

Infection Control

Clinical Aspects of Microbiology

Spread of Infection

Infection Control Methods

Surveillance

Infection Control

- Between 5-10% of all hospitalized patients acquire an infection during their stay.
- The direct cost of treating these nosocomial infections is over a billion dollars per year.
- The indirect cost is even more staggering.

Infection Control

- Approximately 10-40% of all nosocomial infections are pulmonary.
- Among all hospital acquired infections, those affecting the lungs are most likely to result in death.

Infection Control

- Respiratory care equipment and procedures have been identified as a major cause of nosocomial infections.
- Early studies showed that one out of every ten hospital epidemics involved respiratory care equipment.

Infection Control

- As the sophistication of respiratory procedures have evolved, so has the understanding of infection control.
- In addition, RCP's are now paying more attention to protecting themselves against infection.

Infection Control

- Infection control procedures aim to
- 1. Eliminate the sources of infectious agents
- 2. Create barriers to their transmission
- 3. Monitor and evaluate the effectiveness of control.

Clinical Aspects of Microbiology

- Involves the study of microorganisms
- bacteria
- viruses
- fungi
- protozoa
- and algae

Clinical Aspects of Microbiology

- Many respiratory disorders are caused by microorganisms.
- The treatment includes antimicrobial drugs.
- All microorganisms, except for algae are capable of invading a human host and causing disease.

Clinical Aspects of Microbiology

- Bacteria
- Most common cause of nosocomial infections.
- Exist in three basic shapes
- Cocci-spherical
- Bacille- rod-shaped
- Spirochetes-helical or spiral

Clinical Aspects of Microbiology

- Two approaches are used to identify and describe bacteria.
 - Visual classification
 - By shape or morphologic analysis
 - Structural and metabolic features
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- Both are used together to confirm an organism's identity.

Clinical Aspects of Microbiology

- Gram-positive cocci
- Most common respiratory bacterial pathogen.
- *Staphylococcus aureus*

Clinical Aspects of Microbiology

- Gram-negative cocci
- *Moraxella catarrhalis*
- Is part of the normal flora of the upper airway.
- In patients with COPD, alcoholism and other immuno-compromising disorders, *M. catarrhalis* can cause bronchitis and pneumonia

Clinical Aspects of Microbiology

- Gram-negative coccobacilli
- Forms capsules
- Hemophilus influenzae is the most important gram-negative coccobacilli causing respiratory infections.
- Can also cause pneumonia, bronchitis, epiglottitis, and otitis media in children.

Clinical Aspects of Microbiology

- Gram-negative enteric bacilli
- *Pseudomonas aeruginosa* is the most significant.
- It is a motile, aerobic bacillus commonly found in the soil and water.
- It can be cultured from sinks, soap trays, drinking water, food and respiratory care equipment.

Clinical Aspects of Microbiology

- Gram-negative anaerobic bacilli
- Bacteroides can cause a wide variety of infections including endocarditis, pneumonia, and empyema.
- Legionella appears to colonize in water, and has been found in air conditioning units, shower heads, and respiratory care equipment.
- Acquired by direct inhalation of aerosols.

Clinical Aspects of Microbiology

- Acid-fast bacilli
- M. Tuberculosis causes the chronic granulomatous infection most often localized to the lung.
- Pulmonary tuberculosis is classically transmitted by aerosol droplets and droplet nuclei produced by coughing.

Clinical Aspects of Microbiology

- Viruses
- They are submicroscopic, noncellular parasitic particles, composed of a protein shell and nucleic acid core.
- They are resistant to common antibiotics and can withstand many decontamination procedures.
- RSV-respiratory syncytial virus (laryngotracheal bronchitis)

Clinical Aspects of Microbiology

- Mycoplasmas
- Mycoplasma pneumonia is the key pathogen that causes primary atypical pneumonia.
- Infection is spread mainly by contact with respiratory tract secretions.

Clinical Aspects of Microbiology

- Fungi
- *Pneumocystis carinii*
- Causes an opportunistic infection among patients with an abnormal or altered immunologic status.
- Affects those suffering from the acquired immune deficiency syndrome.
- Fatality rates are 50% or higher.

