data collection and analysis
- 1.8. Performance improvement

1.1. Overview of Surveillance of Health Care-Associated Infections

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.

According to WHO, 66% of countries do not report HAI surveillance data (WHO 2011). The data that do exist show that limited-resources 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

In order for surveillance to be effective, it is critical that:

Surveillance is based upon sound epidemiological and statistical principles (see Chapter on 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 the quality of care. Efforts to improve practices and decrease HAI are a critical part of the surveillance plan.

1.2. Characteristics and Types of Surveillance

Outcome surveillance: monitoring of specific HAIs (e.g., SSIs, catheter-associated urinary tract infections [CAUTIs], diarrhea), or

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, or Periodic when data are collected at intervals, such as 1 month each quarter or 1 quarter per year.

Surveillance can be active or passive (**See Box 2-3-1-2 in volume 2 Section 3 chapter 1 of the reference manual**)

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. Trained staff conducts 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 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) The neonatal intensive care staff reports the number of cases of sepsis that occurred last month.

1.3. Purposes of Conducting Surveillance for Health Care-Associated Infections

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

Outcome surveillance helps the IPC team to:

- Determine baseline rates of HAI,
- Identify occurrence of infections above the baseline (expected) rates,
- Detect and report notifiable diseases to the public health authorities
- Detect and investigate clusters, outbreaks, and exposures, including emerging infectious diseases

Process surveillance helps the IPC team to:

- 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
- Meet the safety standards required by the health department and other regulatory agencies

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

1.4. Steps for Conducting Surveillance in a Health Care Facility

Prioritize Surveillance Activities

Depending upon the planned scope of activities, surveillance of HAIs requires: clinical staff time; laboratory diagnosis support; well-designed data collection tools and data management.

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 HAI among patients admitted to health care 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

While the extent of surveillance activities depends upon available resources, the prioritization and focus for any facility are ideally based on a risk analysis (See VOLUME 2, SECTION 1CHAPTER 2: MANAGING INFECTION PREVENTION AND CONTROL PROGRAM).

To set priorities, the health care facility team should:

- Review available HAI data and prioritize what they want to include in surveillance during the initial stages. Globally, surveillance of HAI focuses on SSIs, CAUTIs, CLABSIIs, and ventilator-associated pneumonia (VAP), but other types of HAI 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., intensive care units [ICUs]) with the highest number of HAIs or most serious complications from HAIs.
- Select procedures based on risk of complications as well as 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. Such surveillance activities are for health care facilities that are starting surveillance and those with limited resources. They can help prevent all HAIs.

- Develop a plan to assess whether staffs have access to soap and water and towels to dry their hands or alcohol-based hand rub. Monitor hand hygiene practices. Use surveillance data to improve compliance (see SECTION 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 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 in contact with normally sterile tissue (see VOLUME 1, CHAPTER 7: DECONTAMINATION AND REPROCESSING OF MEDICAL DEVICES (INSTRUMENT PROCESSING)).

- Monitor compliance with recommended practices for certain high-risk procedures, such as inserting and caring for central venous catheters (see SECTION 1CHAPTER 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.

1.5. Design and Develop a Surveillance Approach

Choose whether to monitor an outcome or a process measure

Once the specific type of surveillance activities needed by the facility have 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)

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 (see Table 2-3-1-1 in

volume 2 Section 3 chapter 1 of the Reference manual) 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. Health care facilities should aim at achieving HAI rates that are lower than the chosen benchmark.

Note: *The eventual goal for all health care 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 the number of total possible events is 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 of the reference manual, Section 3, chapter 2 on Basic Epidemiology).

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 health care 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 operating theatre 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 health care 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 health care- 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 among the population at risk during a specific time interval (see chapter on Basic Epidemiology). 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.
- Utilize country-specific surveillance case definitions where they exist so results can be benchmarked with other local facilities.

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 or periodic.

Example of surveillance Time period:

Continuous monitoring—surveillance is on-going throughout the time frame:

Example: All patients who had a C-section for surgical site infection & others.

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

Example: All patients with a central venous catheter for bloodstream infection for 1 month in every 3 months.

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, 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 being collected in the present time, following the patients through their 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 in order 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 health care facility may decide to monitor hand hygiene compliance on each ward for 20 minutes, once each week, aiming for 40 observations every week. The larger the number of observations, the more reliable the results will be. The number of observations will also depend upon available resources.

Data collection plan

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

Data elements: Data elements will depend upon 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.

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.

Data collectors: Appropriate persons to collect data should be selected based on the type of surveillance and frequency of data collection. IPC staff often collects surveillance data; however, data collectors can be clinicians specially assigned for data collection or can be health care providers in the facility. Data collectors should be trained in correctly completing the data collection forms in a standardized manner.

Data collection methods: depend upon several factors and the decisions made about type, frequency, and the 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.

Data management: This is a method of receiving and collating data collection forms as well as filing, storing (electronic or manual) the data collected.

Data sharing: Develop a plan and decide who will collate data, prepare reports, and share data with relevant parties.

1.6. Implement Surveillance Activities

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

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.

1.7. 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:

- Description of the surveillance activity (e.g., SSI in women undergoing C-section in the health care facility, CLABSI from date to date, compliance with surgical attire guidelines before entering the operating theatre 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, as well as 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 9 cases of CLABSI (numerator)
- Rates, percentages, and comparisons with the chosen benchmark (e.g., 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 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.

1.8. 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 ([See Figure 2.3.1.1. about surveillance process on Volume 2 of the Reference Manual, Section 3, Chapter 1](#)), which is part of improving the quality of patient care, in this case by preventing infections. Quality improvement should be an on-going activity that uses data to inform interventions to improve patient safety (see chapter on IPC Programme management and Quality improvement strategies). (WHO 2002)

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 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.

Summary

Surveillance is an effective tool that can be used to improve IPC practices and decrease HAIs. Basic surveillance can be conducted without a large infrastructure or many resources. Surveillance should start with an infection risk assessment. Surveillance is only truly beneficial when the results are used to inform actions that will make patients safer.

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

Chapter Objective

The objective of this chapter is to enable participant understand how basic epidemiology and statistics are important for the interventions of IPC at the health care facility level.



Learning objectives

By the end of this chapter participants will be able to:

- Describe the basic epidemiological and statistical concepts and methods used to analyze and report infection prevention and control (IPC) data
- Identify the inferential and descriptive statistics used for describing health care-associated infections (HAIs)
- Understand the importance of sharing IPC data with key staff
- Identify data visualization methods and techniques for effective data sharing
- Describe basic epidemiology for interpreting IPC literature

Chapter Content:

- 2.1. Overview of basic epidemiological and statistical concepts and methods
- 2.2. Basic epidemiological and statistical concepts and methods
- 2.3. The inferential and descriptive statistics
- 2.4. Measuring Central Tendency
- 2.5. Measuring Disease Occurrences
- 2.6. Measuring Disease Frequency
- 2.7. Data Feedback and Sharing
- 2.8. Understanding IPC Literature and the Basics of Epidemiological Studies

2.1. Overview of Basic Epidemiological and Statistical Concepts and Methods

Infection prevention and control staff need to have a basic understanding of the key principles of statistics as they relate to IPC in order 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. Additionally, IPC staff should 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 and 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 2-1: The Definition of Epidemiology presents an explanation of the definition of epidemiology.

Table 2-1: The Definition of Epidemiology

Term	Explanation
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.	
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 and Seage 2008; Bonita et al 2006; Last 2001.

2.2. Basic epidemiological and statistical concepts and methods

Populations

As a science, epidemiology is concerned with the health of populations, rather than focusing on the health of individuals. Populations can be Fixed or Dynamic. 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 and Seage 2008)

In the context of a health care facility, the population can be both fixed and dynamic, depending upon the situation. The population of patients visiting a health care 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 as 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 ([see Figure 2-3-2-2 on volume 2 of the reference manual](#)). Other patients, both men and women, who received other surgeries, are not part of the “at-risk” population for SSI following C-section.

2.3. 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:

- Inferential
- Descriptive

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. Thus, 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.

Odds ratios and relative risks are used to describe the association between an intervention and an outcome during a study in order to make generalized recommendations

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, since 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 (See Figure 2-1: Mean, Median, and Mode in a Dataset) are the most commonly used central values for describing observed values (e.g., infection) within a dataset. Central values are used to summarize data in a single value, such as the age of persons 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. While 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, 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 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.

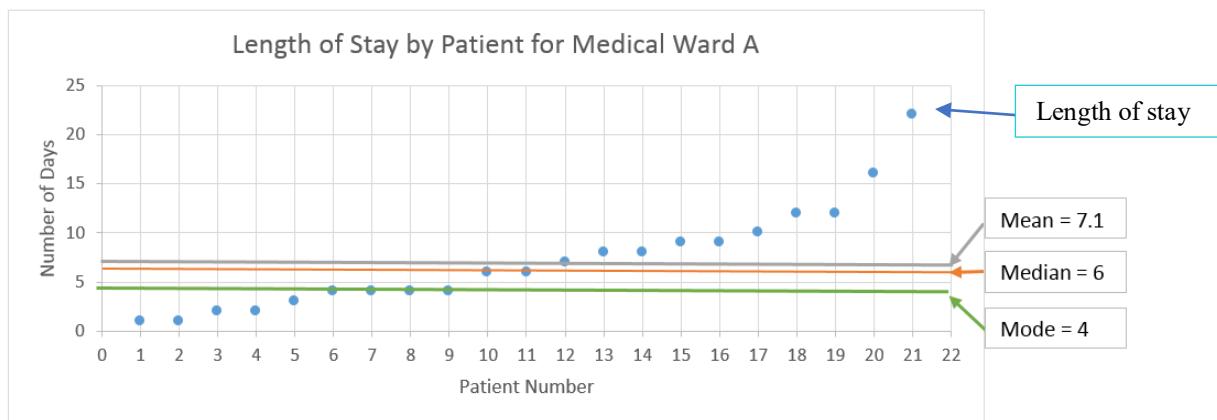


Figure 2-1: Mean, Median, and Mode in a Dataset

2.4. Measure of Central Tendency

Calculating mean

The mean is calculated by adding up all of the values in the dataset (See Table 2-2: Length of Stay for Patients in Medical Ward A) and then dividing by the number of values in the dataset. The dataset in Table 1-2 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.

$$73/9 = 8.1 \text{ days}$$

The mean length of stay is 8.1 days. This number indicates that on average a patient stay in the hospital for 8.1 days. A health care 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.

Table 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

Calculating 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 this (See

Table 2-3: Length of Stay for Patients in Medical Ward A in Ascending Order).

Table 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: $\text{median} = (n+1)/2$, 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 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 2-2: Length of Stay for Patients in Medical Ward A, 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 mean, median, and mode for 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. However, mean gets skewed by extremely large or small values but still allows comparison. Describing the range along with the mean allows 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 (See Table 2-4: Measures of Disease Variability). 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 health care facility. Another example is the range of the number of days patients have an indwelling urinary catheter in place before developing a catheter-associated urinary tract infection (CAUTI).

