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GLOBAL HEALTHCARE WASTE PROJECT

MODULE 25:
Hospital Hygiene, Infection Control and Healthcare Waste Management

World Health Organization

Health Care Without Harm

UIC UNIVERSITY OF ILLINOIS AT CHICAGO SCHOOL OF PUBLIC HEALTH
Environmental and Occupational Health Sciences Division

Module Overview

- Explain the importance of hospital hygiene
- Describe nosocomial infections, their sources, and routes of transmission
- Present standard and transmission-based precautions for infection control
- Describe cleaning, disinfection, sterilization, and hand hygiene
- Present measures to improve infection control
- Describe components of an infection control program

Learning Objectives

- Understand the problem of nosocomial infections and how to prevent them
- Understand basic concepts of cleaning, disinfection, and sterilization
- Describe hand hygiene procedures
- Understand the link between infection control and healthcare waste management

Guiding Principles

- Healthcare Waste Management is an integral part of hospital hygiene and infection control.

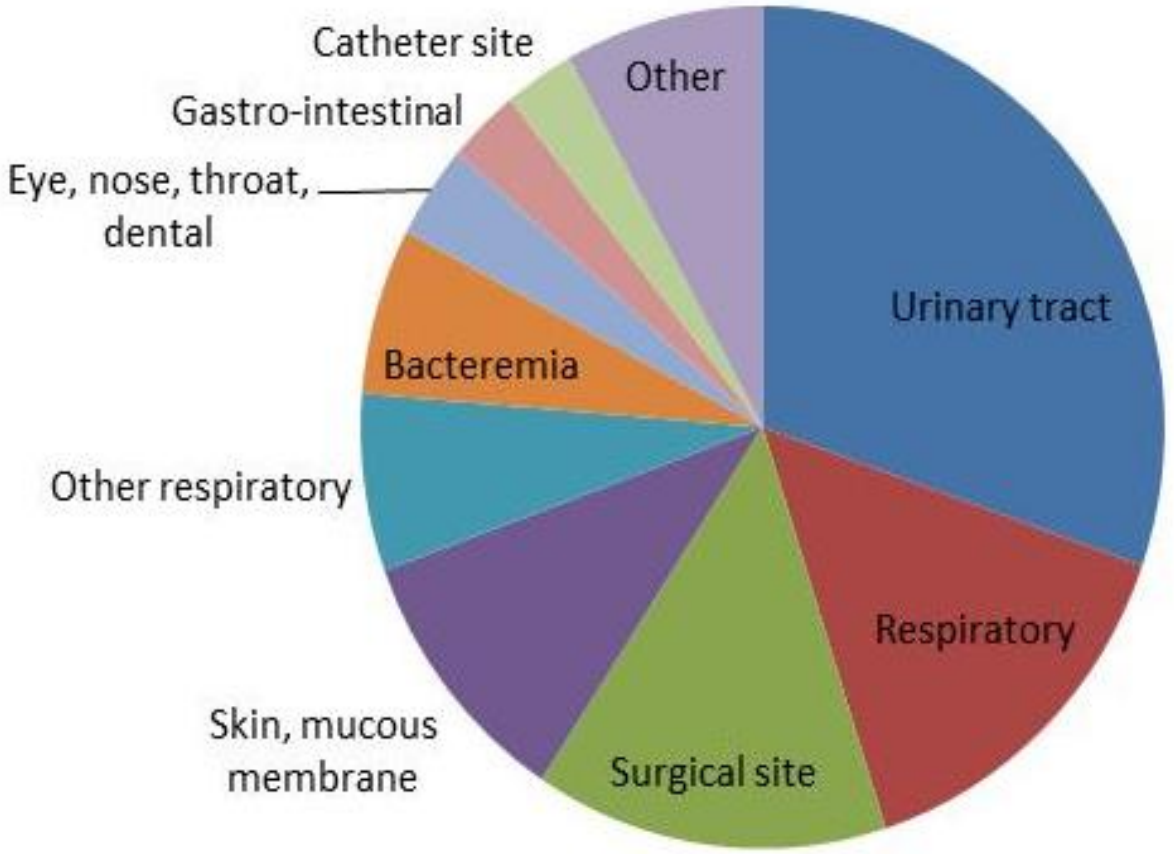
Why Hospital Hygiene?

