Objectives

- Nosocomial infection (HAI)
- CDC hot list
- Common nosocomial pathogens
- Modes of transmission
- Antibiotic-resistant nosocomial pathogens
- Control of nosocomial infections
Introduction for Nosocomial Infections

- Acquired during hospital stay
- Asymptomatic and symptomatic patient can be considered infected
- Infection may be carried by:
  - Healthcare workers
  - Family members
- New antibiotic research is decreasing
- Account for 5% to 10% infection rates in USA
- > 40% in other developing countries
- Huge $$ cost involved in treatment
Types of nosocomial infections

- The CDC has classified 13 types of nosocomial infections based on biological and clinical data:
  - UTI
  - Surgical sites
  - Gastroenteritis
  - Meningitis
  - Respiratory infections
- Increasing rates occur because of cancer therapy, organ transplants, immunotherapy, invasive diagnostic techniques
- Not so good news! HAI have increased 17% to 30% in last 5 years
Types of nosocomial infections

- Bacteria are responsible for about 90% of infections
- Protozoans, fungi, viruses and mycobacteria are less contributing compared to bacterial infections
- Out of these- these are of “concern”
  - Enterococci
  - *P. aeruginosa*
  - *S. aureus*
  - *E. coli*
<table>
<thead>
<tr>
<th>Commonly isolated nosocomial pathogens found in health care facilities</th>
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<tbody>
<tr>
<td>Acinetobacter baumannii</td>
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<tr>
<td>Clostridium difficile</td>
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<tr>
<td>Carbapenem-resistant Enterobacteriaceae (CRE)</td>
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<td>Escherichia coli</td>
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<td>Klebsiella pneumonia</td>
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<td>Methicillin-resistant Staphylococcus aureus</td>
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<td>Psuedomonas aeruginosa</td>
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<td>Staphylococcus aureus</td>
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<td>Vancomycin-Resistant Enterococci</td>
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Virulence factors

- Virulence factors:
  - Innate ability of bacteria to survive and thrive
  - Invade the host
  - Cause disease

- Adherence Factors
  - Many pathogenic bacteria colonize mucosal sites by using pili(fimbriae) to adhere to cells

- Toxins
  - Endotoxins
    - Part of cell wall of gram negative bacteria
    - Trigger inflammation
  - Exotoxins
    - Secreted by bacteria causing inhibition of immune responses

- Destructive enzymes- break down cell walls
- Immune modulators- break down the host’s immunoglobulins using proteases
**S. aureus**

- *Staphylococcus* genus is considered one of the most important pathogens
- Gram-positive cocci, non-spore forming, catalase- and coagulase-positive, immotile, facultatively anaerobe
- Mainly colonizes in nasal passages
S. aureus

- 20% individuals have persistent colonization of S. aureus
- Decreased immunity and immunocompetent patients are greatest risk
- S. aureus infects not only the superficial but also the deep tissues
  - Toxin-mediated diseases of S. aureus include:
    - Food poisoning
    - Toxic shock syndrome
    - Scalded skin syndrome
- Virulence mechanisms of S. aureus include:
  - Toxins
  - Enzymes and
  - Immune modulators
S. aureus

- In hospitals these infections can be fatal:
  - Bacteremia or sepsis when bacteria spread to the bloodstream
  - Pneumonia, which predominantly affects people with underlying lung disease including those on mechanical ventilators
  - Endocarditis (infection of the heart valves), which can lead to heart failure or stroke
  - Osteomyelitis (bone infection), which can be caused by staph bacteria traveling in the bloodstream
E. coli is an emerging nosocomial pathogen

- E. coli is Gram-negative and oxidase-negative facultative anaerobe bacteria
- Colonize in gastrointestinal tract of human beings and other animals
**E-coli**

- *E. coli* is responsible for a number of diseases including
  - UTI
  - Septicemia
  - Pneumonia
  - Neonatal meningitis
  - Peritonitis
  - Gastroenteritis
- Virulence factors are endotoxins, capsule, adhesions and type 3 secretion systems
- Specialized virulence factors are seen in case of UTI and gastroenteritis
Vancomycin-resistant enterococci

- Vancomycin-Resistant Enterococci
- Resistant to vancomycin
  - Drug often used to treat infections caused by enterococci
- 17 different species of Enterococci
- Enterococci are bacteria that are normally present in the human intestines and in the female genital tract
- Can sometimes cause infections
- Most Vancomycin-Resistant Enterococci infections occur in hospitals
- Vancomycin-Resistant Enterococci is also called VRE
Enterococci

- 2nd leading cause of hospital acquired infections worldwide
- 20%-30% of all infections in the USA
- These are facultative anaerobic Gram-positive enteric microbes
- Part of normal microbiota in female genital tract and gastrointestinal tract as well
- Enterococci are involved in the blood-borne infections; UTI, wound infections, and surgical procedures infections
- Virulence factors include extracellular surface proteins, cytolysin, adhesions, hemolysins, gelatinase, extracellular superoxide and aggregation substances
Clostridium difficile (C. difficile)

- Nosocomial pathogen which mainly causes diarrhea worldwide
- It is a Gram-positive bacillus
- It is anaerobic and spore-forming bacteria
- It usually colonizes in intestinal tract and serves as part of normal microbiota
- Diseases caused by toxins produced by C. difficile are colitis and it is responsible for 15%–25% cases of diarrhea.
- Major virulence factors for C. difficile are toxins, fimbriae, capsule and hydrolytic enzymes
Modes of transmission