Calculating the Range

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

In the dataset in Table 2-2: Length of Stay for Patients in Medical Ward A, 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:

$$22 \text{ days} - 2 \text{ days} = 20 \text{ days}$$

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 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 within 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.

2.5. 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 as 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 while 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 opportunities for that process (e.g., hand hygiene opportunities). Picking the right denominator is very 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, in order 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 comparisons between rates can be made. The constant is selected based on how frequently the event occurs; generally, it is globally agreed upon. For example, SSI is expressed as percentages (per 100), CAUTI as number of urinary tract infection per 1,000 catheter-days, and hand hygiene compliance as 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)

Box 2-1: 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

$$14/140 \times 100 = 10\% \text{ during April 2016}$$

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

2.6. 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, while prevalence is the total number of cases of a particular disease in a given population. (Aschengrau and Seage 2008)

Incidence

Incidence measures new cases of a disease or condition that occur in a specified population over a given time period, and thus 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 et al. 2006)

Formula for calculating Incidence:

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

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 Box 2-1: Example of a Rate Calculation). (See Chapter 2, Introduction to Surveillance of Health Care-Associated Infections, in this module for information 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 SSI following C-section). There are many different types of incidence rates calculated in the IPC setting (See Table 2-5: Commonly Used IPC Metrics).

Table 2-5: Commonly Used IPC Metrics

Incidence Rates	How to Calculate
Surgical site infection (SSI) rates, postpartum sepsis rates	(# of infections/# of procedures) x 100 procedures
Central line-associated bloodstream infections (CLABSI) rates	(# of CLABSIs/# of central line-days) x 1,000 central line-days
Catheter-associated urinary tract infection (CAUTI) rates	(# of CAUTIs/# of indwelling urinary catheter-days) x 1,000 urinary catheter-days
Ventilator-associated pneumonia (VAP) rates	(# of VAP/# of ventilator-days) x 1,000 ventilator-days
Multidrug-resistant organism (MDRO) rates (e.g., methicillin-resistant <i>Staphylococcus aureus</i> [MRSA] rates)	(# of MDRO infections/# of patient-days) x 1,000 patient-days
Health care associated-bloodstream infection (sepsis), health care-associated pneumonia, etc., rates	(# of infections/# of patient-days) x 1,000 patient-days
<i>Clostridium difficile</i> rates*	(# of <i>C. difficile</i> 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.

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 (see Table 2-6: Calculation of Hand Hygiene Compliance). 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 the World Health Organization's "My 5 Moments for Hand Hygiene."

Table 2-6: Calculation of Hand Hygiene Compliance

Incidence Rates	How to Calculate
Hand hygiene compliance rates (i.e., hand hygiene performed correctly when indicated)	(# of times hand hygiene is performed correctly/# of opportunities for hand hygiene) x 100 Example: Hand hygiene compliance rates in a medical ward in a large hospital 400 (number of observations when hand hygiene was correctly performed)/1,000 (total number of opportunities when hand hygiene should have been performed) x 100 = 40%

Incidence Density

A specific type of incidence rate frequently used in IPC is incidence density. 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 health care 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 and Seage 2008)

$$\text{Incidence Density} = \frac{\text{Number of cases or events during observation time period}}{\text{Total person-time for the population}} \times \text{constant}$$

Example: Calculating Incidence Density Rate for CLABSI

Table 2-7: Number of Central Line-Days in April

Patient	Number of Days Patients Had a Central Line while in the Health Care 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 (as compared to 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 thus will miss a very important fact that the longer the patient is on a central line the higher the probability is 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 and 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 a very effective measure to express burden of disease in a population. (Aschengrau and Seage 2008)

There are two main types of prevalence (see Box 2-2: Point and Period Prevalence):

- 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 2-2: 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:

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

Example: Point Prevalence of Infection in a Health Care Facility

On April 1, 2016, there were 120 patients in a medical ward in a health care facility; 7 of these patients currently had a gastro-intestinal (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 health care facility) x 100

$$7/120 = 0.05833 \times 100 = 5.83\%$$

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

Example: Period Prevalence of Infection in a Health Care Facility

During the calendar year 2016, 900 C-section 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

$$150/900 = 0.1666666 \times 100 = 16.66\%$$

During the 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 2-2: The Relationship between Incidence and Prevalence 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.

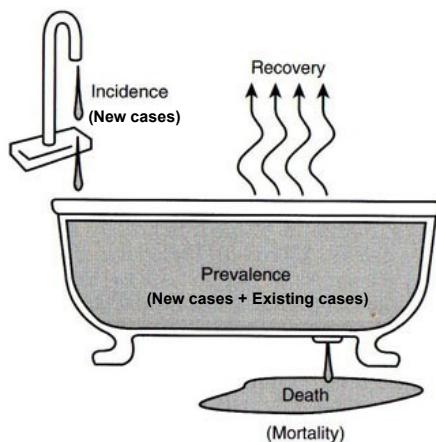


Figure 2-2: The Relationship between Incidence and Prevalence

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 2-8: Comparing Incidence and Prevalence.

Table 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.

Besides incidence and prevalence, there are additional measures of disease frequency used in public health and hospital epidemiology (see Table 2-9: Additional Measures of Disease Frequency Used in Public Health).

Table 2-9: Additional Measures of Disease Frequency Used in Public Health

Measure of Disease Frequency	Explanation
Crude mortality rate	Total number of deaths from all causes per 100,000 population per year
Cause-specific mortality rate	Number of death from a specific cause per 100,000 per year
Age-specific mortality rate	Number of deaths from all causes for individuals within a specific age category 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 per 1,000 live births per year
Morbidity rate	Number of existing or new cases of a particular disease or condition per 100 population
Attack rate	Number of new cases of disease that develop (in a given time period) 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 and Seage 2008.

Standardized Infection Ratio (SIR)

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 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 within a health care 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 ≤ 3 days after admission). (CDC 2016; Dudeck et al. 2013)

Standardized infection ratios are usually calculated by a national-level body and 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.

Many low- and middle-income countries are working toward reporting 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.

2.7. Data Feedback and Sharing

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 in order 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 1-A. Visual Displays of Data on volume 2 of the reference manual at the end of Section 3, chapter 2)

Using Epidemiology to Drive Policy

Epidemiological data can be helpful in influencing health practices and policies, both at the facility level and at the local and national levels. Good data collection and analysis of findings can help health care facilities understand where patient safety 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 health care 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 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 the 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.

2.8. Understanding IPC Literature and the Basics of Epidemiological Studies

Epidemiological studies are commonly designed to look at the causes of a condition or an event, effectiveness of prevention interventions, and treatments of disease. 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 and Seage 2008; 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 health care-associated infections: a randomized clinical trial,” was an experimental study that compared the outcomes of a group 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 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 health care-

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.

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.

The main types of observational studies used in epidemiology are cohort studies and case-control studies (See Table 2-10: Summary of Epidemiological Studies).

Table 2-10: 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	<p>Studies causes, preventions, and treatments of diseases/events; investigator passively observes an exposure as nature takes its course.</p> <p>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.</p> <p>Cross-sectional study: Examines the relationship between exposure and disease prevalence in a defined population at a single point in time.</p> <p>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.</p> <p>Ecological study: Examines the relationship between exposure and disease with population-level disease and exposure, rather than individual level of disease and exposure.</p>

Adapted from: Aschengrau and Seage 2008.

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 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 association, including bias, confounding, and chance. Table 2-11: Statistical Terms Used in IPC Literature provides a high-level summary of the measures that can be used to interpret and understand the literature.

Table 2-11: Statistical Terms Used in IPC Literature

Term	Explanation
Odds Ratio (OR)	<p>Odds ratio is used to compare the likelihood of an event occurring among an exposed group and an unexposed group. It typically is used to describe the results of the analysis of an exposed/intervention group and an unexposed/non-intervention group.</p> <p>An odds ratio 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.</p> <p>For example, one study reported that compliance with hand hygiene among HCWs in a facility when alcohol-based handrub (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 et al. 2015)</p>
Relative Risk (RR)	<p>Relative risk 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 to the risk of the non-intervention group (those not receiving chlorhexidine bathing) developing a disease.</p> <p>Relative risk 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 to people who do not experience the exposure.</p> <p>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 et al. 2015).</p> <p>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 there is no protective effect and it may result in increased risk of developing an HAI.</p> <p>A RR of < 1.0 means that there is a protective effect from the exposure.</p>

Term	Explanation
P-value	<p>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.</p> <p>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.</p>
Statistical Significance	<p>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.</p> <p>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).</p> <p>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.</p>
Confidence Interval (CI)	<p>Confidence intervals (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. Confidence intervals do not determine statistical significance, but are often used as a proxy for statistical significance. If the confidence interval does not overlap the value of 0.00, the findings are considered to be statistically significant.</p> <p>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.</p> <p>For example, a 95% confidence interval of (1.56–1.70) indicates that if one performs a similar study taking 100 additional samples, one can be 95% certain that the confidence interval will contain the true value and will be statistically significant.</p>
Bias	<p>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.</p> <p>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.</p>
Confounding	<p>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</p>

Term	Explanation
	<p>conclusions you are able to draw between the original two variables.</p> <p>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 data it was observed that student nurses in training inserted indwelling urinary catheters in more than 80% of 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.</p>
Random Error	<p>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 in order to increase precision and protect against random error.</p>

Sources: Aschengrau and Seage 2008; CDC 2012; Rothman 2002; 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 health care setting. The IPC team that has a basic understanding of hospital epidemiology and statistics will be able to interpret and share data effectively. The IPC team should be able to share data in a clear, concise, and effective way in order 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.

SECTION 4: IPC IN SPECIAL SETTINGS

CHAPTER 1: SAFE SURGERY AND SAFE PRACTICE IN THE OPERATION ROOM

Chapter Objective

The objective of this chapter is to enable healthcare workers to improve the safety of surgical care and identify the associated risk to healthcare workers, patients/clients.



Learning objectives

By the end of this chapter, participants will be able to:

- Explain proven safe surgical care standards.
- Identify the operating room and associated risks for patients and the staff.
- Identify Instruments as a cause of most injuries in the operating room.
- Describe how to avoid injuries from sharps and designing a safe operation room.

Chapter content

- 1.1. Overview of safe surgery
- 1.2. Implementation of safe surgery checklist
- 1.3. Safe practices in the operating room
- 1.4. The surgical environment
- 1.5. Instruments causing injuries
- 1.6. Designing safer operations

1.1. Overview of safe surgery

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 raise, 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. Mortality from general anaesthesia 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 a serious problem prevailing around the world. Moreover, given the previously estimated rates of major complication and death following in-patient surgery, we have postulated that even using conservative estimate of Seven million patients suffer from complications of surgery half of which were preventable. Given the ubiquity of surgery, these facts have significantly negative impacts on the professional carrier and the service too. 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.