- Examples of surfaces where pathogens have been found
  - Door handles
  - Soap dispensers
  - Sink taps
  - Sites where dust has accumulated
  - Stethoscopes
  - Lifting equipment
  - Ultrasound probes

Nosocomial Infections

- Also called hospital-acquired infections (HAI) or hospital-associated infections
- Infections not present in the patient at the time of admission but developed during the course of the patient's stay in the hospital
- Infections are caused by microorganisms that may come from the patient's own body, the environment, contaminated hospital equipment, health workers, or other patients.
- The risk of HAI is heightened for patients with altered or weakened immunity.

Common Sites of Nosocomial Infections



Examples of Sources of Nosocomial Infections

- Hospital environment
  - *Salmonella*, *Shigella* spp., or *Escherichia coli* O157:H7 in food
  - Waterborne infections from the water distribution system
  - *Legionella pneumophilia* in water cooling of air conditioning
- Healthcare workers
  - Methicillin-resistant *Staphylococcus aureus* (MRSA) carried in the nasal passages of healthcare personnel
- Other patients
  - Chicken pox spread through the air or contact with freshly soiled contaminated items

Examples of Nosocomial Agents From Environmental Sources

SOURCE	BACTERIA	VIRUSES	FUNGI
Air	Gram-positive cocci from skin Tuberculosis	Influenza Varicella zoster	Aspergillus
Water (tap water & bath water)	Acinetobacter calcoaceticus Aeromonas hydrophilia Burkholderia cepacia Legionella pneumophila Mycobacterium Xenopi Mycobacterium chelonae Pseudomonas aeruginosa	Human papillomavirus Molluscum contagiosum Noroviruses	Aspergillus Exophiala jeanselmei
Food	Campylobacter jejuni Clostridium botulinum Clostridium perfringens Escherichia coli Listeria monocytogenes Salmonella Staphylococcus aureus Streptococcus species Vibrio cholerae Yersinia enterocolitica	Caliciviruses Rotavirus	

Examples of Nosocomial Agents By Type of Infection

TYPE OF INFECTION	MICROORGANISM
Urinary Catheter	Escherichia coli Klebsiella spp. Pseudomonas aeruginosa Serratia marcescens Streptococcus faecalis
Pneumonia	Enterobacter spp. Escherichia coli Klebsiella pneumonia Legionella penumophilia Pseudomonas aeruginosa Staphylococcus aureus
Surgical Site	Enterococcus species Escherichia coli Staphylococcus aureus Staphylococcus epidermidis Streptococcus faecalis
Intravenous Catheter	Candida spp. Staphylococcus aureus Staphylococcus epidermidis Streptococcus faecalis

Antibiotic Resistant Microorganisms

- An increasing problem due to overuse and misuse of antibiotics
- Often spread through hands of health workers
- Examples:
  - methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE), clindamycin-resistant Clostridium difficile, multidrug resistant Acinetobacter baumannii

➢ Reduce the general use of antibiotics to encourage better immune response in patients and reduce the cultivation of resistant bacteria

