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**Review Article**

# Nosocomial Infection - A Review

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## ABSTRACT

Nosocomial infections or healthcare associated infections occur in patients under medical care. These infections occur worldwide both in developed and developing countries. Nosocomial infections accounts for 7% in developed and 10% in developing countries. As these infections occur during hospital stay, they cause prolonged stay, disability, and economic burden. Frequently prevalent infections include central line-associated bloodstream infections, catheter-associated urinary tract infections, surgical site infections and ventilator-associated pneumonia. Nosocomial pathogens include bacteria, viruses and fungal parasites. According to WHO estimates, approximately 15% of all hospitalized patients suffer from these infections. During hospitalization, patient is exposed to pathogens through different sources environment, healthcare staff, and other infected patients. Transmission of these infections should be restricted for prevention. Hospital waste serves as potential source of pathogens and about 20%–25% of hospital waste is termed as hazardous. Nosocomial infections can be controlled by practicing infection control programs, keep check on antimicrobial use and its resistance, adopting antibiotic control policy. Efficient surveillance system can play its part at national and international level. Efforts are required by all stakeholders to prevent and control nosocomial infections.

## INTRODUCTION

The term nosocomial is derived from two Greek words: "komeion," which means "to take care of," and "nosus," which means "disease." "Nosocomial" refer to any illness that a patient shrinks while receiving clinical attention. It is the infections that have become lodged in a medical facility and may have their origins in living things. When a patient receiving medical attention in a distant health care administrative centre or clinic develops "nosocomial" or "medical care associated infections," it is considered a medical emergency. It may occur during the patient's transfer to another hospital for another infection or even after they are released from care. In patients who are free of contaminations at the time of

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admission, it appears at least 48 hours following hospital admission. [1]. Nosocomial infections, often also known as "healthcare associated infections" (HCAI), manifest in a patient receiving medical attention in a hospital or other healthcare institution that was not present at the time of admission. These infections may develop both during the course of treating another illness and even after the patient is released from the hospital. They also include infections acquired through work among medical personnel [1]. These infections are linked to invasive medical devices used in contemporary healthcare, such as ventilators and catheters.[2].

In India, nosocomial infections occur in 10–20% of admitted patients [3]. ICUs continue to be the principal locations for healthcare-associated infections (HAIs), accounting for 25% of all hospital infections [4]. Staphylococcus aureus is the most frequent cause in a clinical setting [5]. The growing patient load in hospitals, coupled with inadequate sanitary procedures and circumstances, is a major contributing factor to the same [6]. One major avenue for the selective expansion of resistant bacteria resulting from acquired mutations is the treatment of bacterial illnesses, which is predominantly done with non-susceptible antibiotics without prior testing [5]. Recurrent infections in these patient groups are mostly caused by the severity of the disease and frequent exposure to treatment procedures among ICU patients. [7]. Research indicates that the emergence of more antimicrobial-resistant strains of neonatal illnesses is encouraged by nosocomial transmission, which is a leading cause of infant mortality in India. [8]. Although an external source is more frequent, an endogenous source can also cause an illness. Individuals with diabetes, intubation, drainage, and older populations with impaired immune systems are especially vulnerable [4, 6]. Among the common HAIs are still catheter-related UTIs, bloodstream infections linked to intravenous lines, and ventilator-associated pneumonia (VAP) [9].Long-term surgical procedures, nutritional deficiencies, cardiac cachexia, and hypothermia all contribute to this, which raises the estimated cost of therapy while also increasing the mortality rate [10]. As to the National Nosocomial Infections Surveillance System (NNIS), surgical site infections (SSI) rank third among the most frequently reported health-related illnesses in India. [11]. Immunocompromised organisms that are inherently non-pathogenic can occasionally manifest as HAI. Both epidemics and endemics can result in nosocomial infections [12]. It makes sense that illnesses contracted by medical staff are nosocomial [13]. Even though the ICU makes up fewer than 10% of all hospital beds, 20% of nosocomial infections happen there [4]. Varying ICUs and topographies have significantly varying rates and prevalence of nosocomial infections and resistance grades [14]. The burden of HAI has increased revenue-wise for low- and middle-income countries.[15–17]. Research indicates that lengthier stays in the intensive care unit due to HAI were linked to twice as high treatment expenditures [18]. Additionally, it is observed that one nosocomial infection affects 15 out of every 100 admitted patients, and that one in ten of these patients die [19]. This can be attributed to the necessity for more diagnostic testing, extended hospital stays, and expensive medications for infections that are resistant to several drugs [20]. Crude mortality from HAI is a significant contributor, accounting for 23.6% of cases [21]. Moreover, eliminating the HAI is not feasible; prevention, early detection, and control of spread set out to be the best measures.