The Safe Surgery Checklist is now in use in Ethiopia in few hospitals by a few surgeons. It is being promoted but not consistently used by the members of the Society of Surgeons or Anaesthesiologists. 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.

1.2. The implementation of the safe surgery checklist

The Checklist involves the coordination of the operating team: the surgeons, anaesthetist and nurses to discuss key safety checks prior to specific phases of peri-operative care: a “Sign in” prior to induction of anaesthesia, a “Time Out” prior to 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 which must be optimized for individual patients. In order to minimize unnecessary loss of life and serious complications, operating team formulated 10 basic essential objectives which are congruent to safe surgery guidelines of the WHO. 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 anaesthetics, 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. The team will consistently use methods known to minimize the risk for surgical site infection.
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.

1.3. 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 infection prevention practices.

The operating room is clearly one of the most hazardous environments in the healthcare delivery system.

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.

The surgical environment

The operating room has special characteristics that increase the chance of accidents. The staff often uses and passes 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 the added stress of anxiety, fatigue, frustration and even anger. As are other mishaps, the exposure to blood is often abrupt and happens without being noticed, usually not until the gloves are removed. In some instances, blood enters into the eyes of the operating person further increasing the risk of infection with blood borne pathogens.

Instruments causing injuries

In hospitals, the vast majority of injuries from sharp edged materials occur in the operating room. Most frequently occurring among these are scalpel and suture-needle injuries. Many other sharp edged instruments can also cause direct physical injuries or indirectly inflict harm by tearing gloves to result in exposure to blood.

The “hands-free” technique for passing surgical instruments

A safer method of passing sharp instruments (scalpels, suture needles and sharp scissors) during surgery called the “Hands-Free” technique has recently 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 touch the same instrument at the same time (Bessinger, 1988; Fox, 1992).

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 sharpen materials are placed before and immediately after use.

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.

Blunt needles for suturing

The range of “bluntness” in commercially available blunt-tipped needles varies. Their bluntness range 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.

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 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.

CHAPTER 2: INFECTION PREVENTION AND CONTROL (IPC) IN INTENSIVE (CRITICAL) CARE UNIT (ICU)

Chapter Objective

The objective of this chapter is to enable healthcare workers understand how infections are transmitted in intensive care unit and identify the associated risk to healthcare workers, patients/clients.



Learning objectives

By the end of this module, participants will be able to:

- Describe the Characteristics of ICU patients and settings
- Identify the Commonly used devices for ICU patients
- Explain the source and transmission of infection in the ICU
- Explain the role of the HCW in transmitting infection within the ICU

Chapter Contents

- 2.1. Overview of IPC in ICU
- 2.2. Characteristics of ICU Patients and Settings
- 2.3. Commonly used devices for ICU patients
- 2.4. Source and Transmission of Infection in the ICU
- 2.5. General Interventions for IPC in the ICU
- 2.6. Interventions for the Prevention of Device-Associated Infections in the ICU

2.1. Overview of IPC in ICU

Patients admitted into intensive care units (ICUs) may have several conditions that increase risk of infections. While recommended infection prevention and control (IPC) practices are the same for the ICU as for other areas of a health facility, healthcare workers (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 particularly relevant in low-resource settings where it is estimated that almost all patients (up to nine of every 10 ICU patients) admitted in ICU suffer at least one healthcare-associated infection (HAI) during their stay in an ICU. This is 2–3 times higher in settings with fewer resources than those in higher-income settings. (WHO) Further 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 and by following evidence-based IPC practices HCWs can prevent HAIs in ICU patients.

2.2. 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.

2.3. 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.

- 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 defences against infection. The risk for infection increases with the length of time that each device is in place. (See chapters on preventing HAIs for more information.)

2.4. Source and Transmission of Infection in the ICU

Sources of Infection

In the ICU, sources of infection are similar to those in ordinary wards. However, typical ICU patients are more vulnerable and receive more hands-on care, thus there are more opportunities for transmission. 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 defences of the skin and respiratory and urinary tracts. 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 and often for ongoing treatment in settings without microbiology laboratory.
- Infection with MDROs and non-availability of antimicrobial susceptibility testing.
- Patients colonized with MDRO in ICU continue to transmit infection to other patients without ever developing signs and symptoms many times causing outbreaks involving large number of patients.

Role of the HCW in Transmitting Infection within 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 shortage with one staff taking care of several patients simultaneously overwhelms the staff and reduces compliance to 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 into their workflow.

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 personal protective equipment (PPE), practice injection safety, wear a mask for performing spinal procedures, clean and disinfect thoroughly, 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, Practice rational use of antibiotics and Provide adequate patient spacing
- Establish a workflow that separates “clean” from “dirty.”

2.5. 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 needs to be experts on incorporating IPC Standard Precautions practices into all aspects of the ICU workflow at all times.

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).

Patient Spacing

Ideally, each patient is cared for in an individual room (single-patient rooms) for reasons of safety and privacy as well as infection control. Workflow in the ICU with multiple patients should be designed to avoid cross contamination of equipment and other supplies. Some considerations include:

- 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.
- When conducting patient-care, complete the care of one patient, perform hand hygiene, and then commence the care of another.
- When conducting patient care work from the cleanest to the dirtiest during each episode of care.
- Utilize a central storage area to store medications, feeds, patient supplies, and cleaned equipment. Do not store these 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.
- Prepare medications and feeds away from patient care areas to prevent contamination.
- Follow the guidelines for cleaning and disinfecting patient-care items.
- Thoroughly clean and disinfect common procedure rooms and dressing rooms after each use.
- 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 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.

Patient Care

Excellent patient-care promotes immune function, maintains the natural defence mechanisms, and prevents additional entry points for infection.

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.

2.6. 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 become contaminated during insertion and care easily. 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 convenience of HCW)
- Actively removing devices as soon as possible and strictly
- Vigilantly incorporating basic IPC practices into the insertion and care of invasive medical devices
- Incorporating elements of infection prevention bundles into care (For implementation details, see VOLUME 2 SECTION 2: PREVENTION OF 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 reduced level of consciousness, lack of mobility, anaesthesia, pain, immune suppression, and other

factors. Strict and vigilant IPC practices can help prevent healthcare-associated pneumonia in ICU. (See the chapter on prevention of healthcare-associated pneumonia.)

Surgical Site Infections

Surgical site infection (SSI) is the most common type of HAI in countries with limited resources and is often caused by MDROs and has high rates of mortality. ICU patients are particularly vulnerable including the potential for a high burden of MDRO 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.

Preventing Infections from Bedside Procedures

In ICUs, procedures usually reserved for the operating theater (OT) may be performed at the ICU bedside if emergent or if the patient is too unstable to be transported. All of the IPC and aseptic techniques appropriate for the type of procedure must still be followed for procedures performed at the bedside. However, settings outside of the OT may not have the environmental controls in place to maintain a level of surgical asepsis expected for such a procedure and thus the patient is at an increased risk of infection.

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 MDRO. 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 transmission of MDROs in ICU:

- Adhere to Standard Precautions including hand hygiene and follow Contact Precautions (see the chapters on Standard and Transmission-Based Precautions).
- 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.
- Base the duration of Contact Precautions on the individual MDRO:
 - Continue Contact Precautions indefinitely in 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 single room for patients infected with 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 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 prevention of infections from vancomycin-resistant enterococcus (VRE), infections from central venous catheters, and infections of surgical sites infections related to ventilator use.
- Do not use mupirocin nasal ointment with antimicrobial prophylaxis on a routine basis for prevention of methicillin-resistant *Staphylococcus aureus* (MRSA) colonization; it should only be used during the outbreaks of MRSA in 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).

Additional Information for Facility Leaders

Strategies for Health Facilities to Support IPC in ICU

Health facilities can use the following strategies to facilitate effective IPC in 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 for HAI prevention activities in ICUs among other settings and IPC risks.
- Provide resources for infection control, utilizing 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 and Implement interventions to improve appropriate use of antibiotics.

Strategies for Health Facilities to Prevent HAIs in the ICU by:

- Provide written guidelines/policies for HCWs. These may include policies specific to IPC in 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.
- Ensure that adequate staffing for ICU and train HCWs on the insertion, care, and maintenance of invasive medical devices, prevention of MDRO, and other IPC aspects of ICU care. Training should occur in a systematic way using a competency-based methodology. Training should occur prior to caring for an ICU patient or prior to first performance of a procedure, as applicable, as well as periodically, such as annually.

CHAPTER 3: IPC IN CLINICAL LABORATORY SERVICES

Chapter Objective

The objective of this chapter is to enable healthcare workers understand how infections are transmitted in clinical laboratory services unit and identify the associated risk healthcare workers, patients/clients.



Learning objectives

By the end of this module, participants will be able to:

- Describe Laboratory acquired infections
- Identify Common routes of exposure to laboratory-acquired infections
- Describe Laboratory biosafety
- Identify safe work practices and recommended infection prevention practices for laboratory workers in specific laboratory procedures

Chapter Contents

- 3.1. Overview
- 3.2. Common routes of exposure that can result in laboratory-acquired infections
- 3.3. Factors contributing to laboratory accidents
- 3.4. Laboratory biosafety
- 3.5. Safe work practices and recommended infection prevention practices for laboratory workers
- 3.6. Infection prevention and control for specific laboratory procedures

3.1. Overview

The clinical laboratory is a unique area of the health care facility in which the types of biological materials handled, along with the practices, procedures, and equipment used, can place the health care worker (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, tuberculosis, typhoid, hepatitis, streptococcal infections, and others are known to have been acquired from the laboratory.

Laboratory-acquired infections

Laboratory acquired infection (LAI) is an infection obtained through laboratory or laboratory-related activities as a result of work with infectious biological agents. LAI 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 laboratory-acquired infections suggest that *Brucella* species, *Shigella* species, *Salmonella* species, *Mycobacterium tuberculosis*, and *Neisseria meningitidis* are the most common causes. Infections due to the blood borne pathogens (hepatitis B virus, hepatitis C virus, and human immunodeficiency virus) 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.

3.2. Common routes of exposure that can result in laboratory-acquired infections

- Inhalation.
- Ingestion
- Puncture Wounds
- Contamination of Skin and Mucous Membranes
- Infected Laboratory Animals

3.3. Factors contributing to laboratory accidents

- Poor training.
- Lack of concentration.

- Carelessness and negligence.
- Overwork and fatigue-emergency conditions.
- Untidy and noisy working environment.

3.4. Laboratory biosafety

WHO describes this as containment principles technologies practices implemented to prevent unintentional exposure to pathogens and toxins, or their accidental release (WHO, 2003)

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.

3.5. 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. Correspondingly, they need to know how to protect themselves, fellow workers, and the environment in general.