Spread of Infection

- There are three elements that must be present for an infection to spread.
 - 1. A source of pathogens
 - 2. A susceptible host
 - 3. A mode of transmission

Spread of Infection

- The primary source of pathogens in the hospital are either people or contaminated objects.
- People-patients, personnel, or visitors.
- Objects-equipment or medications.
- Most cases of nosocomial pneumonia are due to bacteria. (40%)

Spread of Infection

- Host
- The presence and growth of microorganisms in a host, without tissue invasion, damage or toxin is referred to as colonization.
- Whether or not a host actually develops an infection depends on the virulence of the organism and the host's resistance.

Spread of Infection

- Age, chronic debilitating disease, shock, coma, traumatic injury or surgical procedures also increase a patient's susceptibility to an infection.
- 3/4 of all nosocomial pneumonia's occur in surgical patients, especially those having had chest or abdominal procedures.

Spread of Infection

- Intubation, anesthesia, surgical pain, and use of narcotics and sedatives further impair host defenses.
- Patients at highest risk include the elderly, the severely obese, those with COPD or a history of smoking, and those having an artificial airway in place for a long period of time.

Spread of Infection

- Manipulation of the endotracheal tubes increases the likelihood of cross contamination, particularly during suctioning.

Spread of Infection

- Transmission
- Pathogens are transmitted via four major routes:
 - Contact
 - Vehicle
 - Airborne
 - Vectorborne

Spread of Infection

- Contact Transmission
- Is the most important and most frequent route for spread of nosocomial infections.
- Methods of contact transmission include:
 - 1. Direct contact
 - 2. Indirect contact
 - 3. Droplet contact

Spread of Infection

- 1. Direct Contact
- It involves direct physical transfer between a susceptible host and an infected or colonized person.
- 2. Indirect Contact
- Involves contact between a susceptible host and a contaminated object.

Spread of Infection

- 3. Droplet contact
- occurs when a pathogen reaches the mucous membranes of a host via an infected person or carrier who is coughing or sneezing.

Spread of Infection

- Vehicle transmission
- Occurs when a host is exposed to pathogens in contaminated food or water.
- Hepatitis A is an example of a food borne infection.

Spread of Infection

- Airborne Transmission
- Occurs when a pathogen is spread via the air.
- Many be in the form:
 - 1. Of aerosol droplets
 - 2. Droplet nuclei
 - 3. Or dust particles.

Spread of Infection

- 1. Aerosol particles
- Liquid particles in the 10-100 μm size range.
- Can be produced by aerosol generators
- Or created by coughing and sneezing

Spread of Infection

- 2. Droplet nuclei
- Are the residue of evaporated water droplets.
- Smaller in size (0.5 to 12 μm)
- Remain suspended in the air for long periods of time.

Spread of Infection

- 3. Dust particles
 - Are usually greater than 50 μm in size
 - They act as minute fomites.

Spread of Infection

- Vectorborne Transmission
- Occurs when an animal, especially an insect, transfers an infectious agent from one host to another.
- Malaria

Spread of Infection

- Spread of infectious agents into the lungs occurs by one or more of three major routes:
 - 1. Aspiration of oropharyngeal or gastric secretions.
 - 2. Inhalation of aerosol droplets, droplet nuclei or dust particles containing bacteria.
 - 3. Blood borne spread from a distant site of infection.

Spread of Infection

- Of these three routes, aspiration is believed to cause the most cases of bacterial pneumonia.
- The likelihood of aspiration is greatest in persons with abnormal swallowing mechanisms.

Infection Control Methods

- Infection control aims to break the chain of events causing the spread of infection.
- This can be achieved by eliminating the source of pathogens, decreasing host susceptibility and interrupting transmission routes.

Infection Control Methods

- Decreasing host susceptibility to infection is the most difficult and least feasible approach.
- Hospital efforts to achieve this end focus mainly on employee immunization.

Infection Control Methods

- Eliminating the source of pathogens
- General sanitation measures help keep the overall environment clean.
- It also aims to reduce the number of pathogens to a safe level.

Infection Control Methods

- The goal of specialized equipment processing is to decontaminate equipment that is linked to infection.
- This process involves cleaning and disinfection or sterilization.

Infection Control Methods

- Cleaning
- It is the first step in equipment processing.
- This process removes infectious materials, particularly organic matter, from equipment that has been in use.
- All equipment should be disassembled and examined for worn parts.