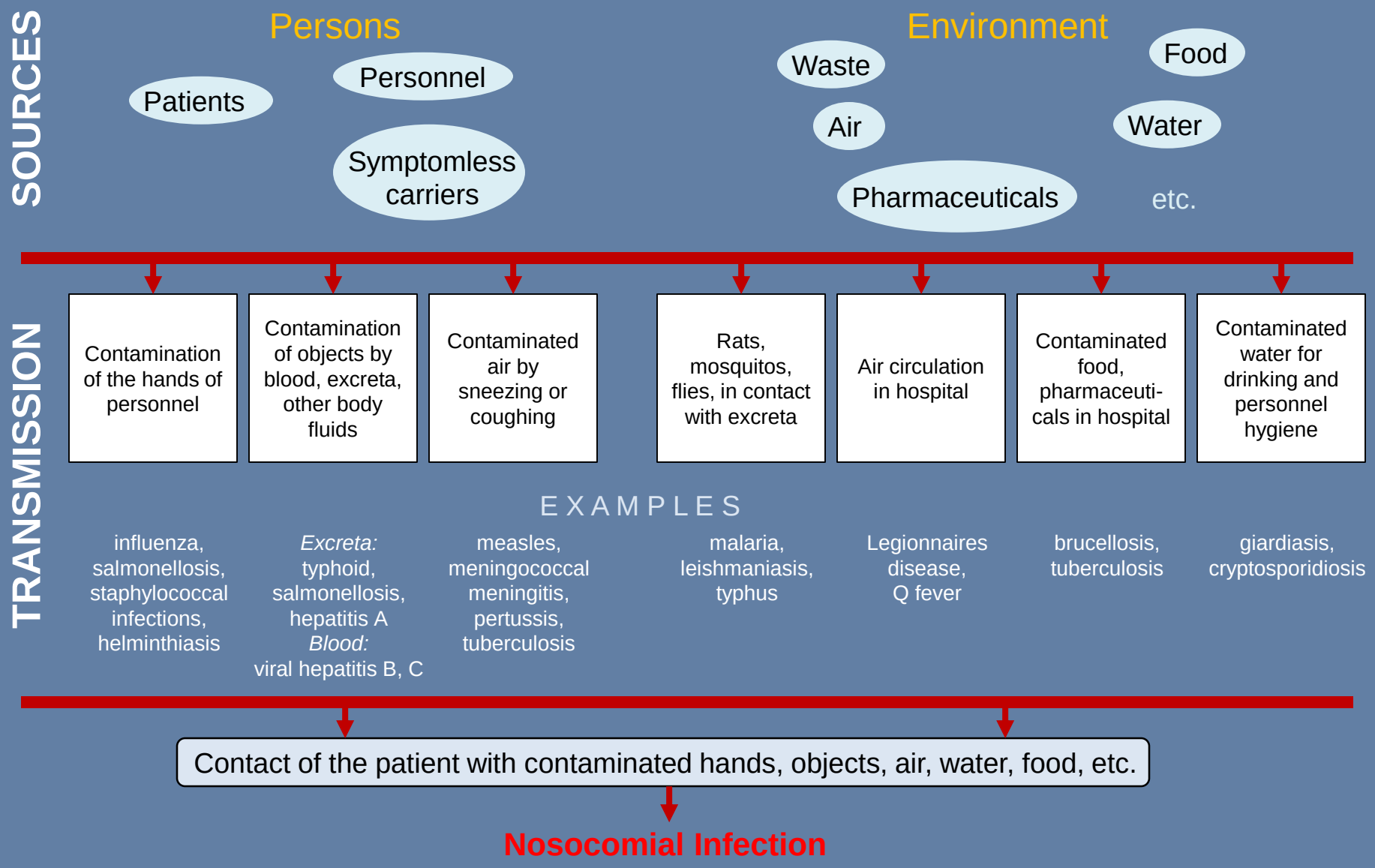
Routes of Transmission of Nosocomial Infections

- Contact transmission
  - Direct contact (e.g., surgeon with infected wound in the finger performing a wound dressing)
  - Indirect contact (e.g., secretion from one patient transferred to another through hands in contact with contaminated waste)
  - Fecal-oral transmission via food
- Bloodborne transmission
  - E.g., needle-stick injury – hepatitis B and C, HIV/AIDS
- Vector transmission
  - E.g., insects or other pests in contact with excreta or secretions from infected patients and transmitted to other patients

Routes of Transmission of Nosocomial Infections

- Droplet transmission (droplets from sneezing, coughing or vomiting are expelled to surfaces or to the air and fall typically within 2 meters of the source)
  - Direct droplet transmission (droplets reach mucous membranes or are inhaled by others)
  - Indirect droplet-to-contact transmission (droplets contaminate surfaces/hands and are transmitted to mucous membranes or other sites) – cold virus, respiratory syncytial virus
- Airborne transmission (small contaminated particles as aerosols carried by air currents >2 meters from source)
  - E.g., Varicella zoster suspended in air and spread by inhalation, *Staphylococcus aureus* depositing in wounds