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

3.6. Infection prevention and control for specific laboratory procedures

- Drawing blood from veins of patients (phlebotomy) is often performed by laboratory staff.
- Safe Handling of Specimens

- Specimen containers and labels
- Transporting specimens within the health care facility
- Receipt of specimens
- Safe Laboratory Bench Workspace
- Use of pipettes and pipetting aids
- Separation of serum
- Use of centrifuges

CHAPTER 4: IPC IN BLOOD BANK AND TRANSFUSION SERVICES

Chapter Objective

The objective of this chapter is to enable healthcare workers understand how infections are transmitted in blood bank and transfusion services and identify the associated risk to healthcare workers, patients/clients.



Learning objectives

By the end of this module, participants will be able to:

- Identify risks of blood transfusion service to donors, health care workers (HCWs), and blood transfusion recipients
- Identify how to Prevent donors, HCWs, and blood transfusion recipients
- Identify Components of safe blood bank services, from donation to transfusion
- Explain activities at Blood bank and transfusion services and infection prevention and patient safety practice

Chapter Content

- 4.1. Overview
- 4.2. Risks of blood transfusion services to donors, health care workers and recipients
- 4.3. Components of safe blood bank services, from donation to Transfusion

4.1. Overview

Transfusing patients with blood and blood components has been used as a treatment for over 200 years. When blood transfusions occur safely, they can save lives and are 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 2015).

The responsibility for safety at blood donor sessions and in the laboratory rests with everyone who works there even if a particular person is assigned for overall responsibility to ensuring

safety. It is the duty of every member of staff to carryout procedures in a responsible way in order to avoid endangering the safety of themselves or anyone else (WHO 2009).

4.2. Risks of blood transfusion services to donors, health care workers and recipients

During the process of blood collection, storage and transfusion, there is a risk of infection for the donor, the recipient and for HCWs who handle the blood and blood components.

Donor: There is a small risk to the donor the possibility of infection at the site from which the blood is drawn and from contaminated equipment or the hands of HCWs. **HCW:** There is also a risk to the HCW of exposure to blood-borne pathogens via splashes into mucous membranes of the eyes, nose and mouth or from a sharp injury while collecting the donor specimen, during testing and when infusing blood/blood components.

Recipient: The greatest risk is to the recipient of the transfusion from pathogens contained in the donated blood, known as transfusion transmitted infection (TTI). There is also a small risk of infection from the intravenous device used to deliver the blood transfusion or from contamination of the health care environment, equipment or hands of HCWs

Preventing donors, health care workers and recipients

Protecting Donors

Risk to the donors can be reduced by following best practices for infection prevention and control (IPC) to prevent infection at the blood collection site and exposure to blood-borne pathogens (BBPs).

Protecting Health Care Workers

Any Staff working in blood banks and transfusion services are at risk of exposure to pathogens in blood in a number of ways, including while collecting the donor specimen, during testing, when infusing blood/blood components, and when disposing wastes of blood collection and transfusion materials.

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
- After the blood is collected
- When transfusing blood and blood products

4.3. Components of safe blood bank services, from donation to transfusion

- Screening and informing blood donors and obtaining their consent
- Collecting blood from screened donors
- Quarantining blood and blood components
- Performing screening tests for infectious diseases on blood components
- Releasing blood and blood components from quarantine
- Storing and transporting donated blood
- Testing and cross-matching recipients' blood prior to transfusion
- Transfusing blood and blood components

Screening and informing blood donors and obtaining their consent

Effective blood transfusion begins with collection of safe blood from healthy blood donors:

- Collecting blood from screened donors
- Avoid Contamination of Collected Blood:
- Quarantining blood and blood components
- 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 (2010) 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

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.
- 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.

Blood Storage and Short Distance Transport:

- Blood units must be stored in a refrigerator at a temperature ranging from 1 to 6°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 onto 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 prior to 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.

Transfusion of Blood or Blood Components

Indications for blood transfusion are:

- Actively bleeding patients and Patients with chronic or symptomatic anaemia.

- The generally accepted Hemoglobin level for transfusing patients with acute blood loss is 7 gm%; those patients having a level of 6gm%, 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.

CHAPTER 5: PREVENTING MATERNAL AND NEWBORN INFECTIONS IN HEALTH CARE SETTINGS

Chapter Objective

The objective of this chapter is to enable healthcare workers understand how infections are transmitted in maternal and new born infections in health care settings and identify the associated risk to healthcare workers, patients/clients.



Learning objectives

- By the end of this module, participants will be able to:
- Describe Epidemiology of maternal, fetal, and newborn infections
- Describe Prevention of maternal and newborn infections during labor, delivery, and the postpartum period
- Explain Prevention of infections in newborns requiring specialized care
- Identify the Management of outbreaks in the nursery or neonatal intensive care unit (NICU)

Chapter content

- 5.1. Overview
- 5.2. Epidemiology of maternal fetal and new born infection
- 5.3. Infection Prevention and Control Interventions during Pregnancy: Prenatal Care
- 5.4. IPC Interventions during Birth: Intrapartum Care
- 5.5. Infection Prevention and Control Interventions after Delivery: Postpartum Care of the Mother
- 5.6. Infection Prevention and Control Interventions after Delivery: Care of the Newborn
- 5.7. Preventing infection in newborns requiring specialized care
- 5.8. Management of the NICU

5.1. Overview

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 health care facility, to caring for a high-risk woman in an operative setting and a newborn in a neonatal intensive care unit (NICU). Further, the outcomes for the mother and her newborn are dependent upon 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.

In many countries in sub-Saharan Africa, South Asia, and South East Asia, more than three-quarters (74.7–89.9%) of women in the lowest two wealth quintiles give birth at home (Montagu et al 2011). However, in some areas this is beginning to change as more mothers are choosing to give birth in health care facilities. This trend increases the importance of infection prevention and control (IPC) in health care facilities, where there are many potential sources of transmission including contaminated equipment and surfaces, other mothers and newborns, HCWs, and visitors.

5.2. Epidemiology of Maternal, Fetal and New Born Infection

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., methicillin-resistant *Staphylococcus aureus* [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 multidrug-resistant organisms (MDRO).

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 low-income countries, that risk can be as great as 1 death per 41 pregnancies, with infection being one of the leading cause 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 1 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.

Table 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	Group B streptococci, E. coli, Coagulase-negative staphylococcus, Listeria monocytogenes, HBV, HIV, HSV
Environment within health care facility	Gram-negative organisms (e.g., Klebsiella pneumoniae) often multidrug resistant (MDR), opportunistic infections (e.g., coagulase-negative Staphylococcus spp.), Gram-positive organisms (e.g., MRSA), respiratory viruses, and gastrointestinal infections (e.g., Staphylococcus spp.)

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.

In addition, 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, particularly with gram-negative bacteria. Inappropriate management of umbilical cord and newborn circumcision procedures can also expose newborns to infectious microbes.

Risk factors for mothers and newborns

Table 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	<ul style="list-style-type: none"> Immunosuppression (e.g., steroids, HIV) Uncontrolled diabetes Nutritional status, either a low or high (< 19 or > 30) body mass index (BMI) American Society of Anesthesiologists score of > 3 Low socioeconomic status Smoking (delays wound healing) Vaginal colonization/infections, which cause problems and infections in the mother (e.g., UTI, GBS (Group-B streptococcus), and bacterial vaginosis) Colonization and infections, which may cause infection in the newborn (e.g., GBS, HIV, HSV, syphilis, gonorrhea, chlamydia)
LABOR-RELATED RISK FACTORS that increase the risk of infection in both the mother and newborn	<ul style="list-style-type: none"> Ruptured membranes (ROM) (may be the cause or consequence of infection) Preterm labor, which may be caused by IAI Premature ROM Prolonged ROM (usually considered longer than 24 hours) Prolonged labor Prolonged prenatal hospital stay Multiple vaginal examinations Use of internal monitoring Trauma to the birth canal (vaginal or perineal lacerations and urethral tears) Use of forceps or vacuum extractor for delivery C-section Manual placental removal
NEWBORN RISK FACTORS that increase the risk of infection in the newborn	<ul style="list-style-type: none"> Lower birth weight Younger gestational age Co-morbidities (e.g., congenital conditions)

Risk Factors	
CARE-RELATED RISK FACTORS that increase the risk infection in the newborn	<ul style="list-style-type: none"> Intensive care stay Presence of invasive medical devices Longer hospital stay Parenteral nutrition Antimicrobial therapy, which may lead to MDRO infection Overcrowding and understaffing Ward layout (sinks, bed spacing) Use of fetal scalp electrodes Contact with colonized/infected family, visitors, or HCWs Proximity of colonized neonates

5.3. 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. (WHO 2015b)

5.4. IPC Interventions during Birth: Intrapartum Care

Vaginal delivery does not require the aseptic conditions of an operating theater, it does require the vigilant use of basic IPC practices during labor and delivery to prevent infections of the mother, infant, and HCWs.

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 5-3: Recommended Practices for Preventing Maternal and Newborn Infections describes the selection of gloves for use by HCWs during the intrapartum period. (also see SECTION 1CHAPTER 4: HAND HYGIENE)

Table 5-3: Recommended Practices for Preventing Maternal and Newborn Infections

Intrapartum practices that reduce infection	<ul style="list-style-type: none"> Use of partograph for prompt diagnosis of prolonged labor Timely management of prolonged labor
---	---

	<p>Minimization of vaginal examinations</p> <p>Prevention and prompt diagnosis and treatment of IAI</p>
The Six Cleans: A memory aid for birth attendants	<p>Clean hands—vigilant hand hygiene and new gloves for vaginal exams or when handling the baby.</p> <p>Clean perineum—feces should be wiped away and the perineum washed prior to the birth (mother can shower or bathe).</p> <p>Nothing unclean introduced into vagina—hands, herbs, or other substances.</p> <p>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).</p> <p>Sterile cord cutting instrument—at home, use a new razor blade. Note: if sterile instruments are not available, high-level disinfected items are acceptable (WHO 2016).</p> <p>Clean cord care—clean, dry cord care is recommended for newborns born in health care facilities and at home in low newborn mortality settings. 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).</p>

Sources: Partnership for Maternal, Newborn & Child Health 2006; WHO 2013b.

5.5. 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:

- Infection prevention education:
- Limit use of antibiotics after birth to recommended indications:
- 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 6 hours and without difficulty.
 - Wear new, sterile gloves when performing perineal care or touching the episiotomy.

- Wear new, non-sterile gloves when handling perineal pads, touching lochia (vaginal discharge), assisting with breastfeeding, etc.

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)

5.6. Infection Prevention and Control Interventions after Delivery: Care of the Newborn

Preventing infection in newborns at birth

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 1 minute after birth, start positive pressure ventilation with room air with a self-inflating bag and mask.

(WHO, UNICEF, UNFPA 2013)

Within the first hour of life

- Initiate breastfeeding within 1 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.

- 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).