**2. Types of nosocomial infections**

The most frequent types of infections include central line-associated bloodstream infections, catheter-associated urinary tract infections,

surgical site infections and ventilator-associated pneumonia. A brief detail of these is given below:

**2.1 Central line-associated bloodstream infections (CLABSI):**

The fatal nosocomial illness known as CLABSIs has a death incidence rate ranging from 12% to 25% [8]. Central line catheters are used to provide medication and fluids, but long-term use can result in dangerous bloodstream infections, which can worsen health and raise medical expenses [9]. Despite a 46% decline in CLABSI in US hospitals between 2008 and 2013, an estimated 30,100 CLABSI still happen on ICU and acute care unit wards annually in the US. [10].

**2.2. Catheter associated urinary tract infections (CAUTI):**

The most common kind of nosocomial infection worldwide is CAUTI [11]. Acute care hospital statistics from 2011 show that over 12% of infections that are reported are UTIs [12]. Patients' endogenous natural microbiota is what causes CAUTIs. The placement of catheters inside the body allows bacteria to enter through the conduit, but the inadequate drainage from the catheter leaves some urine volume in the bladder, stabilising the bacterial residence [11]. For male patients, CAUTI can lead to complications such orchitis, epididymitis, and prostatitis; for all patients, it can cause pyelonephritis, cystitis, and meningitis. [12].

**2.3.Surgical Site Infections (SSI):**

Surgical site infections, or SSIs, affect 2-5% of patients after surgery. These are the second most prevalent kind of nosocomial infections, primarily brought on by Staphylococcus aureus, which increase the risk of death and lengthen hospital stays [13]. The patient's endogenous microflora is the source of the infections that cause SSI. The incidence could reach 20%, contingent on the method and surveillance standards applied. [14].

**2.4 Ventilator associated pneumonia (VAP):**

Pneumonia and other respiratory or lung infections are often associated with the use of a ventilator and account for 22% of all HAIs. A ventilator assists the patient with breathing with tubes which enter the body via the mouth, nose, or incision in the throat. Germs can enter the ventilator and therefore be transported to the lung.

**2.4.Gastrointestinal tract infections:**

The gastrointestinal tract is an organ system made up of all the organs responsible for digesting food and excreting waste. These organs are home to billions of naturally-occurring bacteria, including *E. coli*. When the healthy balance of these bacteria is upset (for example, by the use of antibiotics), or a foreign bacteria is introduced, infection can set in. GI infections lead to contaminated waste as the body tries to remove the infection in the form of vomit and diarrhea. This waste can lead to further contamination, especially if cleaning is not thorough and frequent.

**3. Nosocomial Pathogenesis**

**3.1. Bacteria: The** most well-known microorganisms that can cause nosocomial infections are bacteria. Some are related to the patient's natural flora and cause disease only when the patient's immune system becomes predisposed to illness. ICU diseases are caused by a class of pathogenic microorganisms called acinetobacter. It is present in 80% of reported contaminations in soil, water, and records. In the abdomen lies a commensal bacterium called Bacteroides fragilis. When combined with other germs, it might become contaminated. [3]. If Enterobacteriaceae are spread from the gut, where they are normally found, they can become a source of infections in other parts of the body. It is made up of Klebsiella species and Escherichia coli. Methicillin-resistant S. aureus (MRSA) spreads by hands contaminated with germs, open wounds, and direct contact. It begins with sepsis and pneumonia and spreads to other organs or the circulatory system. This has a high level of resistance to beta lactam antibiotics.

The primary cause of Clostridium difficile-induced colon inflammation, colitis, and diarrhoea is the endosymbiotic bacteria that replace helpful microorganisms in the colon. Medical personnel handling infected patients can spread C. difficile to others by using improperly cleansed hands. [4, 5].