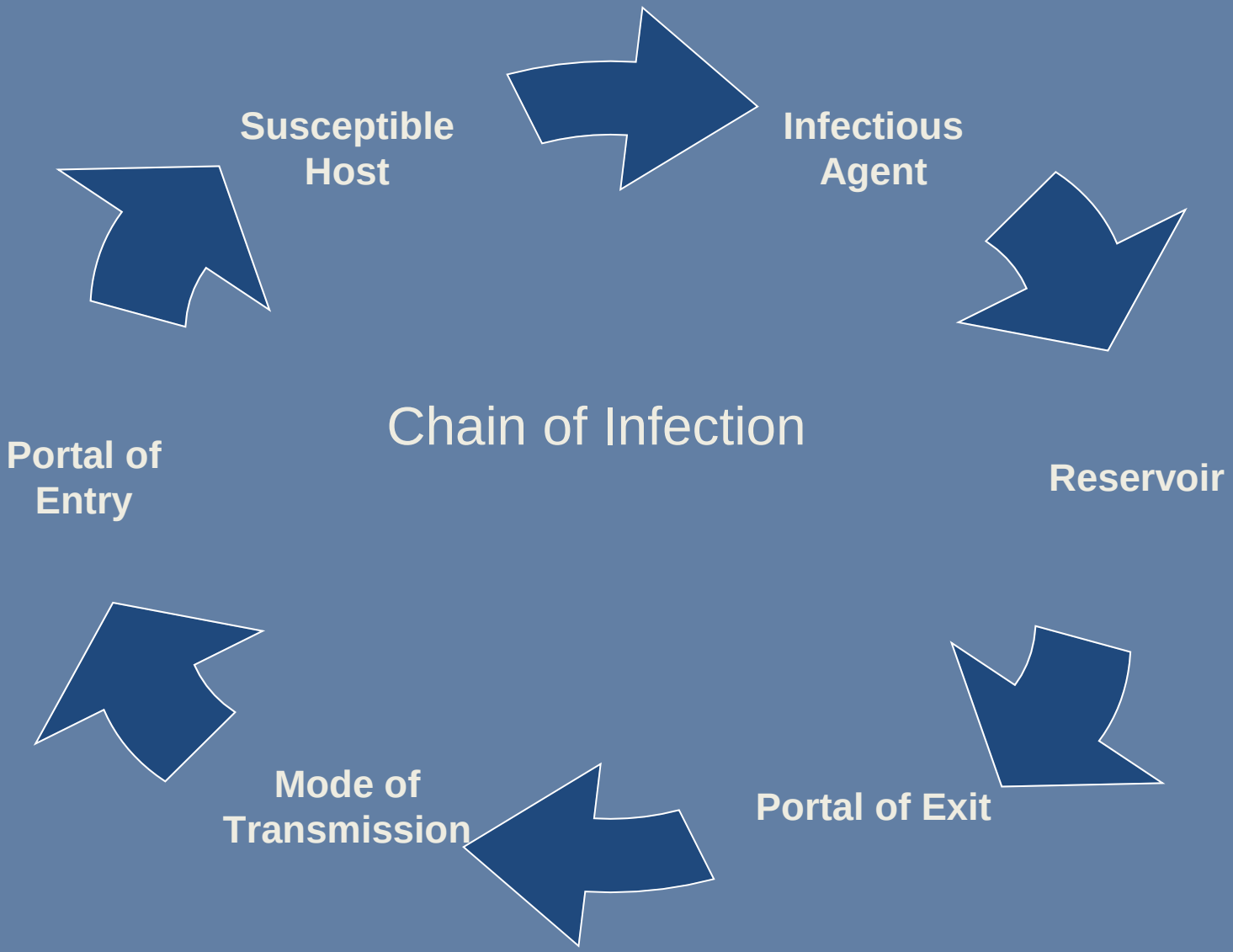
Spread of Nosocomial Infections



Guiding Principles

- Knowing the chain of infection helps identify effective points to prevent disease transmission.

