

Nosocomial Infections (NIs) or Hospital Acquired Infections (HAIs)

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Hospital Acquired Infection (HAI) is the infection that is acquired by the patient when hospitalized. It is also known as Nosocomial infection (NI). This term is derived from two Greek words “nosos” (disease) and “komeion” (to take care of). Florence Nightingale who is the pioneer of nosocomial infection theory said, “Hospitals should do the sick no harm”. Lister is credited with the beginnings of sterilization in the operating Room. Before surgery, he sprayed the operating rooms with carbolic acid, because he thought that the infections were caused by dust particles in the air.

Nosocomial infections occur worldwide. The incidence is about 5-8% of hospitalized patients, 1/3rd of which are preventable. Nosocomial infections can affect the patients as well as community in the following ways:

- They lead to functional disability and emotional stress to the patient.
- They lead to disabling conditions that reduce the quality of life.
- They are one of the leading causes of death.

They increase economic costs by: Increased length of hospital stay, extra investigations, extra use of drugs and extra health care by doctors and nurses.

Hospital Acquired Infection (HAI) or Nosocomial infection (NI) is defined as:

A localized or a systemic condition that,

- a. Results from an adverse reaction to the presence of an infectious agent(s) or its toxin(s) which
- b. Was neither present nor incubating at the time of admission to the hospital.

Healthcare associated infection (HCAI): Infections associated with contact with the healthcare system like

hospitals, ambulatory services, home care, laboratories, etc.

Clinically, nosocomial infections are defined as those occurring within 48 hours of hospital admission or within 3 days of discharge or within 30 days of an operation.

Factors Influencing Nosocomial Infections:

- **The microbial agent:** Development of clinical disease depends on the characteristics of the organism such as their virulence, the amount of the infective dose. The majority of HAIs are caused by bacteria or fungi with low-to-moderate virulence. They are usually commensals or saprophytic organisms.
- **Patient’s susceptibility:**
 - Patients of extreme ages i.e., infants and old-aged have decreased resistance to infection.
 - Patients with chronic diseases such as malignancy, leukemia, diabetes mellitus, renal failure or AIDS have increased susceptibility to infection.
 - Patients on immunosuppressive drugs or irradiation are also vulnerable to infections.
 - Patient with invasive procedures i.e. catheterization, endotracheal intubation or patients who have undergone surgery are prone to infection at those sites, as infected substances may be introduced directly into the normally sterile tissues.
- **Environmental factors:** Healthcare settings are an environment, where the infected persons and the persons at high risk of infection gather together increasing the incidence of HAIs. The contributors to this are:
 - The crowded conditions within hospital and frequent transfers of patients between units.
 - Microbial flora of one patient may contaminate objects, devices and materials which subsequently would contact the susceptible body sites of the other patients.

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Sources of Nosocomial Infections

• **Endogenous:**

Almost 50% of HAIs are endogenous in origin, i.e. they are caused by the patient's own flora. These organisms are not pathogenic under normal conditions, but only when they find an opportunity, they produce infection. The following conditions may enable these organisms to reproduce, spread and implant themselves at the sites where they produce infection.

1. Invasive diagnostic or therapeutic procedures leading to a breach in the epithelial lining of skin or of the mucous membrane and thus allowing the surface colonizing bacteria to enter within.
2. Catheters, implants or stitches may provide the path for the organisms from their normal colonizing sites to otherwise sterile sites of the body.
3. Immuno-compromised status of a patient may allow the development of infections by the low-virulent commensals.

• **Exogenous (cross-infection):**

These infections are as a result of spread from:

1. Other patients
2. Healthcare worker
3. Environment: Several types of micro-organisms survive well in the hospital environment such as water and food, linen, equipments and other inanimate articles and furniture in hospital premises, dust and droplet nuclei present in air. These micro-organisms form the hospital flora. e.g., *Pseudomonas* spp., *Acinetobacter* spp. etc.

Modes of Transmission of Nosocomial Infections:

A. **Direct contact route:**

1. Via hands or clothing of hospital staff or other patients.
2. Through inanimate objects.
3. Through instruments or disinfecting solutions.

B. **Oral route and faeco-oral route :**

C. **Air-borne route :**

1. From patients and hospital personnel: By droplet or droplet nuclei containing organisms.
2. Environmental sources
 - i. Dust
 - ii. Aerosols produced by humidifiers, nebulizers and air conditioning systems.

D. **Parenteral route:**

1. By blood transfusion, tissue donation, contaminated blood products, contaminated infusion fluid.
2. From sharp instruments.