**3.22. Viruses: A** significant contributing factor to this infection, aside from bacteria, is infections. Regular investigation reveals that viruses are to blame for 5% of these diseases. They can exchange information by hand-mouth, respiratory, or fecal-oral routes. The persistent illness spread by this is hepatitis. Hepatitis infections are given and transferred to patients and labourers by therapeutic institutions. Risky infusion practices are typically used to spread hepatitis B and C. Other illnesses include the flu, rotavirus, HIV, and herpes simplex infection. [6, 7].

**3.3. Fungal: It** functions as an opportunistic bacterium that causes these infections in individuals with weakened immune systems. Aspergillus species have the ability to spread illnesses through ecological means. Candida albicans and Cryptococcus neoformans are also susceptible to infection during an emergency. Whereas Candida infections originate from the patient's own endogenous microbiota, Aspergillus contaminations are nearly entirely spread by inhaling parasite spores from contaminated air during construction or renovation of medical facilities. [8]

**3.4. Parasites:** It has been observed that parasites are the etiological agents of diarrhoea. Protozoa, such as Cryptosporidium sp., Entamoeba histolytica, Giardia lamblia, and Blastocystis, are typically responsible for contaminations. Food and water tainted with excrement can transmit protozoa that cause loose diarrhoea. One agent that may be responsible for watery nosocomial parasite illness is T. gondii. Transfusion-related nosocomial illness transmission is another plausible explanation. The Plasmodium species is the most well-known blood parasite that can spread by transfusion. It is occasionally possible to get nosocomial parasite infections from contaminated medical clinic equipment. There have been cases of injectors, contaminated gloves, and bedside glucometers spreading Plasmodium, a class of protozoans. It has also been reported that S. stercoralis has been transmitted from tainted endoscopes. [9].

**4. Epidemiology of nosocomial infection:** Numerous patients worldwide are impacted by nosocomial infections, which dramatically increase mortality rates and financial losses. About 15% of hospitalised patients had these illnesses, according to estimates provided by the WHO [23]. With an incidence rate of 75% in South-East Asia and Sub-Saharan Africa, these illnesses account for 4%–56% of all neonatal death causes [1]. In high-income nations, the incidence ranges from 3.5% to 12%, whereas in middle-class and low-income nations, it varies from 5.7% to 19.1%. While the incidence of infections in neonates is three to twenty times greater, the frequency of infections overall is three times higher in low-income nations than in high-income countries. [24].

**5. Transmission**

| **Main routes of transmission** | |
|---|---|
| **Route** | **Description** |
| Contact transmission | The most important and frequent mode of transmission of nosocomial infections is by direct contact. |
| Droplet transmission | Transmission occurs when droplets containing microbes from the infected person are propelled a short distance through the air and deposited on the patient's body; droplets are generated from the source person mainly by coughing, sneezing, and talking, and during the performance of certain procedures, such as bronchoscopy. |

| | |
|---|---|
| Airborne transmission | Dissemination can be either airborne droplet nuclei (small-particle residue {5 µm or smaller in size} of evaporated droplets containing microorganisms that remain suspended in the air for long periods of time) or dust particles containing the infectious agent. Microorganisms carried in this manner can be dispersed widely by air currents and may become inhaled by a susceptible host within the same room or over a longer distance from the source patient, depending on environmental factors; therefore, special air-handling and ventilation are required to prevent airborne transmission. Microorganisms transmitted by airborne transmission include *Legionella*, *Mycobacterium tuberculosis* and the rubeola and varicella viruses. |
| Common vehicle transmission | This applies to microorganisms transmitted to the host by contaminated items, such as food, water, medications, devices, and equipment. |
| Vector borne transmission | This occurs when vectors such as mosquitoes, flies, rats, and other vermin transmit microorganisms. |