Chain of infection



Standard Precautions

- Basic level of infection control to be used in the care of all patients
- Key components
  - Hand hygiene
  - Use of PPE (gloves, face protection, gown)
  - Safe injection practices
  - Respiratory hygiene and cough etiquette
  - Safe handling of contaminated equipment and surfaces in the patient environment
  - Environmental cleaning
  - Handling and processing of used linens
  - Proper waste management

Transmission-Based Precautions

- Additional precautions used when routes of transmission are not completely interrupted by Standard Precautions
- Three categories of transmission-based precautions
  1. Contact Precautions – e.g. for E. coli O157:H7, Shigella spp. Hepatitis A virus, C. difficile, abscess draining, head lice
  2. Droplet Precautions – e.g., for Neisseria meningitidis, seasonal flu, pertussis, mumps, Yersinia pestis pneumonic plague, rubella
  3. Airborne Precautions – e.g., for M. tuberculosis, rubeola virus
- Combined precautions, e.g.
  - Airborne and contact precautions for varicella zoster, methicillin-resistant S. aureus (MRSA), severe acute respiratory syndrome virus (SARS-CoV), avian influenza
  - Contact and droplet precautions for respiratory syncytial virus

Some Standards of Hospital Hygiene

- The hospital environment must be visibly clean, free from dust and soilage, and acceptable to patients, visitors and staff.
- Increased levels of cleaning, including the use of hypochlorite and detergent, should be considered in outbreaks where the pathogen survives in the environment and environmental contamination may contribute to spread.
- Shared equipment in the clinical environment must be decontaminated appropriately after each use.
- All healthcare workers need to be aware of their individual responsibilities for maintaining a safe environment for patients and staff.
- Regular cleaning will not guarantee complete elimination of microorganisms, so hand decontamination is required.

Cleaning

- The most basic measure for maintaining hygiene in a healthcare facility
- Cleaning is the physical removal of visible contaminants such as dirt without necessarily destroying microorganisms
- Thorough cleaning with soaps and detergents can remove more than 90% of microorganisms

Sterilization and Disinfection

- Sterilization – rendering an object free from microorganisms; shown by a 99.9999% reduction of microorganisms
- High-level disinfection – destruction of all microorganisms except for large numbers of bacterial spores
- Intermediate disinfection – inactivation of Mycobacterium tuberculosis, vegetative bacteria, most viruses and fungi, but not bacterial spores
- Low-level disinfection – destruction of most bacteria, some viruses and fungi, but no resistant microorganisms such as tubercle bacilli or bacterial spores

Methods for Sterilization and Disinfection

- Autoclaving – use of steam under pressure (moist heat)
- Dry heat – relatively slow and requiring higher temperature compared to moist heat
- Use of chemical sterilants and disinfectants
- Others: low-temperature plasma with hydrogen peroxide gas, radiation sterilization, germicidal ultraviolet irradiation

Main Chemical Disinfectants

Agent	Spectrum	Uses	Advantages	Disadvantages
Alcohols (60–90%) including ethanol or isopropanol	Low to intermediate-level disinfectant	• Used for some semi critical and noncritical items (e.g. oral and rectal thermometers and stethoscopes) • Used to disinfect small surfaces such as rubber stoppers of multi-dose vials • Alcohols with detergent are safe and effective for spot disinfection of countertops, floors and other surfaces	• Fast acting • No residue • No staining • Low cost • Readily available in all countries	• Volatile, flammable, and irritant to mucous membranes • Inactivated by organic matter • May harden rubber, cause glue to deteriorate, or crack acrylate plastic
Chlorine and chlorine compounds: the most widely used is an aqueous solution of sodium hypochlorite 5.25–6.15% (house bleach) at a concentration of 100–5000 ppm free chlorine	Low to high-level disinfectant	• Used for disinfecting tonometers and for spot disinfection of countertops and floors • Can be used for decontaminating blood spills • Concentrated hypochlorite or chlorine gas is used to disinfect large and small water-distribution systems such as dental appliances, hydrotherapy tanks, and water-distribution systems in haemodialysis centres	• Low cost, fast acting • Readily available in most settings • Available as liquid, tablets or powders	• Corrosive to metals in high concentrations (>500 ppm) • Inactivated by organic material • Causes discoloration or bleaching of fabrics • Releases toxic chlorine gas when mixed with ammonia • Irritant to skin and mucous membranes • Unstable if left uncovered, exposed to light or diluted; store in an opaque container

