

- Nosocomial infection
- Nosocomial infection — also called “hospital acquired infection” can be defined as:
- An infection acquired in hospital by a patient who was admitted for a reason other than that infection . An infection occurring in a patient in a hospital or other health care facility in whom the infection was not present or incubating at the time of admission. This includes infections acquired in the hospital but appearing after discharge, and also occupational infections among staff of the facility.

Despite progress in public health and hospital care, infections continue to develop in hospitalized patients, and may also affect hospital staff. Many factors promote infection among hospitalized patients:

1. decreased immunity among patients.
2. the increasing variety of medical procedures and invasive techniques creating potential routes of infection.
- 3.the transmission of drug-resistant bacteria among crowded hospital populations, where poor infection control practices may facilitate transmission.

- Frequency of infection
- Nosocomial infections occur worldwide and affect both developed and resource-poor countries.
- Infections acquired in health care settings are among the major causes of death and increased morbidity among hospitalized patients. They are a significant burden both for the patient and for public health.
- At any time, over 1.4 million people worldwide suffer from infectious complications acquired in hospital. The highest frequencies of nosocomial infections were reported from hospitals in the Eastern Mediterranean and South-East Asia Regions (11.8 and 10.0% respectively), with a prevalence of 7.7 and 9.0% respectively in the European and Western Pacific Regions.
- The most frequent nosocomial infections are infections of surgical wounds, urinary tract infections and lower respiratory tract infections.
- The WHO study, and others, have also shown that the highest prevalence of nosocomial infections occurs in intensive care units and in acute surgical and orthopedic wards.
- Infection rates are higher among patients with increased susceptibility because ;of old age, underlying disease, or chemotherapy.
- Impact of nosocomial infections
- Hospital-acquired infections add to functional disability and emotional stress of the patient and may, in some cases, lead to disabling conditions that reduce the quality of life.

Nosocomial infections are also one of the leading causes of death. The economic costs are considerable. The increased length of stay for infected patients is the greatest contributor to cost.

- One study showed that the overall increase in the duration of hospitalization for patients with surgical wound infections was 8.2 days, ranging from 3 days for gynecology to 9.9 for general surgery and 19.8 for orthopedic surgery. Prolonged stay not only increases direct costs to patients or payers but also indirect costs due to lost work.
- The increased use of drugs, the need for isolation, and the use of additional laboratory and other diagnostic studies also contribute to costs.
- Hospital-acquired infections add to the imbalance between resource allocation for primary and secondary health care by diverting scarce funds to the management of potentially preventable conditions.
- The advancing age of patients admitted to health care settings, the greater prevalence of chronic diseases among admitted patients, and the increased use of

diagnostic and therapeutic procedures which affect the host defenses will provide continuing pressure on nosocomial infections in the future.

Organisms causing nosocomial infections can be transmitted to the community through discharged patients, staff, and visitors.

If organisms are multi resistant, they may cause significant disease in the community.

- Factors influencing the development of nosocomial infections
- The microbial agent;

The patient is exposed to a variety of microorganisms during hospitalization. Contact between the patient and a microorganism does not by itself necessarily result in the development of clinical disease.

- other factors influence the nature and frequency

of nosocomial infections. The likelihood of exposure leading to infection depends partly on the characteristics of the microorganisms, including resistance to antimicrobial agents, intrinsic virulence, and amount (inoculum) of infective material.

- Many different bacteria, viruses, fungi and parasites may cause nosocomial infections.
- Infections may be caused by a microorganism acquired from another person in the hospital (cross-infection) or may be caused by the patient's own flora (endogenous infection). Some organisms may be acquired from an inanimate object or substances recently contaminated from another human source (environmental infection).
- Patient susceptibility
- Important patient factors influencing acquisition of infection include age, immune status, underlying disease, and diagnostic and therapeutic interventions.
- The extremes of life — infancy and old age — are associated with a decreased resistance to infection.
- Patients with chronic disease such as malignant tumors, leukemia, diabetes mellitus, renal failure, or the acquired immunodeficiency syndrome (AIDS) have an increased susceptibility to infections with opportunistic pathogens.
- Injuries to skin or mucous membranes bypass natural defense mechanisms.
- Malnutrition is also a risk.
- Many modern diagnostic and therapeutic procedures, such as biopsies, endoscopic examinations, catheterization, intubation/ventilation and suction and surgical procedures increase the risk of infection. Contaminated objects or substances may be introduced directly into tissues or normally sterile sites such as the urinary tract and the lower respiratory Tract.
- Environmental factors
- Health care settings are an environment where both infected persons and persons at increased risk of infection congregate. Patients with infections or carriers of pathogenic microorganisms admitted to hospital are potential sources of infection for patients and staff. Patients who become infected in the hospital are a further source of infection.
- Crowded conditions within the hospital, frequent transfers of patients from one unit to another, and concentration of patients highly susceptible to infection in one area (e.g. newborn infants, burn patients, intensive care) all contribute to the development of nosocomial infections.
- Microbial flora may contaminate objects, devices, and materials which subsequently contact susceptible body sites of patients
- Bacterial resistance
- Many patients receive antimicrobial drugs. Through selection and exchange of genetic resistance elements, antibiotics promote the emergence of multidrug resistant strains of bacteria; microorganisms in the normal human flora sensitive to the given drug are suppressed, while resistant strains persist and may become endemic in the hospital. The widespread use of antimicrobials for therapy or prophylaxis (including topical) is the major determinant of resistance.
- Antimicrobial agents are, in some cases, becoming less effective because of resistance.
- As an antimicrobial agent becomes widely used, bacteria resistant to this drug eventually emerge and may spread in the health care setting.