1. Contact transmission is divided into two subgroups: direct-contact transmission and indirect-contact transmission.

| **Routes of contact transmission** | |
|---|---|
| **Route** | **Description** |
| Direct-contact transmission | This involves a direct body surface-to-body surface contact and physical transfer of microorganisms between a susceptible host and an infected or colonized person, such as when a person turns a patient, gives a patient a bath, or performs other patient-care activities that require direct personal contact. Direct-contact transmission also can occur between two patients, with one serving as the source of the infectious microorganisms and the other as a susceptible host. |
| Indirect-contact transmission | This involves contact of a susceptible host with a contaminated intermediate object, usually inanimate, such as contaminated instruments, needles, or dressings, or contaminated gloves that are not changed between patients. In addition, the improper use of saline flush syringes, vials, and bags has been implicated in disease transmission in the US, even when healthcare workers had access to gloves, disposable needles, intravenous devices, and flushes.[12] |

**6. Determinants**

The setting in which treatment is provided; the patient's state and vulnerability, and the staff's and healthcare professionals' ignorance of such prevalent infections are risk factors that determine nosocomial infections.

**6.1 Environment**

Poor hygienic conditions and inadequate waste disposal from health care settings.

**6.2 Susceptibility**

Immunosuppressant in the patients, prolonged stay in intensive care unit, and prolonged use of antibiotic.

**6.3 Unawareness**

Improper use of injection techniques, poor knowledge of basic infection control measures, inappropriate use of invasive devices (catheters), and, lack of control policies[25]. In low income countries these risk factors are associated with poverty, lack of financial support, understaffed health care settings and inadequate supply of equipments [5].

**7. Prevention of nosocomial infection**

Being a significant cause of illness and death, nosocomial infections need to be prevented from the base line so that their spread can be controlled.

**7.1Transmission from environment: An** unclean atmosphere is the ideal setting for harmful

organisms to proliferate. Food, drink, and the air can all become polluted and spread to people receiving medical care. Policies must be in place to guarantee that windows, doors, floors, beds, bathtubs, toilets, and other medical equipment are cleaned and cleaned with cleaning products. Airborne bacterial pollution can be removed using fresh, filtered air that is properly vented. It is necessary to maintain and record the regular inspection of the ventilation systems and filters in the general wards, surgical rooms, and intensive care units. The reason behind infections linked to water is that medical facilities don't satisfy the required standards. microbiological surveillanceTechniques ought to be applied while analysing water. Patients who are infected need to take separate baths. Food-borne illnesses can result from improper food handling practices. The meal should be of a standard that is met, and the area should be cleaned. [22].

7.2**Transmission from staff:**

Healthcare personnel may transmit infections to others. Healthcare workers have a responsibility to participate in infection control. Everybody needs to practise good personal hygiene; therefore employees should do the same. After coming into contact with sick people, one must properly decontaminate their hands with hand disinfectants. Sterilised equipment and safe injection techniques must to be employed. It is imperative for healthcare providers to wear masks, gloves, head coverings, or appropriate uniforms.[22]

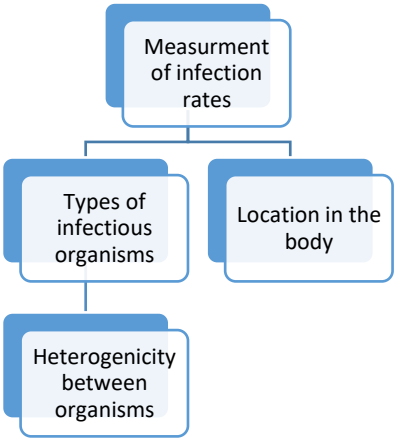
7.3**Hospital waste management:**

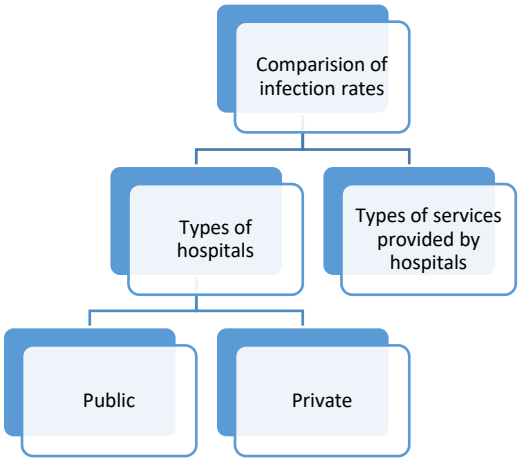
Hospital waste presents a risk of harbouring germs and should be handled carefully. Hazardous waste makes around 10–25% of the garbage produced by healthcare facilities. Healthcare waste that is infectious should be kept in a location with limited access. Waste from surgeries, infected people, contaminated with blood and sputum, and diagnostic lab waste—all of which have a high concentration of heavy metals—must be disposed of separately. Cleaners and healthcare personnel should be made aware of the risks associated with trash and how to properly manage it.[22].