Main Chemical Disinfectants

Agent	Spectrum	Uses	Advantages	Disadvantages
Aldehydes glutaraldehyde: ≥2% aqueous solutions buffered to pH 7.5–8.5 with sodium bicarbonate There are novel glutaraldehyde formulations	High-level disinfectant/ sterilant	• Most widely used as high-level disinfectant for heat-sensitive semi critical items such as endoscopes (for 20 minutes at 20 °C)	• Good material compatibility	• Allergenic and its fumes are irritating to skin and respiratory tract • Causes severe injury to skin and mucous membranes on direct contact • Relatively slow activity against some mycobacterial species • Must be monitored for continuing efficacy levels
Peracetic acid 0.2–0.35% and other stabilized organic	High-level disinfectant/ sterilant	• Used in automated endoscope reprocessors • Can be used for cold sterilization of heat-sensitive critical items (e.g. haemodialysers) • Also suitable for manual instrument processing (depending on the formulation)	Rapid sterilization cycle time at low temperature (30–45 min. at 50–55 °C) Active in presence of organic matter Environment friendly by-products (oxygen, water, acetic acid)	• Corrosive to some metals • Unstable when activated • May be irritating to skin, conjunctive and mucous membranes
Orthophthalaldehyde (OPA) 0.55%	High-level disinfectant/ sterilant	• High-level disinfectant for endoscopes	Excellent stability over wide pH range, no need for activation Superior mycobactericidal activity compared to glutaraldehyde Does not require activation	• Expensive • Stains skin and mucous membranes • May stain items that are not cleaned thoroughly • Eye irritation with contact May cause hypersensitivity reactions in bladder cancer patients following repeated exposure to manually processed urological instruments • Slow sporicidal activity • Must be monitored for continuing efficacy levels