Infection Control Methods

- Small parts with tiny crevices can be treated in an ultrasonic cleaner.
- After disassembly, parts should be placed in a clean basin filled with hot water and soap or detergent.
- Soaps act by lowering surface tension.

Infection Control Methods

- Some commercial products combine a germicide with a detergent, thus providing the dual action of cleaning and preliminary disinfection.
- Objects that cannot be immersed, such as electrical equipment, should at least be surfaced disinfected with 70% alcohol solution.

Infection Control Methods

- After cleaning, equipment should be carefully rinsed and dried.
- Good drying ensures that all the residues are removed.
- To avoid recontamination, the processed equipment should be moved to a clean area.

Infection Control Methods

- Disinfection destroys the vegetative form of pathogenic organisms.
- Can be achieved by either physical or chemical means.
- The most common physical method of disinfection is pasteurization.

Infection Control Methods

- Pasteurization
- Is an efficient and cost effective method for disinfecting respiratory care equipment.
- Uses moist heat to coagulate cell proteins.
- The temperatures used are not high enough to kill bacterial spores.

Infection Control Methods

- Chemical disinfection
- Involves application of chemical solutions to contaminated equipment or surfaces.
- These agents may kill microorganisms by disrupting their cell membranes, coagulating their proteins and destroying their enzyme processes.

Infection Control Methods

- The Centers for Disease Control (CDC) recognize three levels of chemical disinfection.
 - 1. Low
 - 2. Intermediate
 - 3. And High

Infection Control Methods

- Low and intermediate level disinfection
- Disinfectants can kill most vegetative bacteria and fungi.
- They have variable activity against spores and nonlipid viruses.

Infection Control Methods

- Agents that fall into the low and intermediate category include:
- Alcohol
- Phenols
- Halogens
- Iodophors
- Ammonium compounds
- and Acetic acid

Infection Control Methods

- Alcohols
- Disinfect by denaturing cell proteins
- Both ethyl and isopropyl alcohol are good disinfectants when combined with water.
- Ethyl alcohol is best at 70% concentration.

Infection Control Methods

- Acetic Acid
- In the form of white vinegar has been used as a disinfectant in both the hospital and at home.
- It probably kills bacteria by lowering the pH and inactivating enzymes.
- A 1.25% (1 part to 5% household vinegar to 3 parts water) is optimum.

Infection Control Methods

- High level disinfection
- common high level chemical disinfectants include:
 - Glutaraldehyde
 - Hydrogen peroxide
 - Peracetic Acid

Infection Control Methods

- Glutaraldehydes
- Chemically related to formaldehyde
- Kills microorganisms by attacking the lipoproteins in bacterial cell membranes and cytoplasm.
- Under most conditions, kills all living material.

Infection Control Methods

- Alkaline glutaraldehyde
- Cidex
- It is a bactericidal, tuberculocidal, fungicidal and virucidal at room temperature in ten minutes.
- After 3-10 hours of submersion spores are killed.

Infection Control Methods

- Does not harm metals, rubber, or plastics and can be used with fiberoptic endoscopes.
- The solutions is reusable for 14-28 days.
- Direct skin contact needs to be avoided.

Infection Control Methods

- Sterilization
- Can be achieved by either physical or chemical means.
- There are two most common physical methods used to sterilize equipment.
 - 1. Heat
 - 2. Ionizing radiation

Infection Control Methods

- Heat
- Usually the most practical and efficient means of sterilization.
- The higher the temperature, the shorter the time needed for sterilization.
- Common methods include:
- Incineration, dry heat, boiling and moist heat under pressure (autoclaving).

Infection Control Methods

- Interrupting routes of transmission
- Elimination of the source is not enough
- Efforts must be made to stop the spread of pathogens.

Infection Control Methods

- The two major infection control methods which help prevent the spread of pathogens include:
 - 1. Equipment handling procedures
 - 2. Barrier and isolation techniques

Infection Control Methods

- Equipment handling procedures
 - 1. Maintenance of in-use equipment
 - 2. Processing of reusable equipment
 - 3. The use of disposables
 - 4. Fluid and medication precautions.