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.
- Keep the mother separated from the baby for IPC purposes only when the mother has multidrug-resistant TB. Consult to IPC staff regarding precautions for other infections in the mother. There are few reasons to keep the mother from the baby.
- Follow patient spacing guidelines in the newborn nursery. See section on Management if the NICU in this chapter.
- Encourage exclusive breastfeeding. Manage expressing and storage of breast milk carefully to prevent infection
- Manage the preparation of formula
- 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.
- 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 vaccine virus to immunocompromised 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, hepatitis A, 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)

5.7. Preventing Infection in Newborns Requiring Specialized Care

Introduction to specialized care of newborns

Newborns that require a higher level of care than can be provided in the newborn nursery may be transferred to a special care nursery (SCN) or NICU (see the Key Terms section in this chapter for levels of newborn care). 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.

This section describes on IPC considerations to the NICU. These 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 upon 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 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.

- NICU attire and linen
- 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.
- 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 from those for other age groups.
- See recommendations for central line-associated blood stream infection prevention.
- See recommendations for catheter-associated urinary tract infection prevention.
- See recommendations for surgical site infection prevention.

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 tube 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.

Routine active surveillance cultures

The use of surveillance cultures to identify colonization with specific MDROs (e.g., MRSA, vancomycin-resistant enterococci [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.

- 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.

5.8. Management of the NICU

Patient spacing

Health care 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.

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 upon arrival to the hospital)
- 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.
- Bassinets, cribs, warmers, and incubators
- 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 humidifiers 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 5-4: Breast Milk Storage

Table 5-4: 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) Hang time for feeds: ≤4 hours. Replace entire feeding set every 4 hours.	Potential for contamination if stored at bedside awaiting use Use containers covered with a lid or tied at the top 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 Label with infant's name, medical record number, and date of birth 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 Label with infant's name, medical record number, and date of birth 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 Do no use hot water 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 Do not refrigerate once milk has

Location	Temperature	Length of Time	Details
			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 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.

Summary

Maternal and newborn care is unique and complex, requiring the simultaneous care of two interdependent patients. Their outcomes are dependent upon 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 as well as recommendations specific to maternal and newborn health.

Infants in specialized care settings such as the SCN and NICU are particularly vulnerable to infection.

Outbreaks of HAIs are common and need to be investigated and measures to halt any further spread implemented promptly.

CHAPTER 6: MORTUARY-INFECTION PREVENTION AND CONTROL FOR HANDLING HUMAN REMAINS

Chapter Objective

The objective of this chapter is to enable healthcare workers understand how Mortuary—Infection Prevention and Control for Handling Human Remains and identify the associated risk to healthcare workers, patients/clients.



Learning objectives

By the end of this chapter, participants will be able to:

- Explain Infection prevention and control for handling human remains
- Explain Preparing the dead body and transporting the human remains to morgue
- Identify Infection prevention and control practice for post mortem examination
- Explain Infection prevention and control practice for handling remains of patients with highly infectious disease.
- Identify Infection prevention and control practice for handling for handling during natural disaster

Chapter Content

- 6.1. Overview
- 6.2. Infection Prevention and Control Practices for Handling Human Remains
- 6.3. Preparing the Dead Body and Transporting Human Remains to the Morgue
- 6.4. IPC Practices for Post-Mortem Examinations
- 6.5. IPC Practices for Handling Remains of Patients with Highly Infectious Diseases
- 6.6. IPC Practices for Handling Human Remains during Natural Disasters

6.1. Overview

Managing human remains begins immediately after pronouncement of death. It includes hygienically preparing the body for transport to the mortuary, storing in the mortuary, conducting the post-mortem examination (*if needed*), and handing over the body 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.

Clinical and mortuary staffs 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 within the mortuary, and autopsies always involve handling potentially infected material, and all human remains should be treated as potentially infectious. While 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 infection prevention and control (IPC) practices, healthcare workers (HCWs) can prevent the risk of injury and infection occurring while handling bodies.

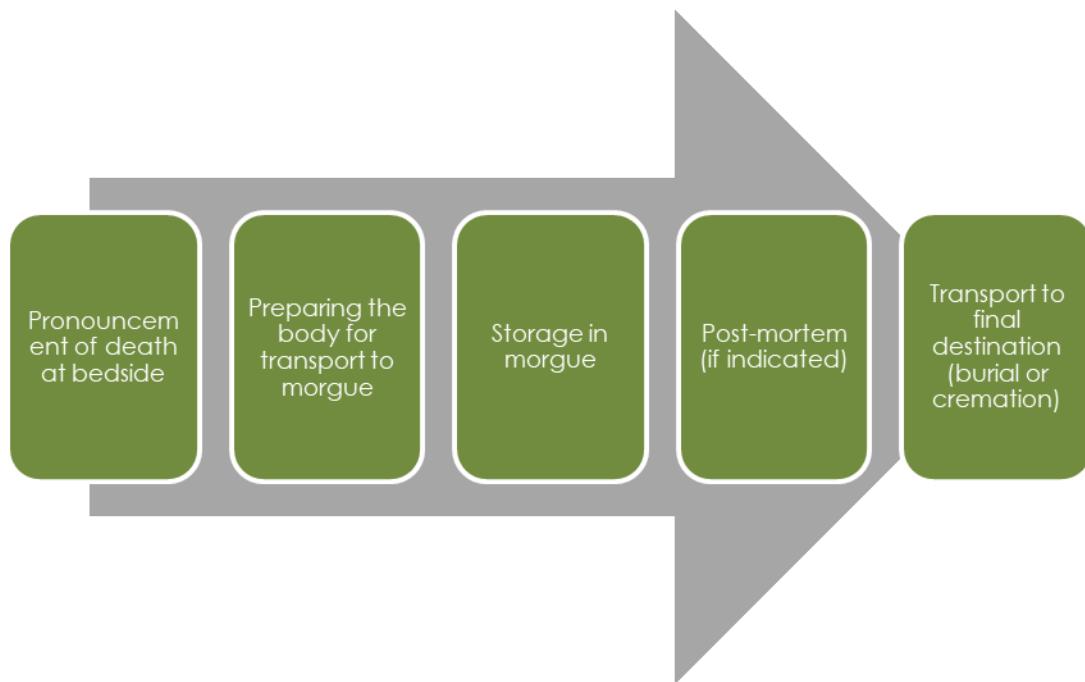


Figure 6-1: Steps in the Process of Post-Mortem Care in Healthcare Facilities

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, particularly during autopsies when exposure to aerosols, spills/spatters, and punctures with sharp objects results in blood borne diseases and TB. Further, sampling of environmental surfaces in morgues has revealed surfaces contaminated with fecal matter and DNA, even after routine cleaning. While the risk of infection in most cases is low, HCWs who handle human remains are at risk from infection from the following:

- Blood borne pathogens (*e.g., hepatitis viruses, HIV, Ebola*) from:
- 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 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

6.2. 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 Ebola*) additional precautions are required.

6.3. 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.

6.4. IPC Practices for Post-Mortem Examinations

Post-mortem examinations are routinely performed in health facilities both for forensic purposes and to ascertain cause of death for public health reasons. Post-mortems involve collection of anatomical samples, such as viscera and other organs, to ascertain the cause of death. Performing the post-mortem 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 post-mortems 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
- Follow the standard operating procedures for performing post-mortem examinations.
- Treat all specimens as infectious.
- Where possible, use safe engineering designs and work practice controls to avoid sharps hazards.
- Where possible, employ safe engineering designs to avoid cutting, splashing, and aerosol-generating actions during post-mortem procedures.

- 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 post-mortem room.
- Reprocess instruments and surfaces contaminated during post-mortem procedures using standard cleaning procedures to remove all vegetative organisms:
- 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.

6.5. 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 Ebola in the West African countries of Liberia, Guinea, and Sierra Leone during the outbreak from 2014–2016.

Ebola

Remains of patients with Ebola 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 Ebola.

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:

Tuberculosis

Tuberculosis 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.

If body bags are not available

- Conduct risk assessment to make sure that use of 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

Healthcare workers 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 infection prevention precautions by preparing the post-mortem/autopsy room and assisting with photography.

Post-Mortem

Infection prevention and control requirements for post-mortem examinations may be regulated by national health and occupational safety organizations.

6.6. 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 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 mortuary or burial site.

- Ensure that transport vehicles are cleaned and disinfected at the end of the day.
- Apply control measures including disinfection of body using 0.5% chlorine.
- Limit physical contact by family members with remains.
- Store body in refrigerated storage facility at 2-4°C ($35-40^{\circ}F$). Keep bodies in original body bags or plastic wraps.
- Ensure that 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 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 Ebola Virus Disease
- Recommendations for Design and Layout Plan of a Mortuary

SECTION 5: IPC MANAGEMENT AND GOVERNANCE

CHAPTER 1: PRINCIPLES OF PUBLIC HEALTH EMERGENCY PREPAREDNESS AND OUTBREAK MANAGEMENT FOR HEALTH CARE FACILITIES

Chapter objective:

The objective of this chapter is to enable participant understand IPC in Public Health Emergency Preparedness and Outbreak Management for Health Care Facilities



Learning objectives

By the end of this chapter participants will be able to:

- Describe infection prevention and control in public health emergencies
- Explain the principles of emergency management: mitigation, preparedness, response, and recovery
- Identify the role of the health care facility in data collection and epidemiological investigation during an emergency or outbreak
- Understand the importance of information sharing and communication during a public health emergency

Chapter Content:

- 1.1. Overview of Public Health Emergency Preparedness and Outbreak Managements
- 1.2. Infection control in public health emergencies
- 1.3. Principles of emergency management
- 1.4. Role of health care facility in data collection and epidemiological investigation during an emergency or outbreak
- 1.5. Information sharing and communication during a public health emergency

1.1. Overview of Public Health Emergency Preparedness and Outbreak Managements

Disease outbreaks and other public health emergencies may be considered major disasters. Thus, planning ahead for these emergencies is critical for all organizations, including health care facilities. With proper planning and preparedness, a health care facility is able to respond more quickly and thoughtfully to a public health emergency.

Public health emergencies bring many challenges, including an urgent need for response, proper case identification, use of basic and enhanced infection prevention and control (IPC) practices, data collection, and communication, all while essential health services must still be maintained. The more a facility can prepare in advance, the better the ability to respond and adapt to a public health emergency. (APIC 2014; WHO 2005b)

“Outbreaks are urgent emergencies accompanied by rapid efforts to care for cases, prevent further spread, and bring the outbreak under control. Decisions, often with life-saving potential, need to be made rapidly and actions need to be followed promptly.”

—World Health Organization 2005a

The Nature of Public Health Emergencies

Public health emergencies can be 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 impact a large number of individuals, 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 health care 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)

1.2. Infection Prevention and Control in 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 Ebola Virus Disease outbreak, one of the commonest finding was frequent lapses in basic IPC practices during a rapid needs assessment in the affected countries. The team identified a lack of dedicated IPC personnel and standard operating procedures related to many IPC practices, including screening, triage, and isolation and poor skills in the appropriate use of PPEs.

1.3. Principles of Emergency Management

Public health emergencies should be planned for and responded to using the primary principles of emergency management (see Figure 1-1: The Four Principles of Emergency Management): mitigation, preparedness, response, and recovery.