- Many strains of pneumococci, staphylococci, enterococci, and tuberculosis are currently resistant to most or all antimicrobials, which were once effective. Multi resistant Klebsiella and Pseudomonas aeruginosa are prevalent in many hospitals. This problem is particularly critical in developing countries where more expensive second-line antibiotics may not be available or affordable.
- Nosocomial infections are widespread. They are important contributors to morbidity and mortality. They will become even more important as a public health problem with increasing economic and human impact because of:
 - Increasing numbers and crowding of people.
 - More frequent impaired immunity (age, illness, treatments).
 - New microorganisms.
 - Increasing bacterial resistance to antibiotics
- **Epidemiology of nosocomial infections**
 - Type of nosocomial; Simplified criteria
 - infection
 - Surgical site infection; any purulent discharge, abscess, or spreading cellulitis at the surgical site during the month after the operation.
 - Urinary infection; Positive urine culture (1 or 2 species) with at least 10⁵ bacteria/ml, with or without clinical symptoms.
 - Respiratory infection Respiratory symptoms with at least two of the following signs appearing during hospitalization:
 - — Cough
 - — Purulent sputum
 - — New infiltrate on chest radiograph consistent with infection.
 - Vascular catheter Inflammation, lymphangitis or infection purulent discharge at the insertion site of the catheter.
 - Septicemia; Fever or rigors and at least one
 - Positive blood culture.
 - **Urinary infections**
 - This is the most common nosocomial infection; 80% of infections are associated with the use of an indwelling bladder catheter . Urinary infections are associated with less morbidity than other nosocomial infections, but can occasionally lead to bacteremia and death. Infections are usually defined by microbiological criteria: positive quantitative urine culture ($\geq 10^5$ microorganisms/ml, with a maximum of 2 isolated microbial species) .The bacteria responsible arise from the gut flora, either normal (Escherichia coli) or acquired in hospital (multiresistant Klebsiella).
 - Surgical site infections
 - Surgical site infections are also frequent: the incidence varies from 0.5 to 15% depending on the type of operation and underlying patient status .
 - These are a significant problem which limit the potential benefits of surgical interventions. The impact on hospital costs and postoperative length of stay (between 3 and 20 additional days) is considerable.
 - The infection is usually acquired during the operation itself; either exogenously (e.g. from the air, medical equipment, surgeons and other staff), endogenously from the flora on the skin or in the operative site or, rarely, from blood used in surgery. The infecting microorganisms are variable, depending on the type and location of surgery, and antimicrobials received by the patient.
 - The main risk factor is the extent of contamination during the procedure (clean, clean contaminated, contaminated, dirty), which is to a large part dependent on the length of the operation, and the patient's general condition.
 - Other factors include the quality of surgical technique, the presence of foreign bodies including drains, the virulence of the microorganisms, and concomitant infection at other sites, the use of preoperative shaving, and the experience of the surgical team.
 - Nosocomial pneumonia
 - Nosocomial pneumonia occurs in several different patient groups. The most important are patients on ventilators in intensive care units, where the rate of pneumonia is 3% per day. There is a high case fatality rate associated with

ventilator-associated pneumonia, although the attributable risk is difficult to determine because patient comorbidity is so high. Microorganisms colonize the upper airway and bronchi, and cause infection in the lungs.

- (Pneumonia): they are often endogenous (digestive system or nose and throat), but may be exogenous, often from contaminated respiratory equipment
- Other nosocomial infections
- These are the four most frequent and important nosocomial infections, but there are many other potential sites of infection. For example
- Skin and soft tissue infections: open sores (ulcers, burns and bedsores) encourage bacterial colonization and may lead to systemic infection.
- Gastroenteritis is the most common nosocomial infection in children, where rotavirus is a chief pathogen: Clostridium difficile is the major cause of nosocomial gastroenteritis in adults in developed countries .
- Sinusitis and other enteric infections infections of the eye and conjunctiva.
- Endometritis and other infections of the reproductive organs following childbirth.

Infection control programs

- Hospital programs
The major preventive effort should be focused in hospitals and other health care facilities.

Risk prevention for patients and staff is a concern of everyone in the facility, and must be supported at the level of senior administration. A yearly work plan to assess and promote good health care, appropriate isolation, sterilization, and other practices, staff training, and epidemiological surveillance should be developed.