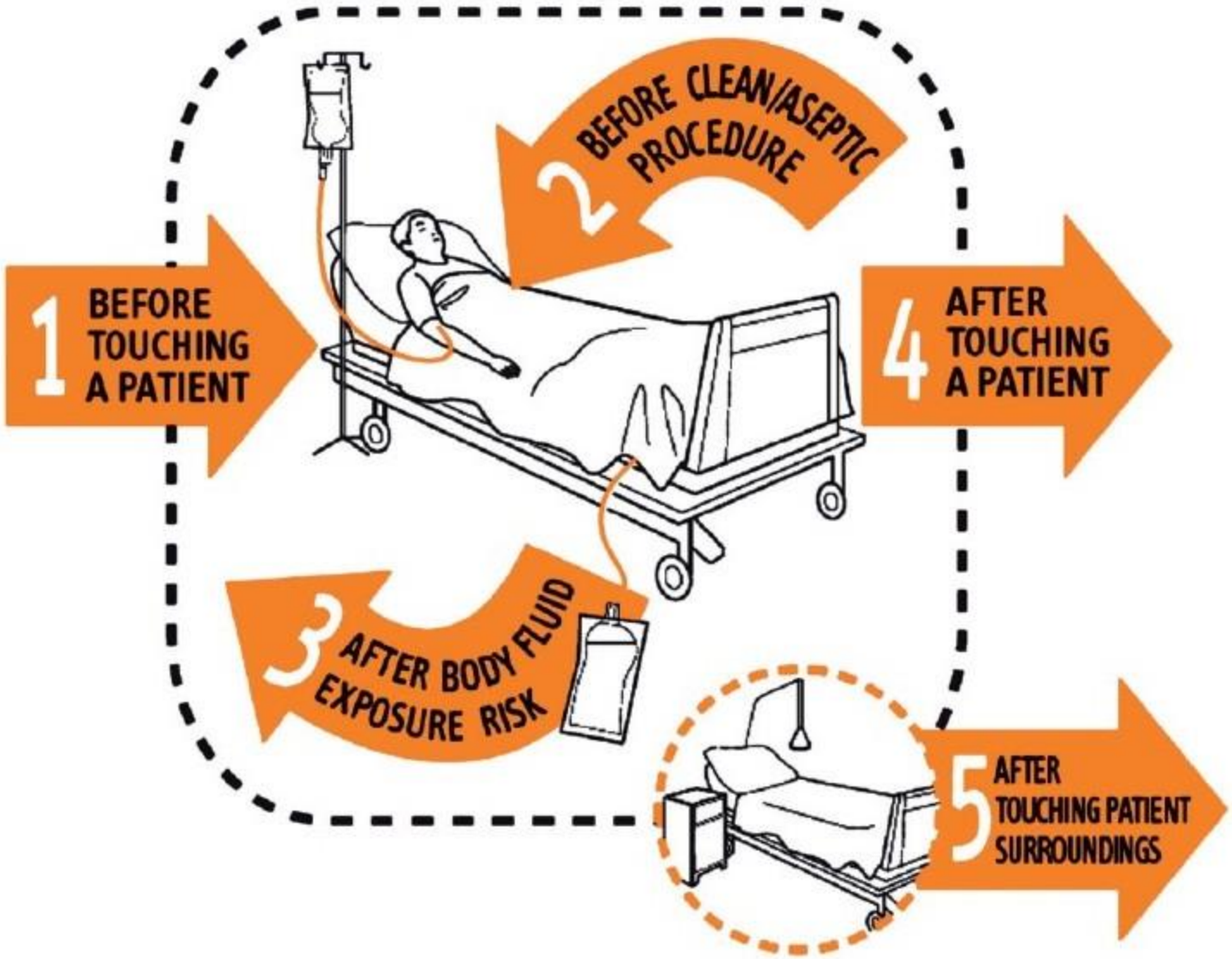
Main Chemical Disinfectants

Agent	Spectrum	Uses	Advantages	Disadvantages
Hydrogen peroxide 7.5%	High-level disinfectant/ sterilant	• Can be used for cold sterilization of heat-sensitive critical items • Requires 30 min at 20 °C	No odour Environment friendly by-products (oxygen, water)	• Material compatibility concerns with brass, copper, zinc, nickel/silver plating
Hydrogen peroxide 7.5% and peracetic acid 0.23%	High-level disinfectant/ sterilant	• For disinfecting haemodialysers	Fast-acting (high-level disinfection in 15 min) No activation required No odour	• Material compatibility concerns with brass, copper, zinc and lead • Potential for eye and skin damage
Glucoprotamin	High-level disinfectant	• Manual reprocessing of endoscopes • Requires 15 min at 20 °C	Highly effective against mycobacteria High cleansing performance No odour	• Lack of effectiveness against some enteroviruses and spores
Phenolics	Low to intermediate-level disinfectant	• Have been used for decontaminating environmental surfaces and non-critical surfaces • Should be avoided	Not inactived by organic matter	• Leaves residual film on surfaces • Harmful to the environment • No activity against viruses • Use in nurseries should be avoided due to reports of hyberbilirubinemia in infants
Iodophores (30–50 ppm free iodine)	Low-level disinfectant	• Have been used for disinfecting some non-critical items (e.g. hydrotherapy tanks); however, it is used mainly as an antiseptic (2–3 ppm free iodine) • Phenolics	Relatively free of toxicity or irritancy	• Inactivated by organic matter • Adversely affects silicone tubing • May stain some fabrics

Hand Hygiene

- Wash Hands
  - Immediately after arriving for work
  - Always after handling healthcare waste
  - After removing gloves and/or coveralls
  - After using the toilet or before eating
  - After cleaning up a spill
  - Before leaving work

My 5 moments for HAND HYGIENE



Hand Hygiene

- Steps in hand washing
  - Wet hands and apply soap
  - Work up lather on palms, back of hands, sides of fingers, and under fingernails
  - Scrub vigorously with soap for at least 20 seconds
  - Rinse well
  - Dry with a clean towel or allow to air dry

Hand Hygiene Technique with Soap and Water
Recommended Duration: 40-60 seconds

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Wet hands with water;

1

Apply enough soap to cover all hand surfaces;

2

Rub hands palm to palm;

3

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

4

Palm to palm with fingers interlaced;

5

Backs of fingers to opposing palms with fingers interlocked;

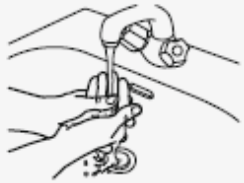
6

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

7

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

8

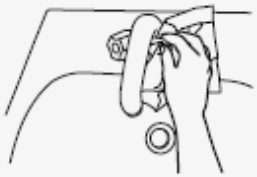


Rinse hands with water;

9

Dry hands thoroughly with a single use towel;

10



Use towel to turn off faucet;

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Your hands are now safe.