Figure 1-1: The Four Principles of Emergency Management

Mitigation

These include strategies that would prevent or reduce the chance of an emergency, or reduce vulnerability of high-risk groups

Preparedness

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. It is essential to test the plans, the system and make sure 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 if the facility is prepared and where actions and resources for handling a public health emergency are most needed. (See Appendix 2-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 include:

- 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. A strong disease surveillance system should assist a facility in identifying cases of disease that are of concern. (**See Chapter on Surveillance of Health Care-Associated Infections**)

Case definitions

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 health care facilities or

public health authorities. Table 1-1: Example of Case Definition provides an example of a case definition. 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 2015)

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 particular 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.

Table 1-1: Example of Case Definition

Disease Condition	Suspected Case	Confirmed case
Viral Hemorrhagic Fever (VHF)	Illness with onset of fever and not showing improvement to treatments of usual causes of fever in the area, and at least one of the following signs: bloody diarrhea, bleeding from gums, bleeding into skin (purpura), bleeding into eyes and urine.	A suspected case with laboratory confirmation (positive IgM antibody or viral isolation), or epidemiologic link to confirmed cases or epidemic.
Yellow fever	A person with acute onset of fever followed by jaundice within two weeks of onset of first symptoms. Hemorrhagic manifestations and renal failure may occur.	A suspected case with laboratory confirmation (positive IgM antibody or viral isolation) or epidemiologic link to confirmed cases or epidemics.
Cholera	In a patient age 5 years or more, with severe dehydration or death from acute watery diarrhea. If there is a cholera epidemic, a suspected case is any person age 5 years or more with acute watery diarrhea, with or without vomiting.	A suspected case in which <i>Vibrio cholerae</i> O1 or O139 has been isolated in the stool.

PHEM National Guideline 2012.

As an outbreak evolves and more information becomes available, it is common for case definitions to be adapted and change.

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 health care facility, thus minimizing the risk of disease transmission within 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 helpful to have print copies of screening forms as job aids. The person conducting screening (any trained staff) 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. (See for more information SECTION 1CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S)

Reinforce infection prevention and control practices

IPC practices should be followed every day with every patient in a health care 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 health care facilities at all times, including during an outbreak.

A facility must have strong IPC principles in place before the outbreak occurs in order to rapidly prevent any further spread. A component of preparedness is training HCWs and other facility staff on the basics of IPC. Box 1-1: IPC Topics for Staff Education during the Preparedness Phase lists topics related to IPC to be prioritized for education as part of a preparedness plan.

Box 1-1: IPC Topics for Staff Education during the Preparedness Phase

- | | |
|--|--|
| <ul style="list-style-type: none">⊕ 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 | <ul style="list-style-type: none">⊕ Respiratory etiquette⊕ Use and reuse of PPE⊕ 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⊕⊕ |
|--|--|

Adapted from: Rebmann 2009.

Most outbreaks involve organisms that require Transmission-Based Precautions, in addition to Standard Precautions. 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 et. al 2015). See SECTION 1CHAPTER 5: PERSONAL PROTECTIVE EQUIPMENT'S).

As part of the preparedness, a health care 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:

$$\begin{aligned} & \text{(Number of HCWs} \times \text{number of PPE sets per HCW per day}) \times \text{estimated number of days in} \\ & \quad \text{outbreak} = \\ & \quad \text{Estimated number of PPE sets needed for stockpile} \end{aligned}$$

The estimated cost of the PPE stockpile can be calculated by multiplying this number by the average cost of one set of PPE. (Hashikura and Kizu 2009; NAMRU3 and USAID Egypt 2011) See Appendix 2-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 Vol. 1, Chapter 2, Basic Microbiology for Infection Prevention and Control, 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 Chapter on Clinical Laboratory Biosafety).

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. The Ministry of Health/Regional Health Bureaus 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 within 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 health care facility are better able to come together during times of public health emergency.

Perform drills and tests of the system

Health care facilities should perform regular drills to 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 upon the nature of the emergency, response activities may be restricted to the health care 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 1-2: Public Health Emergency Response by Time Frame).

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).

Table 1-2: Public Health Emergency Response by Time Frame

Immediate Response (0–2 hours)	Intermediate Response (2–6 hours)
<ul style="list-style-type: none"> • Assess the situation. • Contact key government health personnel. • Develop immediate response objectives and establish plan of action. • Establish emergency operation center if indicated and engage public health professionals. • Ensure that the site health and safety plans to protect response personnel are followed. • Establish communication with key health and medical organizations. • Assign and deploy resources and assets for initial health response objectives (including health care needs of those affected). • Address requests for assistance and information. • Initiate risk communication activities. • Engage legal counsel, if available. • Document all response activities 	<ul style="list-style-type: none"> • Continue activities already initiated. • Verify that surveillance activities are operationalized. • Ensure that laboratories are operational for confirmation of cases. • Address the needs of special populations (e.g., children, pregnant women, elderly). • Communicate with community about need for health-related volunteers and donations. • Update risk communication messages as new information becomes available.
Intermediate Response 6–12 hours	Extended Response 12–24 hours
<ul style="list-style-type: none"> • Continue activities already initiated, as appropriate. • Collect and analyze disease surveillance and laboratory data. • Update information and make changes to objectives and plans, as needed. • Prepare for onsite assistance from public health authorities. • Assess and acquire supplies and other resources. 	<ul style="list-style-type: none"> • Address mental and behavioral health support needs. • Prepare for transition to extended operations.

Extended Response: Ongoing Public Health Emergency Response Functions and Tasks from 24 Hours Onward

- | | | |
|---|---|--|
| <ul style="list-style-type: none">• Identify environmental hazards.• Assess potential hazards.• Assess epidemiological services.• Assess health and medical needs.• Identify and treat affected individuals.• Control contamination.• Conduct surveillance, include laboratory.• Manage wastes.• Quarantine and isolate affected individuals. | <ul style="list-style-type: none">• Provide public health information.• Communicate with facility staff and community.• Assess responder safety and health.• Assess overall health and medical personnel resources.• Check health and medical equipment availability.• Organize health-related volunteers and donations.• Review in-hospital care.• Plan evacuation and sheltering in place. | <ul style="list-style-type: none">• Manage trauma and fatalities.• Assess morgue services and disposal of human remains.• Initiate mental health and social services.• Ensure water and food safety.• Control vectors.• Review sanitation and hygiene practices.• Maintain routine services.• Coordinate with veterinary services.• 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 the 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. 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 they understand their roles and responsibilities in an emergency. Lastly, 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.

1.4. Role of the Health Care Facility in Data Collection and Epidemiological Outbreak Investigation during an Emergency

Outbreak investigation requires cooperation and collaboration between many groups, including health care providers, epidemiologists, IPC staff, public health authorities, and the community. The health care facility has a role in assisting public health authorities with data collection and outbreak investigation during outbreak situations.

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 Ebola Virus Disease 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 health care 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 concern
- 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

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 communications 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

IPC practices play an important role during outbreaks and public health emergencies. The four main principles of emergency management—mitigation, preparedness, response, and recovery—help determine how a health care facility will respond to an emergency or outbreak. Key steps in preparing facilities for an emergency include: 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 health care facility in preparing will help determine how successful the facility will be in responding to emergency.

CHAPTER 2: MANAGING INFECTION PREVENTION AND CONTROL PROGRAM

Chapter objective:

The objective of this chapter is to enable participant understand the concept of managing IPC activities.



Learning objectives

By the end of this chapter participants will be able to:

- Describe the structure and organization of IPC program management
- Identify the roles and responsibilities of health care workers (HCWs) involved in IPC programs
- Explain the attributes of effective infection prevention control (IPC) and Patient Safety programs
- Mention the core components of IPC program.
- Describe the major Infection Prevention and Control Activities
- Explain the continuous improvement of IPC practices using model for improvement
- Describe the organizing principles of IPC Program

Chapter Content:

- 2.1. Overview
- 2.2. Structure and Organization of IPC program management
- 2.3. Roles and responsibilities of health care workers (HCWs) involved in IPC programs
- 2.4. Attributes of effective infection prevention and control (IPC) and Patient Safety programs
- 2.5. Major infection prevention and control program activities
- 2.6. Continuous improvement IPC practices using model for improvement
- 2.7. Organizing Principles of IPC Program

2.1. Overview

Proper management of infection prevention and patient safety programs at various levels of implementation has paramount importance for the success and fulfilment of basic strategic objectives for improving health outcomes. It is also a key component of health system strengthening. Due to the fact that available resources are invariably limited, careful planning, implementing and monitoring activities on a regular basis are all essential from primary tertiary level in the health care system. A proper supportive supervision for performance improvement and change management is also critical for IPC activities management. In many countries, including Ethiopia, functioning infection surveillance systems are lacking and laboratory backup to identify the cause of nosocomial infections is inadequate. When properly implemented, infection prevention and patient safety are not only cost-effective option of mitigating morbidity burden but also the only realistic method to limit the spread of disease and insure patient safety within healthcare facilities. To make this happen, healthcare administrators, clinic managers and staff at all levels of the healthcare system must be totally committed to support and be responsible to apply recommended infection prevention and Patient Safety practices.

2.2. 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 the World Health Organization's (WHO) Core Components of IPC (2016), in which the first six components have requirements at the national and facility levels. The WHO Core Components of IPC are:

1. IPC programs at national and facility level
2. IPC guidelines at national and facility level
3. IPC education and training at national and facility level
4. Surveillance of HAIs at national and facility level

5. Multimodal strategies for implementing IPC activities at national and facility level
6. Monitoring and evaluations and feedback at national and facility level
7. Workload, staffing, and bed occupancy at the facility level
8. Built environment, materials, and equipment for IPC at facility level (WHO 2016)

Composition, Roles, and Responsibilities for IPC Programs at different levels. (**See Reference Manual Vol. 2, Section 5, Table 2-5-2-25**).

The three primary goals for facility-level IPC programs are to:

- Protect patients from health care associated infections and other health related hazard
- Protect HCWs, visitors, and others in the health care environment
- Achieve this protection in the most cost-effective manner within the constraints of available resources (APIC 2014b; Friedman et al. 1999; Scheckler et al. 1998)

The structure and organization of the program tasked with achieving these goals can vary and should take into account the unique situation, needs, resources of each facility, the type of care given and the environment in which it operates. 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.

- All responsibilities of the program are carried out by IPC focal staff and are guided by a health care epidemiologist/infectious disease physician or other physicians with relevant expertise. 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/s, chair of the committee (an appropriately qualified clinician/professional, health care 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 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 et al. 2011; Wiblin and 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 staffs have designated hours each week (less than full time) to dedicate to IPC. The remainder of their time may be spent in clinical care or another area, such as occupational health or quality improvement. (APIC 2014b; Smith et al. 2008; WHO 2002)
- If one IPC staff member attends multiple clinics or facilities for IPC activity, a structure like an IPC committee is important for maintaining support and oversight. (APIC 2014b; Smith et al. 2008; WHO 2002; WHO 2016)
- The IPC focal staff report to the IPC Committee and are overseen by a separate administrative area, such as microbiology, laboratory, medical or nursing hierarchy, public health services, quality improvement department, patient safety department, or another area. (APIC 2014b; WHO 2002)

Ratio of IPC professionals to workload

The WHO Core Components for 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 well as expectations and responsibilities of the IPC staff. (WHO 2016)

Roles and Responsibilities of Health Care Workers (HCWs) Involved in IPC Programs

In addition to the designated program leader, key Staff and Groups Involved in Infection Prevention and Control 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 health care facilities and can be adapted to fit to the local context of the facility. One or more health care administrators will supervise the leader of the IPC program and will take an active role in helping to shape and support the program's priorities and plans.