Infection Control Methods

- Maintenance of in-use equipment
- The equipment most likely to cause a problem would include:
 - large reservoir jet nebulizers
 - ventilator circuits
 - bag-value mask devices
 - and oxygen therapy apparatus

Infection Control Methods

- Several procedures can be used to prevent nebulizers from spreading pathogens
- 1. Nebulizers should always be filled with sterile distilled water
- 2. Fluid reservoirs should be filled immediately before use
- 3. Fluid should not be added to existing fluid

Infection Control Methods

- 4. Tubing condensate should be discarded and not allowed to drain back into the reservoir.
- 5. Large volume jet nebulizers, medication nebulizers and their reservoirs should be routinely changed and replaced with equipment that has been sterilized or has undergone high level disinfection Q 24 hours.

Infection Control Methods

- 6. Humidifiers or nebulizers that create droplets for purposes of room humidification should never be used.
- In-use ventilator circuits
- Prior recommendations were to change the circuit every 24 hours.

Infection Control Methods

- Current lecture shows that adult and infant circuits can be changed every 7 days.
- If a heat moisture exchanger is used instead of a water humidifier, the circuits definitely can go longer to be changed.

Infection Control Methods

- Bag-valve mask devices
- Have long been recognized as a potential vehicle for spread of infection between patients.
- They are a source for colonizing the airways of intubated patients and the hands of personnel.

Infection Control Methods

- Oxygen therapy apparatus
- Pose much less threat than other in-use devices.
- Humidifiers are not needed with flows less than 4 L/min
- Wherever possible, pre-filled sterile disposable humidifiers should be used with oxygen therapy

Infection Control Methods

- Reusable oxygen humidifier reservoirs should be emptied and then replenished with sterile distilled water
- No tap water
- The tubing and oxygen delivery device should be changed between patients
- The use-time of pre-filled disposal humidifiers can be safely extended to 6-12 days and possibly longer.

Infection Control Methods

- Improperly processed reusable equipment is another potential source for pathogens.
- Several factors must be considered in selecting processing methods for reusable equipment.
 1. Devices should be categorized according to their infection risk.

Infection Control Methods

- There are three infection risk categories;
 - a. Critical
 - b. Semi-critical
 - c. Non-critical
- 2. Once the risk category is known, then its composition is matched to the resources available for hospital disinfection and sterilization.

Infection Control Methods

- Disposable equipment
- This was a major approach to preventing the spread of pathogens in the hospital.
- Items that are disposable:
 - Humidifiers
 - nebulizers
 - incentive spirometers

Infection Control Methods

- Ventilator circuits
- Bag-valve mask resuscitators
- and monitoring transducers

- Concern has been for their quality compared to their reusable counterparts.

Infection Control Methods

- Fluids and medications precautions:
- Represent a major source for spreading infections.
- Only sterile fluids should be used to fill nebulizers and humidifiers.
- Contaminated equipment should not be allowed to enter or touch the fluid while it is being dispensed.

Infection Control Methods

- After a large bottle of fluid has been opened, unused fluid should be discarded within 24 hours.
- Either single dose or multi dose vials can be used for respiratory therapy.

Infection Control Methods

- If multi dose vials are used, they should be stored (refrigerated or room temperature) according to the label or insert.
- Vials should be used no longer than the expiration date given on the label.

Infection Control Methods

- General barrier-type precautions:
 - Handwashing
 - Gloves
 - Masks
 - Gowns

Infection Control Methods

- Isolation Precautions:
- Strict
- Prevents the transmission of highly contagious or virulent infections
- May be spread both via air and direct contact.
- Smallpox, chickenpox, pneumonic plague and diphtheria.

Infection Control Methods

- Contact Isolation
- Designed to prevent transmission of highly contagious infections or colonization that do not need strict isolation.
- Acute respiratory infections
- Bronchitis
- Viral pneumonia
- Viral bronchiolitis

Infection Control Methods

- Respiratory Isolation
- used to prevent the transmission of infectious diseases via the droplet contact route.
- Epiglottitis
- Meningitis
- Childhood pneumonia
- Mumps

Infection Control Methods

- Tuberculosis Isolation
 - Protects against active disease.
 - Generally infants and young children do not require isolation because they rarely cough.
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- Enteric Precautions
 - Prevent infections that are transmitted by contact with feces.

