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

- Urinary tract
- Respiratory
- Surgical site
- Skin, mucous membrane
- Other respiratory
- Bacteremia
- Eye, nose, throat, dental
- Gastro-intestinal
- Catheter site
- Other
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 pneumophila* 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

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>BACTERIA</th>
<th>VIRUSES</th>
<th>FUNGI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Gram-positive cocci from skin</td>
<td>Influenza</td>
<td>Aspergillus</td>
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<td></td>
<td>Tuberculosis</td>
<td>Varicella zoster</td>
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<tr>
<td>Water (tap water &amp; bath</td>
<td>Acinetobacter calcoaceticus</td>
<td>Human papillomavirus</td>
<td>Aspergillus</td>
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<tr>
<td>water)</td>
<td>Aeromonas hydrophilia</td>
<td>Molluscum contagiosum</td>
<td>Exophiala jeanselmei</td>
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<td></td>
<td>Burkholderia cepacia</td>
<td>Noroviruses</td>
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<td></td>
<td>Legionella pneumophila</td>
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<td></td>
<td>Mycobacterium Xenopi</td>
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<td>Mycobacterium chelonae</td>
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<td></td>
<td>Pseudomonas aeruginosa</td>
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<tr>
<td>Food</td>
<td>Campylobacter jejuni</td>
<td>Caliciviruses</td>
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<td></td>
<td>Clostridium botulinum</td>
<td>Rotavirus</td>
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<td></td>
<td>Clostridium perfringens</td>
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<tr>
<td></td>
<td>Escherichia coli</td>
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<td></td>
<td>Listeria monocytogenes</td>
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<tr>
<td></td>
<td>Salmonella</td>
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<td>Staphylococcus aureus</td>
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<td></td>
<td>Streptococcus species</td>
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<td></td>
<td>Vibrio cholerae</td>
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<td>Yersinia enterocolitica</td>
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</table>
# Examples of Nosocomial Agents By Type of Infection

<table>
<thead>
<tr>
<th>TYPE OF INFECTION</th>
<th>MICROORGANISM</th>
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<tbody>
<tr>
<td>Urinary Catheter</td>
<td>Escherichia coli</td>
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<tr>
<td></td>
<td>Klebsiella spp.</td>
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<td></td>
<td>Pseudomonas aeruginosa</td>
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<td>Serratia marcescens</td>
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<td></td>
<td>Streptococcus faecalis</td>
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<tr>
<td>Pneumonia</td>
<td>Enterobacter spp.</td>
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<tr>
<td></td>
<td>Escherichia coli</td>
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<td></td>
<td>Klebsiella pneumonia</td>
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<td></td>
<td>Legionella pneumophilia</td>
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<tr>
<td></td>
<td>Pseudomonas aeruginosa</td>
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<td></td>
<td>Staphylococcus aureus</td>
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<tr>
<td>Surgical Site</td>
<td>Enterococcus species</td>
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<tr>
<td></td>
<td>Escherichia coli</td>
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<td></td>
<td>Staphylococcus aureus</td>
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<td></td>
<td>Staphylococcus epidermidis</td>
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<td></td>
<td>Streptococcus faecalis</td>
</tr>
<tr>
<td>Intravenous Catheter</td>
<td>Candida spp.</td>
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<tr>
<td></td>
<td>Staphylococcus aureus</td>
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<tr>
<td></td>
<td>Staphylococcus epidermidis</td>
</tr>
<tr>
<td></td>
<td>Streptococcus faecalis</td>
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</tbody>
</table>
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

**Sources**
- Patients
- Personnel
  - Symptomless carriers

**Transmission**
- Contamination of the hands of personnel
- Contamination of objects by blood, excreta, other body fluids
- Contaminated air by sneezing or coughing
- Rats, mosquitos, flies, in contact with excreta
- Air circulation in hospital
- Contaminated food, pharmaceuticals in hospital
- Contaminated water for drinking and personnel hygiene

**Examples**
- Excreta: typhoid, salmonellosis, hepatitis A
- Blood: viral hepatitis B, C
- Measles, meningococcal meningitis, pertussis, tuberculosis
- Malaria, leishmaniasis, typhus
- Legionnaires disease, Q fever
- Brucellosis, tuberculosis
- Giardiasis, cryptosporidiosis

**Contact of the patient with contaminated hands, objects, air, water, food, etc.**

**Nosocomial Infection**
Guiding Principles

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

Susceptible Host → Infectious Agent → Reservoir

Portal of Entry → Mode of Transmission → Portal of Exit

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, rubella 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