- **S. aureus**
  - Skin or contact via shared items and surfaces like door handles, benches, towels and taps

- **E. coli**
  - Transmitted through person to person, environment or contaminated water and food

- **Vancomycin-resistant enterococci**
  - Patients with diarrhea
  - Room items such as surfaces and equipment’s act as reservoirs
  - Can survive on these surfaces for days or weeks
Modes of transmission

- Klebsiella pneumonia
  - Person-to-person contact
  - Healthcare professionals do not wash or clean hands after checking a contaminated patient
  - Ventilators, catheters or exposed wounds can be the source of its transmission
  - Transmitted through stool, patients’ hands and pharynx
- P. aeruginosa
  - Common reservoirs include breast pumps, incubators, sinks and hands of hospital staff and hand soaps
Modes of transmission

- C. difficile
- Spores of C. difficile can hold for months
- Inanimate objects and infected intestinal patients are major sites acted as reservoirs
- Hospital staff along with hospital settings are also part of the problem
Antibiotic-resistant nosocomial pathogens

- Multi-drug-resistant nosocomial organisms include
  - MRSA
  - Vancomycin-Resistant Enterococci
  - P. aeruginosa
  - K. pneumonia
- C. difficile shows natural resistance
- 50% to 60% of hospital-acquired infections are caused by resistant pathogens in the United States
- Improper use of antibiotics is thought to be the major cause of this drug resistance
Antibiotic-resistant nosocomial pathogens

- **MRSA**
  - β-Lactamase antibiotics including penicillin became resistant in the 1940s
  - Resistance of penicillin due to its improper use
  - Due to the Staphylococcal species having penicillinase enzyme
    - Penicillinase-resistant antibiotics were developed such as cephalosporin's
  - In the 1960s, methicillin-resistant species of *S. aureus* were first reported
  - Resistance was due to the modification of penicillin-binding proteins
  - β-lactam antibiotics along with their derivatives ineffective
  - Aminoglycosides resistance was another addition to methicillin resistance
Antibiotic-resistant nosocomial pathogens

- Vancomycin-resistant enterococci
  - Resistance in the enterococcal species due to the *vanA* and *vanB* genes
  - Part of plasmid
  - Enterococci are resistant to different classes of antibiotics which include:
    - Penicillin
    - Ampicillin
    - Aminoglycosides
    - Tetracycline's
    - Carbapenem
    - Fluoroquinolones
    - Macrolides
Antibiotic-resistant nosocomial pathogens

- *P. aeruginosa* is becoming resistant due to different mechanisms
  - These mechanisms include:
    - Restricted uptake of drug
    - Modification and altered targets sites for antibiotics
- Due to this increasing resistance, complications are seen in these infections
- Ineffective due to increasing resistance include
  - Cephalosporin's
  - Trimethoprim
  - Macrolides
  - Chloramphenicol
  - Tetracycline's
  - Fluoroquinolones
Antibiotic-resistant nosocomial pathogens

- Klebsiella pneumonia
  - Resistance to β-lactam antibiotics
  - Resistance to 3rd and 4th generation Cephalosporin's
- C. difficile
  - Increased use of broad-spectrum antibiotics against C. difficile-associated diseases makes it resistant
  - Improper antibiotic use
Control of nosocomial infections

- Lack of actual statistics regarding the causes and antimicrobial susceptibility in developing countries
- Pathogens with resistant organisms make it extremely difficult to devise a proper plan for control
- It is also difficult to measure the infection rates in different healthcare settings
Control of nosocomial infections

It is important to know the types of microorganism involved in infection.

Infectious organisms are heterogeneous in nature which makes them different from one another.

Compare the infection rates in different healthcare settings.

Determine the management of infections in different hospital settings.

Types of services that a hospital provides to patients must be taken into account.
Control of nosocomial infections

- Development of infection control programs
  - Guidelines for the sterilization and disinfection of invasive devices and medical instruments
  - Guidelines for the prevention of catheter-associated UTI
  - Lack of compliance with the guidelines leads to the transmission of nosocomial infections
  - CDC provides the methodology for surveillance of nosocomial infections along with investigation of major outbreaks
  - Training of healthcare professionals, especially nurses, is extremely important for the control and prevention of infection
Control of nosocomial infections

- Surveillance of nosocomial infections
  - The ongoing, systematic collection, analysis, and interpretation of health data
  - Surveillance obliges the data related to infected individuals with their infection sites
  - Hospitals can work on this data to control the infections by evaluating the efficacy of treatment
  - Surveillance can devise a strategy comprising of infection control practices
Summary

- Even with the best antibiotics, nosocomial infections are still uncontrollable.
- Control of organisms responsible for nosocomial infections is much needed as they cause great economic as well as production loss.
- Transmission of these infections in the hospital settings through healthcare workers can be avoided by the use of infection control practices.
- Improper and frequent use of antibiotics is an important cause of drug-resistant organisms that are difficult to treat.
- Hospitals should devise the infection control programs through which infection rates can be compared and controlled.
- A well-managed surveillance methodology is required.
- Best practice should be shared among hospitals to stop the spread of nosocomial infections.
References