- Hospitals must provide sufficient resources to support this programme.
- Infection Control Committee

An Infection Control Committee provides a forum for multidisciplinary input and cooperation, and information sharing. This committee should include wide representation from relevant programmes: e.g. management, physicians, other health care workers, clinical microbiology, pharmacy, central supply, maintenance, and housekeeping, training services.

- The committee must have a reporting relationship directly to either administration or the medical staff to promote program visibility and effectiveness. In an emergency (such as an outbreak), this committee must be able to meet promptly. It has the following tasks:
- to review and approve a yearly program of activity for surveillance and prevention.
- to review epidemiological surveillance data and identify areas for intervention
- to assess and promote improved practice at all levels of the health facility.
- to ensure appropriate staff training in infection control and safety
- Nosocomial infection surveillance
- The nosocomial infection rate in patients in a facility is an indicator of quality and safety of care. The development of a surveillance process to monitor this rate is an essential first step to identify local problems and priorities, and evaluate the effectiveness of infection control activity. Surveillance, by itself, is an effective process to decrease the frequency of hospital-acquired infections.
- Improvements in health care with increased quality and safety but changes in care with new techniques, new pathogens or changes in resistance, increased patient acuity, ageing population, etc.
- Need for active surveillance to monitor changing infectious risks and identify needs for changes in control measures.
- Dealing with outbreaks
- An outbreak is defined as an unusual or unexpected increase of cases of a known nosocomial infection or the emergence of cases of a new infection. Outbreaks of nosocomial infection should be identified and promptly investigated because of their importance in terms of morbidity, costs and institutional image. Outbreak investigation may also lead to sustained improvement in patient care practices.
- Identifying an outbreak
- Early identification of an outbreak is important to limit transmission among

patients by health care workers or through contaminated materials. A potential problem may be initially identified by nurses, physicians, microbiologists, or any other health care worker, or through a nosocomial infection surveillance programme.

- Appropriate investigations are required to identify the source of the outbreak, and to implement control measures. The control measures will vary depending on the agent and mode of transmission, but may include isolation procedures or improvements in patient care or environmental cleaning.
- Immediate control measures for outbreak management
- Type of transmission suspected Suggested action
- Cross-transmission (transmission between individuals); Patient isolation and barrier precautions determined by infectious agent(s).
- Hand transmission ;Improvements in hand washing; cohorting
- Airborne agent; Patient isolation with appropriate ventilation
- Agent present in water; waterborne agent Checking of water supply and all liquid containers, Use of disposable devices.
- Foodborne agent; Elimination of the food at risk
- Prevention of nosocomial infection
- Prevention of nosocomial infections requires an integrated, monitored, programme which includes the following key components:
- Limiting transmission of organisms between patients in direct patient care through adequate hand washing and glove use, and appropriate aseptic practice, isolation strategies, sterilization and disinfection practices, and laundry controlling environmental risks for infection.
- Protecting patients with appropriate use of prophylactic antimicrobials, nutrition, and vaccinations
- Limiting the risk of endogenous infections by minimizing invasive procedures , and promoting optimal antimicrobial use.
- surveillance of infections, identifying and controlling outbreaks
- Prevention of infection in staff members
- Enhancing staff patient care practices, and continuing staff education.
- Infection control is the responsibility of all health care professionals — doctors, nurses, therapists, pharmacists, engineers and others.
- Optimal “hand hygiene” requirements
- For hand washing:
- Running water: large washbasins which require little maintenance, with anti splash devices and hands-free controls products: soap or antiseptic depending on the procedure facilities for drying without contamination (disposable towels if possible).
- For hand disinfection:
- Specific hand disinfectants: alcoholic rubs with antiseptic and emollient gels, which can be applied to physically clean hands.
- There must be written policies and procedures for hand washing.
- Jewellery must be removed before washing. Simple hygiene procedures may be limited to hands and wrists;
- Surgical procedures include the hand and forearm.
- Personal hygiene
- All staff must maintain good personal hygiene. Nails must be clean and kept short. False nails should not be worn. Hair must be worn short or pinned up. Beard and moustaches must be kept trimmed short and clean.
- Working clothes
- Staff can normally wear a personal uniform or street clothes covered by a white coat. In special areas such as burn or intensive care units, uniform trousers and a short-sleeved gown are required for men and women. In other units, women may wear a short-sleeved dress.
- The working outfit must be made of a material easy to wash and decontaminate. If possible, a clean outfit should be worn each day. An outfit must be changed after exposure to blood or if it becomes wet through excessive sweating or other fluid exposure.
- Masks

- Masks of cotton wool, gauze, or paper are ineffective.
- Paper masks with synthetic material for filtration are an effective barrier against microorganisms.
- Masks are used in various situations; mask requirements differ for different purposes.
- Patient protection: staffs wear masks to work in the operating room, to care for immune-compromised patients, to puncture body cavities. A surgical mask is sufficient.
- Staff protection: staff must wear masks when caring for patients with airborne infections, or when performing bronchoscopies or similar examination. A high-efficiency mask is recommended.
- Patients with infections that may be transmitted by the airborne route must use surgical masks when outside their isolation room.