IPC committee: 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. Additionally, the committee 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 post & clinics) where these functions often overlap, the group may consist of only two or three individuals. The IPC committee should meet on a regular basis, usually monthly, to review the available IPC data and any problems or issues that are identified but the IPC team (usually composed of key persons involved in the day-to-day activity such as the IPC focal, the Lab personnel and the pharmacist) may meet more frequently on need basis.

Task forces/working groups: These may be permanent or temporary groups, and may 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 individuals 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: 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 process can highlight important areas of risk and opportunities for improvement. (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 front-line information to the public health authorities.

Roles and responsibilities of facility level staffs

The organization and structure of a facility's IPC program, should 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 2-1: IPC Program Staff Structure at Health Care Facility Level). Facility leadership should adapt the program structure based on the scope of the IPC program and the needs of the facility. Small health care 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 2-1: IPC Program Staff Structure at Health Care Facility Level.

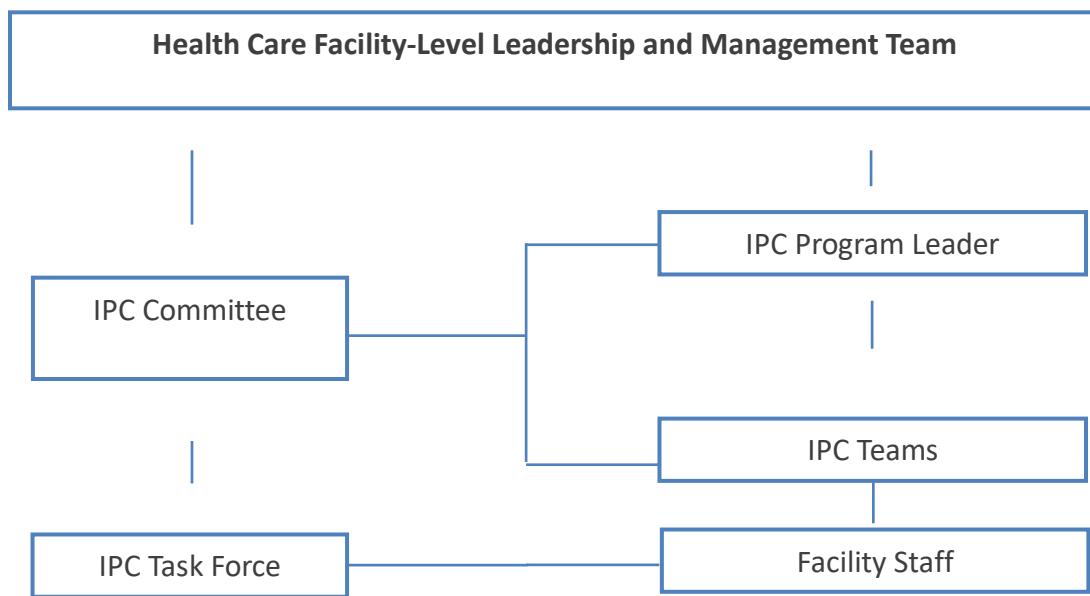


Figure 2-1: IPC Program Staff Structure at Health Care Facility Level

(For more detail see Ref. Manual)

Attributes for Effective Infection Prevention and Control and Patient Safety 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 following are necessary for an IPC program to succeed. To achieve this, 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 front-line HCWs
- Effective communication about IPC

Major Infection Prevention and Control and Patient Safety Program Activities

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 within the oversight of the program. The designated program leader should ensure that these activities are carried out:

- Facility Infection Prevention and Control Risk Assessment
- Program planning,
- Implementation strategies for evidence-based practice
- IPC Program evaluation

(see for more detail Ref. Manual Vol. 2, Section 5, Chapter 2)

Continuous Improvement of IPC Practices Using 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.

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 are knowledge to implement a solution as well as 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)

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; (see Figure 2-2: Deming’s PDSA Cycle and Key Elements of Each Step). PDSA outlines a model for the process of continuous quality improvement. This process has been used widely for IPC improvement projects:

Plan—the health care facility staff design interventions to improve an IPC-related process or to address a gap in IPC practices

Do—the health care facility staff implement the intervention

Study—the health care facility staff analyze results of the interventions that were gathered through the timely collection of monitoring data

Act—the health care facility staff institutionalize or reject the intervention based on the results and plan another intervention.

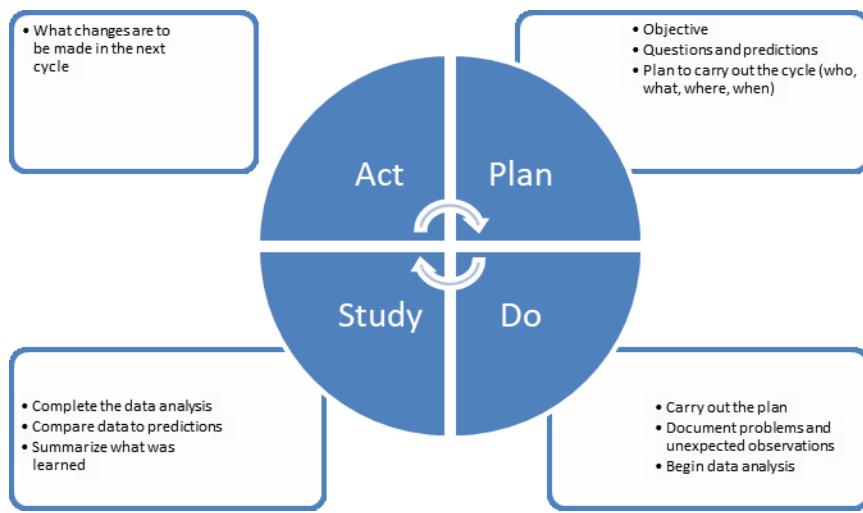


Figure 2-2: Deming's PDSA Cycle and Key Elements of Each Step

Standards-Based Management and Recognition (SBM-R): a continuous quality improvement model which has been used in health care facilities in a number of countries to improve the quality of family planning, HIV/AIDS care and treatment, IPC, and other areas of health care.

The four steps of the SBM-R model are:

- **Setting standards**
- **Implementing standards**
- **Measuring progress**
- **Rewarding achievement**

Translating Evidence into Practice: The focuses on changing behaviors of the health care team within 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 within the local unit and larger system (Pronovost 2008)

Organizing Principles of IPC Program

The three recommended organizing principles for managing IP/PS program:

1. Establishing the relative importance of problems using their level of significance according to Spaulding's categories of potential infection risk. These are:
 - Critical
 - Semi-critical
 - Non critical
2. Identifying and analysing reasons for poor or incorrect implementation/performance. The second principle correctly identifying why performance is not up to the standard, at this point, it usually comes up with three possible reasons. The performance is poor because the 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 patient safety equipment; or
 - 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-Benefit Analysis: Estimating the cost-benefit of the corrective intervention and activities. This may be difficult due to lack of data which should be used whenever available.

Developing Successful IPC Programs:

Throughout this manual, evidence is presented to help managers make a better, more informed decisions and recommendations regarding frequently encountered problems. In making these 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 (in addition to education). To change unsatisfactory performance by staff (e.g., lack of compliance with hand washing guidelines) requires management reinforcement if the behavior change is going to be sustained.

Health facilities administrators and managers, working in conjunction with staff serving on infection prevention and Patient Safety committees should.

Set standards for practice, mentor staff and regularly monitor staff practice; and

Help staff at all levels “buy in” to using common sense when performing their assigned duties, as well as using appropriate personal protective equipment at all times.

Consistently 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., hand washing between patient contacts).

Be role models, especially physicians and other senior staff and faculty, who actively support recommended infection prevention and Patient Safety practices and demonstrate appropriate behaviour.

Basic guidance and activities that help managers to implement successful IP/PS program rollout;

Have written policies, guidelines and procedures established to handle situations in which patients or staffs 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 concern

Training and Staff Development

Healthcare workers are often willing to change bad attitudes and work habits when they understand the rationale and significance of new safety procedures. Nonetheless, this positive behavioral change and compliance shortly attained often starts to decline again in a few days or

weeks. Thus, in order to ensure continued compliance, management reinforcement as well as a monitoring system that sums up results to overall performance indicators is necessary. Healthcare workers at all levels (e.g. Lab technicians, nurses, physicians, housekeepers and cleaners & others) need to know why infection prevention and patient safety is important.

The training should be standardized in terms of content, modality and time. All trainings and domestically operating procedures should be in line with the national strategic framework and this guideline. To attain long-term effects, the initial training should be followed up and monitoring should be targeted towards identifying and solving specific problems related to the introduction the new processes or procedures.

General reminders regarding the importance of maintaining an infection-free environment for safer delivery of services should be repeatedly emphasized as well.

Supportive Supervision and Review Meeting

Regular supportive supervision and periodic evaluation of the implementations on infection prevention and safety of patients at various levels is a critical element of the IPC program management. Supportive supervision to be held at a health facility level can fully employ the operational standards for IP in health facility are enlisted in the Ethiopian health facility Implementation guidelines and Ethiopian Health Center Implementation Guideline

Responsible entities at national, regional and local level should plan and exercise supportive supervision and review meetings in their respective settings. Facility level managers and technical committee members should spearhead the routine implementation of IPC activities and should actively collaborate in all supportive supervision and review meetings pertinent to their respective facilities.

Change management for continuous IPC improvement

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:

Develop common goal, involve stakeholders, Communicate, involve all staff, Anticipate and negotiate, Monitor and Demonstrate commitment and consistency

Monitoring Infection Prevention and Patient Safety Practices

Regular monitoring of infection prevention and patient safety 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 member. Keeping records of infections and patient.

Miss-management occurring in facilities has now a day become the best way to monitor the effectiveness of infection prevention and patient safety practices. Supervisors and managers at all level should always use a standardized monitoring and evaluation tools to guide all their monitoring and evaluation activities (see **Appendix** for sample IP Monitoring and Surveillance Form).

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 regards the strengthening of record and report systems of IPC activities as a requirement. At national level, continuous monitoring and evaluation of IPC activities of the healthcare facilities should be established and for that indicators for assuring or improving the quality of IPC practice in general should be developed and used for periodic evaluation of the status of IPC related quality

The Ethiopian Hospital Implementation Guidelines listed indicators as monitoring tool to assess the effectiveness/outcomes of implementation of recommended IPC practices in a given facility (see Reference Manual for the indicators).