Other nosocomial infections are :

1. Skin and soft tissue infections. (i.e. infection of bed sore or burns site)
2. Gastroenteritis, antibiotic associated diarrhea.
3. Sinusitis, infections of eyes and conjunctiva.
4. Endocarditis.
5. Hepatitis B, Hepatitis C, HIV.
6. Air borne viral haemorrhagic fever.

Prevention of Nosocomial Infections :

Prevention of nosocomial infections is the responsibility of every individual and health service provider in the healthcare setting.

Infection requires a “chain” of events.

- There must be **sufficient quantities** of the pathogen,
- The pathogen must be **virulent** enough to cause disease,
- The pathogen moves through a **route of transmission**,
- Reaches a **“portal of entry,”** such as eyes, nose, mouth, or puncture wound,
- Enters the **susceptible host.**

Common Nosocomial Infections

Table 1: Common Nosocomial Infections

Urinary tract infection (30-40%)	1. Indwelling urinary catheter 2. Instrumentation	<ul style="list-style-type: none"> • E.coli • Enterococci • Pseudomonas • Candida • Klebsiella • Proteus • Providencia • Staphylococci 	Positive urine culture (1 or 2 species) with at least 10^5 c.f.u./ml, with or without clinical symptoms.
Respiratory infections (20%)	1. Intubation 2. Mechanical ventilation 3. Aspiration 4. Underlying chronic lung diseases.	<ul style="list-style-type: none"> • Pseudomonas • Staphylococci • Candida • Klebsiella • Acinetobacter • Legionella • Respiratory viruses 	Respiratory symptoms with at least 2 signs: cough, purulent sputum, new infiltrate on chest, appearing during hospitalization.
Wound infection (15%)	1. Wound contamination 2. Duration of surgery 3. Associated predisposing conditions	<ul style="list-style-type: none"> • Pseudomonas • E.coli • Proteus • Staphylococci • Enterococci • Acinetobacter 	Any purulent discharge, abscess or spreading cellulitis at the site of traumatic or surgical wound.
Bacteremia and septicemia (5-10%)	Intravenous cannulation	<ul style="list-style-type: none"> • Pseudomonas • E.coli • Klebsiella • Candida • Staphylococci 	Inflammation, lymphangitis or purulent discharge at the vascular catheter insertion site. Fever or rigors and at least one positive blood culture; SIRS.

The role of the hospital epidemiologist/infection control officers is to understand this chain and the most efficient means of interrupting transmission. Disease transmission can be prevented by breaking one or more of the links in this chain of transmission.

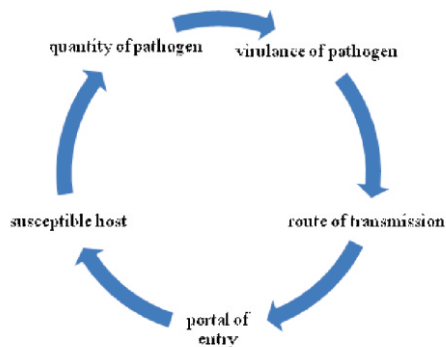
Strategies to Reduce Nosocomial Infection :**Infection control precautions**

Infection Control Precautions: Used to reduce transmission of microorganisms.

A Standard (Universal) precautions :**a) Hand hygiene :**

Hand washing with soap and water if hands are visibly soiled.

Figure 1: Chain of events in Nosocomial Infections



If resources permit, perform hand rubbing with an alcohol-based preparation. Indications of hand hygiene :

- Before touching a patient.
 - After contact with any potentially infected material i.e. blood, body fluids or secretion, or wound dressings, prior to performing any aseptic procedure i.e. placing an intra-venous line, preparing an injection.
- b) Using personal protective equipment :**
- Including gloves, gowns, face masks, respirators, goggles and face shields.
- c) Following injection safety :**
- Do not reuse the syringe or needle used for medication or diagnostic purpose.
 - Used syringes and needle should be properly disposed after use.
- d) Following safety measures for safe handling potentially contaminated equipments or surfaces :**
- Use proper procedures for the routine cleaning and disinfection of environmental and other frequently touched surfaces.
 - Moreover, the staff should be trained on the strategy of Managing blood and body-fluid spillage.
 - Cordoning off the area until the spillage is cleaned and disinfected. No access to visitors or unprotected staff members should be available for the cordoned area.
 - All non-disposable cleaning materials (mops, brushes, and rags are to be disinfected by saturating with disinfectant solution and allowing it to air dry).

- Remove gloves and place in a garbage bag with all other soiled cleaning materials and double bag and securely tie them up to be discarded.
- Thoroughly wash hands with soap and water.

e) Respiratory hygiene :

Cover the nose and mouth with a mask or tissue when coughing/sneezing and dispose off the used tissues and masks. Perform hand hygiene after contact with respiratory secretions.