<table>
<thead>
<tr>
<th>Agent</th>
<th>Spectrum</th>
<th>Uses</th>
<th>Advantages</th>
<th>Disadvantages</th>
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</thead>
<tbody>
<tr>
<td><strong>Alcohols</strong>&lt;br&gt;(60–90%) including ethanol or isopropanol&lt;br&gt; <strong>Low to intermediate-level disinfectant</strong>&lt;br&gt; • Used for some semi critical and noncritical items (e.g. oral and rectal thermometers and stethoscopes)&lt;br&gt; • Used to disinfect small surfaces such as rubber stoppers of multi-dose vials&lt;br&gt; • Alcohols with detergent are safe and effective for spot disinfection of countertops, floors and other surfaces</td>
<td>• Fast acting&lt;br&gt; • No residue&lt;br&gt; • No staining&lt;br&gt; • Low cost&lt;br&gt; • Readily available in all countries</td>
<td>• Volatile, flammable, and irritant to mucous membranes&lt;br&gt; • Inactivated by organic matter&lt;br&gt; • May harden rubber, cause glue to deteriorate, or crack acrylate plastic</td>
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<tr>
<td><strong>Chlorine and chlorine compounds</strong>: 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&lt;br&gt; <strong>Low to high-level disinfectant</strong>&lt;br&gt; • Used for disinfecting tonometers and for spot disinfection of countertops and floors&lt;br&gt; • Can be used for decontaminating blood spills&lt;br&gt; • 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</td>
<td>• Low cost, fast acting&lt;br&gt; • Readily available in most settings&lt;br&gt; • Available as liquid, tablets or powders</td>
<td>• Corrosive to metals in high concentrations (&gt;500 ppm)&lt;br&gt; • Inactivated by organic material&lt;br&gt; • Causes discoloration or bleaching of fabrics&lt;br&gt; • Releases toxic chlorine gas when mixed with ammonia&lt;br&gt; • Irritant to skin and mucous membranes&lt;br&gt; • Unstable if left uncovered, exposed to light or diluted; store in an opaque container</td>
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<tbody>
<tr>
<td>Aldehydes</td>
<td>High-level disinfectant/sterilant</td>
<td>- Most widely used as high-level disinfectant for heat-sensitive semi critical items such as endoscopes (for 20 minutes at 20 °C)</td>
<td>- Good material compatibility</td>
<td>- Allergenic and its fumes are irritating to skin and respiratory tract</td>
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<tr>
<td>Glutaraldehyde</td>
<td>≥2% aqueous solutions buffered to pH 7.5–8.5 with sodium bicarbonate</td>
<td>There are novel glutaraldehyde formulations</td>
<td></td>
<td>- Causes severe injury to skin and mucous membranes on direct contact</td>
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<tr>
<td>Peracetic acid 0.2–0.35% and other stabilized organic</td>
<td>High-level disinfectant/sterilant</td>
<td>- Used in automated endoscope reproprocessors</td>
<td>Rapid sterilization cycle time at low temperature (30–45 min. at 50–55 °C)</td>
<td>- Corrosive to some metals</td>
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<td>- Can be used for cold sterilization of heat-sensitive critical items (e.g. haemodialysers)</td>
<td>Active in presence of organic matter</td>
<td>- Unstable when activated</td>
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<td></td>
<td>- Also suitable for manual instrument processing (depending on the formulation)</td>
<td>Environment friendly by-products (oxygen, water, acetic acid)</td>
<td>- May be irritating to skin, conjunctive and mucous membranes</td>
</tr>
<tr>
<td>Orthophthalaldehyde (OPA) 0.55%</td>
<td>High-level disinfectant/sterilant</td>
<td>- High-level disinfectant for endoscopes</td>
<td>Excellent stability over wide pH range, no need for activation</td>
<td>- Expensive</td>
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<td>Superior mycobactericidal activity compared to glutaraldehyde</td>
<td>- Stains skin and mucous membranes</td>
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<td></td>
<td>Does not require activation</td>
<td>- May stain items that are not cleaned thoroughly</td>
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<td>- Eye irritation with contact</td>
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<td>May cause hypersensitivity reactions in bladder cancer patients following repeated exposure to manually processed urological instruments</td>
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<td>- Slow sporicidal activity</td>
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<p>|                           |                                                                                                                          |                                                        | Must be monitored for continuing efficacy levels |
|                           |                                                                                                                          |                                                        |                                                   |
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</tr>
</thead>
</table>
| 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                                  | 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 inactivated 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 hyperbilirubinemia 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

1. Before touching a patient
2. Before clean/aseptic procedure
3. After body fluid exposure risk
4. After touching a patient
5. After touching patient surroundings
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

0. 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;
11. Your hands are now safe.
Hand Hygiene Technique with Alcohol-Based Formulation
Recommended Duration: 20-30 seconds

1a. Apply a palmful of the product in a cupped hand, covering all surfaces;
1b. Rub hands palm to palm;
2. Right palm over left dorsum with interlaced fingers and vice versa;
3. Palm to palm with fingers interlaced;
4. Backs of fingers to opposing palms with fingers interlocked;
5. Rotational rubbing of left thumb clasped in right palm and vice versa;
6. Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;
7. 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?