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Hand Hygiene Technique with Alcohol-Based Formulation
Recommended Duration: 20-30 seconds

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

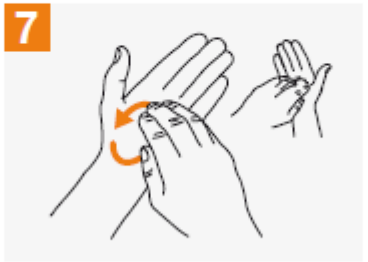
Rub hands palm to palm;

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

Palm to palm with fingers interlaced;

Backs of fingers to opposing palms with fingers interlocked;

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



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

Once dry, your hands are safe.

Measures for Improving Infection Control

Wasteful practices that should be eliminated:

- routine swabbing of health care environment to monitor standard of cleanliness
- routine fumigation of isolation rooms with formaldehyde
- routine use of disinfectants for environment cleaning, e.g. floors and walls
- inappropriate use of PPE in intensive care units, neonatal units and operating theatres

Measures for Improving Infection Control

Wasteful practices that should be eliminated (contd.,):

- use of overshoes, dust attracting mats in the operating theatres, intensive care and neonatal unit
- unnecessary intramuscular and intravenous (IV) injections
- unnecessary insertion of invasive devices (e.g. IV lines, urinary catheters, nasogastric tubes)
- inappropriate use of antibiotics for prophylaxis and treatment
- improper segregation and disposal of clinical waste.

Measures for Improving Infection Control

No-cost measures: using good infection-control practices:

- use aseptic technique for all sterile procedures
- remove invasive devices when no longer needed
- isolate patients with communicable diseases or a multidrug-resistant organism on admission
- avoid unnecessary vaginal examination of women in labour
- minimize the number of people in operating theatres
- place mechanically ventilated patients in a semi-recumbent position.

Measures for Improving Infection Control

Low-cost measures: cost-effective practices:

- provide education and practical training in standard infection control (e.g. hand hygiene, aseptic technique, appropriate use of PPE, use and disposal of sharps)
- provide hand-washing material throughout a health-care facility (e.g. soap and alcoholic hand disinfectants)
- use single-use disposable sterile needles and syringes
- use sterile items for invasive procedures

Measures for Improving Infection Control

Low-cost measures: cost-effective practices (Contd.,):

- avoid sharing multi-dose vials and containers between patients
- ensure equipment is thoroughly decontaminated between patients
- provide hepatitis B immunization for health-care workers
- develop a post-exposure management plan for health-care workers
- dispose of sharps in robust containers.

Infection Control Program

- Infection Control Committee
- Should be multidisciplinary with representation from management, doctors, nurses, other health workers, clinical microbiology, pharmacy, central supply, maintenance, housekeeping and waste management coordinator

Infection Control Program

- Role of the Infection Control Committee
  - Annual work program of activities for surveillance and prevention
  - Periodic review of epidemiological surveillance data and identification of areas for intervention
  - Review of risks of new technologies, devices, and products
  - Assessment of cleaning, disinfection, and sterilization
  - Review of antibiotic use and antibiotic resistance
  - Promotion of improved practices
  - Provision of staff training in infection control and prevention
  - Integration of healthcare waste management
  - Response to outbreaks

Discussion

- What are the potential routes of disease transmission and how can they be eliminated?
- What are the main components of the infection control program of your facility?
- Discuss any available surveillance data related to nosocomial infections in your facility?
- What are your specific responsibilities regarding hospital hygiene and infection control?
- What areas of patient safety would you like to focus on in your facility? What are the barriers to patient safety?
- How can proper health care waste management minimize disease transmission?