Summary

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.

DEFINITION OF TERMS

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 the 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 is the ability of a microorganism to resist the effects of an antimicrobial agent using various resistance mechanisms. 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 off-spring, or in some cases to other bacteria via plasmids.

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

Colonization is the establishment of a site of pathogen reproduction in or on a host individual that does not necessarily result in clinical symptoms or findings (e.g., cellular change or damage). A colonized individual may transmit the colonizing pathogens to their immediate surroundings and other individuals.

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.

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.

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

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

Infection is the condition resulting from an invasion and multiplication of microorganisms—such as bacteria, viruses, and fungi—that are not normally present within the body. An infection may cause no symptoms and be subclinical, or it may cause symptoms and be clinically apparent.

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).

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).

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 as they enable antimicrobial resistance to pass from one genus of bacteria to another.

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 amounts to test the DNA, RNA, or protein sequences and identify specific microorganisms.

Resistance mechanism is a feature of a bacterial cell that enables it to be unaffected by an antibiotic or group of antibiotics. Mechanisms can include 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).

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.

Species is the lowest taxonomic rank in the biological classification system; 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. It is one of the most commonly used techniques in the clinical laboratory and important for identifying bacteria types for treatment and IPC. 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*.

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.

Antibiograms are periodic summaries of antimicrobial susceptibilities of bacterial isolates submitted to a hospital's clinical microbiology laboratory. Clinicians and other health care workers (HCWs) use antibiograms to assess local susceptibility rates, aid in the selection of empiric antibiotic therapy, and monitor resistance trends within a facility over time.

Antibiotic is a drug that fights infections caused by bacteria in both humans and animals. Antibiotics fight these infections either by killing the bacteria or making it difficult for the bacteria to grow and multiply. Antibiotics do not have any effect on viruses or fungi.

Antibiotic consumption is the rate of antibiotic use, which is used for measurement purposes and can be measured in various ways, such as defined daily dose or antibiotic days.

Antibiotic resistance is the ability of bacteria to resist the effects of an antibiotic. Antibiotic resistance occurs when bacteria change in a way that reduces the effectiveness of antibiotics to treat or prevent infections. The bacteria survive and continue to multiply, creating more bacteria that are resistant.

Multi-Drug Resistance Organism (MDRO): Refers to resistance by a microorganism to antimicrobials of two or more different groups.

Antimicrobial is a broad category of drugs that fight infections caused by microorganisms such as bacteria, viruses, parasites, and fungi. Antibiotics are a type of antimicrobial.

Antimicrobial resistance (AMR) is the ability of a microorganism (such as bacteria, viruses, fungi, and parasites) to resist the effects of an antimicrobial agent using various resistance mechanisms. Micro-organism can transmit AM characteristics changes on to their offspring, or in some cases to other bacteria via plasmids.

Antimicrobial resistance surveillance consists of programs designed to identify trends and provide information regarding pathogen incidence and antimicrobial resistance.

Antimicrobial stewardship is the coordination of interventions designed to improve and measure the appropriate use of antimicrobials by promoting the selection of the optimal antimicrobial drug regimen, dose, duration of therapy, and route of administration. Antimicrobial stewards seek to achieve optimal clinical outcomes related to antimicrobial use, minimize toxicity and other adverse events, reduce the costs of health care for infections, and limit the selection for antimicrobial-resistant strains.

Days of therapy, or antibiotic days, is the aggregate number of days for which any amount of a specific medication was documented as administered to an individual patient by route of administration.

Defined daily dose is the assumed average maintenance dose per day for a drug used for its main indication in adults, which allows for meaningful comparisons of drug use. An alternative is days of therapy.

Empiric treatment: In initial therapy based on known sensitivity patterns for the region and the suspected organism. Initiated based on knowledge or experience with the expected pathogens causing an infection and/or disease based on signs and symptoms, epidemiology, and preliminary laboratory results (such as Gram staining), in the absence of complete clinical, radiological, and/or laboratory information.

Minimal inhibitory concentration is the least amount of an antibiotic necessary to inhibit growth of the organism.

Rational use of antimicrobials ensures that patients receive antimicrobial agent(s) that are appropriate to their clinical needs, in doses that meet their own individual requirements, for an adequate period of time, and at the lowest cost to them and their community.

Antimicrobial resistance is the ability of microorganisms to resist the effects of an antimicrobial. Antimicrobial resistance occurs when microorganisms change in a way that reduces the effectiveness of antimicrobials to treat or prevent infections. The microorganisms survive and continue to multiply, creating more organisms that are resistant to the antimicrobial.

Bundle (prevention bundle) is a structured way of improving patient care and outcomes by using a set of evidence-based practices (i.e., recommendations by health experts in the field). The prevention bundle is generally three to five practices that, when performed collectively, help prevent certain HAIs (e.g., bundle for prevention of catheter-associated urinary tract infections).

Biofilm is a thin, accumulated layer of bacteria and extracellular material that tightly adheres to surfaces and cannot be easily removed. The presence of biofilm can reduce the effectiveness of disinfectants and sterilization because products cannot penetrate the surface.

Device-associated Infection is an infection associated with a medical device (e.g., endotracheal tubes, central line, indwelling urinary catheter, or any other medical device) that was used within the 48-hour period before onset of infection.

Empiric is an action, intervention, or practice implemented on the basis of an informed clinical guess prior to definitive diagnoses or confirmation by lab tests. Transmission-Based Precautions must be implemented empirically while test results are pending based on the clinical presentation and likely pathogens.

Emergent refers to unexpected events or events that arise suddenly.

Intensive care unit (ICU), or critical care unit, is a dedicated place in a hospital where seriously injured or ill patients can receive close monitoring and constant care by specially trained staff with fewer patients to care for than an ordinary ward. Larger facilities may have ICUs for special patient groups such as surgical, neurological, burn, or cardiac patients or sick or premature newborns. In smaller facilities a single ICU may cater for all patients needing that level of care.

Invasive medical device penetrates inside the body, in whole or in part, either through a natural opening in the body (e.g., nose, oral cavity, and urethra) orifice or through the surface of the body

Multidrug-resistant organisms are microorganisms that are resistant to one or more classes of antimicrobial agents.

Nurse-patient ratio is the ratio of nurses on a particular floor, ward, or unit to the number of patients. The greater the anticipated acuity of care, as in the ICU, the lower is the ratio in a high-quality healthcare facility (1:6 is the normal ratio in a medical-surgical unit, 1:2 to 1:1 in an ICU).

Bio-safety involves containment principles, technologies, and practices implemented in the laboratory to prevent unintentional exposure of staff or the community to pathogens and toxins or their unintentional releases.

Biosafety cabinet (BSC) is an piece of laboratory equipment shaped like a cabinet that includes ventilation and is designed to provide protection to personnel, the environment, or a product being worked with (bacteria, viruses, human or animal tissues, or vaccine samples). Procedures are conducted in a workspace within the cabinet where the structure and airflow cabinet provide protection. This protection relies upon all recommended practices and procedures being followed. There are three types of safety cabinets:

Class I BSCs are open-fronted, negative-pressure cabinets. They provide personnel and environmental protection but not product protection. Exhaust air passes through a high efficiency particulate air (HEPA) filter.

Class II BSCs are vertical, laminar-flow biosafety cabinets that are open-fronted and ventilated. They are equipped with HEPA filters for air inflow and outflow. They provide personnel, environmental, and product protections. Depending upon the purpose, there are different types (A, A1, B1, B2, and A2) with increasing levels of protection.

Class III BSCs are totally enclosed, ventilated cabinets of gas-tight construction with exhaust air filtered by two HEPA filters. They provide maximum protection to workers and the environment.

Biosafety level (BSL) is a set of laboratory precautions used to handle materials and microorganisms that are based on the individual and community risks from the materials and microorganisms being handled (ability to cause disease, mode of transmission, availability of treatment, and prevention measures). There are four biosafety levels (1 to 4) with clearly defined criteria based on these risks.

Biosafety level guidelines were established to ensure the safety of those working in the laboratory or the surrounding environment. They have the fundamental objective of containing potentially harmful biological agents, including all pathogenic microorganisms (bacteria, viruses, and fungi that can lead to infection). The guidelines include safe laboratory practices and techniques, safety equipment (primary barriers and personal protective equipment [PPE]), and facility design and construction.

Bio-security is the protection, control, and accountability for valuable biological materials within laboratories in order to prevent their unauthorized access, loss, theft, misuse, diversion, or intentional release.

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

Microorganisms are causative agents of infection, and include bacteria, viruses, fungi, and parasites. Some bacteria can exist in a vegetative state (during which the organism is active and infective) and as endospores (in which a rough, dormant, non-reproductive structure protects the cell). Endospores are more difficult to kill due to their protective coating.

Asymptomatic bacteriuria is the presence of bacteria within the urinary tract with no symptoms. This is not considered significant except in pregnant women who are undergoing an invasive procedure involving the urinary tract, children with vesicoureteral reflux (backward flow of urine from the bladder to the upper urinary tract) or with accompanying blood culture with matching microorganism.

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 products cannot penetrate the surface.

Catheter-associated urinary tract infection (CAUTI) is a UTI in a patient with an indwelling urinary catheter.

Health care-associated infection (HAI) is an infection that occurs in a patient as a result of care at a health care facility and was not present at the time of arrival at the facility. HAIs is said to occur if noticed after 48hours of admission. The term “health care-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 health care.

Indwelling urinary catheter is inserted into the urinary bladder and left in place for continuous drainage of urine (e.g., Foley catheter). It should be connected to a drainage bag.

Prevention bundle is a structured way of improving patient care and outcomes by using a set of evidence-based practices (i.e., recommendations by health experts in the field). The prevention bundle is generally small number of evidence-based practices that, when performed collectively, help prevent certain HAIs (e.g., bundle for prevention of CAUTIs or central line-associated bloodstream infections).

Urinary tract infection (UTI) is an infection involving any part of the urinary system, including the urethra, bladder, ureter, and kidney.

Colonization is the establishment of a site of pathogen reproduction in or on a host individual that does not necessarily result in clinical symptoms or findings (e.g., cellular change or damage). A colonized individual may transmit the colonizing pathogens to other individuals.

Endemic is the usual prevalence (occurrence) of cases of a disease or infectious agent in a population in a geographic area; it is the baseline level of disease occurrence in a community.

Epidemic is the occurrence of more cases of a disease than expected in a defined community, geographic area, or season.

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

Opportunistic pathogen is a pathogen that can cause an infection only when introduced into an unusual location or in a host with a compromised immune system.

Outbreak is the occurrence of more cases of a disease or an infectious agent than expected in a defined community, 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 (such as a health care facility ward) than that of an epidemic.

Persistent carriage (*asymptomatic excretion*) occurs when a microorganism is excreted in stool but the person does not have any symptoms. This may occur after the resolution of symptoms of certain infections such as typhoid.