Infection Control Methods

- Drainage/secretion Precautions
- Prevent infections that could be contacted by indirect contact with purulent material or drainage from an infected site.
- Blood and body fluid Precautions
- Prevent infections transmitted by direct or indirect contact with contaminated blood or body fluids.

Infection Control Methods

- Other considerations:
- Contaminated articles
- Bag and double bag
- Needles and syringes
- Avoid recapping needles and disposable
- Laboratory specimens
- Prevent contamination

Infection Control Methods

- Universal precautions should be used for all patients.
- Endorsed by the CDC
- These strengthen normal blood and body fluid precautions.
- Apply to blood, semen, vaginal secretions, body tissues, cerebrospinal fluid, pleural fluids, pericardial fluid and amniotic fluid.

Infection Control Methods

- Precautions for invasive procedures:
- Gloves and surgical masks for all procedures
- Protect eyewear and gown are recommended.
- During procedure if splashing of blood or other body fluids occurs, immediate removal of gloves and wash the affected area.

Surveillance

- Involves three components:
 - 1. Equipment processing quality control
 - 2. Routine sampling of in-use equipment
 - 3. Microbiological identification
- During major outbreaks of nosocomial infections, surveillance will also involve epidemiological investigation.

Surveillance

- Policies are set up by an infection control committee.
- Administered by an infection control RN or epidemiologist.
- Can be centralized or decentralized.

Surveillance

- 1. Equipment processing quality control
- Monitoring and evaluating personnel are the first steps.
- There must be an assessment of outcomes.
- In order to achieve this, one must use both specially prepared processing indicators and culture sampling methods.

Surveillance

- Processing indicators
- This shows whether or not a sterilization or disinfection process has worked.
- Usually used with heat, ionizing radiation, and gas.
- Can use chemical or a biological process

Surveillance

- Chemical
 - impregnated on packaging tape
 - change color when exposed to specific conditions
- Biological
 - strips of paper impregnated with spores
 - placed in capsule/ watching for a change in growth medium.

Surveillance

- Culture sampling
- Used to evaluate other procedures such as pasteurization and chemical disinfection.
- Bacteriologic samples are obtained and cultured from equipment.
- Determines how much residual bacteria remains on the equipment.

Surveillance

- Contamination is common during this procedure.
- Makes reading the results difficult.
- Random sampling and culturing of stored items is used to assess packaging adequacy and material shelf life.

Surveillance

- 2. Sampling of in-use equipment
- Purpose is to:
 - a. Help establish the frequency with which in-use items should be removed from use and reprocessed
 - b. Help identify the source of nosocomial epidemics before they become widespread.

Surveillance

- Three common methods used to sample respiratory care equipment
- 1. Swab sampling
- 2. Liquid broths
- 3. Aerosol impaction
- Each of these methods is designed to aid sample collection.

Surveillance

- Swab sampling
- specially prepared sterile swab is rubbed on the equipment surface at a single location.
- Each location sampled requires a new swab
- using aseptic technique, the swab is placed wither in a tube of sterile liquid broth or used to inoculate a plate of growth media.

Surveillance

- Liquid broths
- Swab sampling cannot reach all locations, including the inside of tubing.
- Sterile liquid broths are used to obtain a sample.
- The broth is poured into circuitry tubing and swished back and forth.
- Once exposed, the broth is poured into a sterile container for culturing

Surveillance

- Aerosol Impaction
- Sometimes it is necessary to sample the actual particulate output of jet nebulizers.
- Sampling of liquid particle aerosols is done by inertial impaction devices.
- These range in complexity from a simple funnel with attached culture plate to a sophisticated multi-chamber devices that segregated aerosol particles according to size.

Surveillance

- Microbiological Identification
- A hospital's microbiology lab fulfills a central role in bacteriologic surveillance.
- Organisms are cultured, isolated, and identified according to a variety of specialized procedures.
- Most of its work focuses on diagnostic procedures.

Surveillance

- Microbiology lab works closely with the infection control nurse or epidemiologist in support of the program.
- If program is decentralized to the departmental level, the RCP's may work closely with the microbiology lab to develop, maintain and evaluate the methods and procedures used to gather and interpret bacteriologic samples.

Infection Control

- *All finished*