B. Transmission-based precautions:

Standard precautions are used for all patients regardless of their diagnoses to ensure protection of the healthcare worker and the patient. For certain highly transmissible or epidemiologically important pathogens, transmission-based precautions are used in addition to standard precautions:

a) Contact precautions:

- For protection against skin-to-skin contact and physical transfer of microorganisms to a host from a source e.g., Discharging wounds are common source of Methicillin Resistant Staphylococcus Aureus (MRSA).
- Precautions: Isolation, hand washing, use of gloves

b) Precaution from droplet infections :

- For infectious agents with droplet nuclei > 5 microns, through cough or sneezing e.g., Pertussis, Influenza, Meningococcal meningitis
- Precautions: -Isolation room, use of surgical mask

c) Precautions from air-borne transmission :

- For infectious agents with droplet nuclei <5 microns e.g., Tuberculosis, Measles, Chickenpox
- Precautions: -Isolation rooms with negative pressure, Air cycling >12/hour, HEPA filters
- Use respirators or N95 mask, patient will use a surgical mask

d) Reverse isolation :

- Barrier protection to protect patients that are highly susceptible to infection.

Identification of source :

The source of infection in the hospital should be identified by

- Regular surveillance,
- Outbreak investigation and
- Epidemiological data analysis.

Surveillance of nosocomial infections include the following points

- Active surveillance: By surveillance personnel (i.e. infection control nurse) including environmental sampling for bacteria and fungi.
- Passive surveillance: By medical personnel
- Laboratory or clinical-based surveillance by analyses of clinical and laboratory data.

Environmental disinfection :

Environmental services should approach cleaning in an orderly fashion with regularly scheduled methods with appropriate concentration of disinfecting solutions.

Commonly used hospital disinfectants :

- 5% Sodium hypochlorite
- 2% Glutaraldehyde
- Hydrogen peroxide + silver nitrate
- Phenolic compounds

Appropriate use of antibiotics :

There is a causal association between antimicrobial use and the emergence of antimicrobial resistance. This fact is supported by following evidences:

- Changes in antimicrobial usage are paralleled by changes in the prevalence of resistance.
- Resistance is more prevalent in healthcare associated bacterial infections compared with those from community-acquired infections.
- Patients with healthcare-associated infections caused by resistant strains are more likely than control patients to have received prior antimicrobials.
- Areas within hospitals that have the highest rates of resistance also have the highest rates of use.
- Increasing duration of patient exposure to antimicrobials increases the likelihood of colonization with resistant organisms.

Antibiotic stewardship program

To control the use of antibiotics every hospital should have an antibiotic stewardship program.

Definition: "Coordinated interventions designed to improve and measure the appropriate use of antimicrobial agents by promoting the selection of the optimal antimicrobial drug regimen including dosing, duration of therapy, and route of administration."

In other words antimicrobial stewardship is the:

- Right drug, in the
- Right person, at the
- Right time, using the
- Right dose, and for the
- Right duration.

The primary goal of antimicrobial stewardship is to:

- Improve patient outcomes
- Optimize selection, dose and duration of treatment
- Reduce adverse drug events including secondary infection (e.g. C. difficile infection)
- Reduce morbidity and mortality
- Limit emergence of antimicrobial resistance
- Reduce length of stay
- Reduce healthcare expenditures

Infection Control Programme in the Hospital

Every hospital must have an effective hospital acquired **Infection Control Committee (ICC)** which should be with responsibilities for the control of hospital acquired infections (HAI) and monitoring of hygienic practices in the hospital.

Infection Control Committee (ICC)

It is a multidisciplinary committee responsible for preparation of infection control policies, monitoring the policy implementation and recommending corrective actions.

Members of the infection control team are general physicians, infectious disease specialists, surgeons, clinical microbiologists, infection control nurses and representatives from other

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relevant departments (laboratory, housekeeping, pharmacy and central supply).

Functions of ICC:

- a. Developing and recommending policies and procedures pertaining to infection control

Infection control committee should form policies for prevention and control of HAI; and make it functional in the hospital.

The policies should include the following:

- Infection control policy
 - Sterilization and disinfection policy
 - Hospital waste management
 - Antibiotic policy
 - Surveillance policy
 - Training of healthcare provider
- b. Obtaining and managing critical bacteriological data and information, including surveillance data.

- c. Recognizing and investigating outbreaks of infections in the hospital and community.

- d. Intervening directly to prevent infections.

- e. Educating and training health care workers, patients, and nonmedical caregivers.

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