8. **Control of nosocomial infection**

There is a 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 and its implementation for control [3].

8.1**Measurement and comparison of infection rates:** Measuring infection rates in various hospital settings is challenging. It is crucial to understand the kinds of microorganisms involved and their precise location within a person's body in order to measure infection rates. Because of their inherent heterogeneity, infectious organisms differ from one another. It is plausible that infection rates inside a hospital may exhibit similarities, albeit significant differences in the location and variability of organisms. Since infection rates differ between public and private hospitals, it is necessary to know the type of healthcare setting in order to compare the infection rates. Furthermore, there are significant differences in how infections are managed in various facilities.






**8.2 Guidelines for control of nosocomial infection.**

| S. No | Guidelines |
|---|---|
| 1. | Aprons to be removed by all the physicians prior to their entry into the intensive care units (ICU'S) |
| 2. | Mandatory use of shoe covers by all staff and visitors before entering the intensive care units |
| 3. | Disinfection of the stethoscope using an alcohol swab after examining each patient |
| 4. | Dry mops instead of brooms to be used in all the ICU'S by the hospital housekeepers |
| 5. | Instead of saline wash, heplocks should be used to flush intravenous (IV) lines |
| 6. | Sterile drapes for all the Incubatory procedures |
| 7. | Cloth masks and caps to be substituted with disposable caps and masks |
| 8. | Provision of N-95 masks for all open cases of tuberculosis |
| 9. | Color coding stickers for identification of infected patients |
| 10. | Use of spacers for nebulization of patients on ventilators |
| 11. | The housekeeping, nursing staff, and technicians in critical areas have to be vaccinated against Hepatitis-B |
| 12. | Regular monitoring of fumigation practices in the intensive care units |
| 13. | Implementation of air sampling in the operation theatresand intensive care units |
| 14. | Methicillin-resistant Staphylococcus aureus (MRSA) policy was executed |
| 15. | Antifungal painting to protect the exterior surfaces from microbial activity |
| 16. | Disinfection of all surgical instruments using Korsolex |

## 9. Antimicrobial use and resistance

Microbes are microscopic organisms that are too small for human vision, although they are present all over the planet. Antimicrobial medications are used to combat pathogenic bacteria that pose a threat to living things. Antimicrobial resistance is the result of bacteria learning to withstand the effects of medications; they continue to multiply and are not destroyed.

### 9.1 Appropriate antimicrobial use:

The use of antibiotics in treating disease is widespread. The use of antibiotics should support a correct clinical diagnosis or a bacterium that causes infection. Office-based physicians prescribe over 100 million courses of antibiotics annually, of which roughly half are unnecessary, according to estimates from the Centres for Disease Control and Prevention (CDC). Antimicrobial selection should take into account the pathogen and disease characteristics as well as the patient's tolerance. Using a medication that is selectively active against the most likely infection and least likely to result in resistance and side effects is the goal of antimicrobial therapy. When applicable, i.e., before surgery, antimicrobial prophylaxis should be given to lower the postoperative incidence of surgical site infections. Prolonged prophylaxis is used in

immunocompromised patients until immunological markers are restored.

**9.2. Antibiotic resistance:**

In the Southeast Asian region, antibiotic resistance is the cause of one child's death every five minutes. Medication used to cure fatal diseases is no longer as effective since drug-resistant germs are growing. The primary causes of the rise in resistance include self-medication with antibiotics, improper dosing, prolonged usage, a lack of standards for healthcare staff, and abuse in animal husbandry. This resistance jeopardises the ability to effectively combat the germs that cause bloodstream infections, pneumonia, and UTIs. High incidence rates of nosocomial infections are caused by highly resistant bacteria, such MRSA, or multidrug-resistant Gram-negative bacteria. Reports from the South-East Asian region show that K. pneumoniae and E. Col have a high level of resistance to third-generation cephalosporins, and more than 25% of Staphylococcus aureus infections are resistant to methicilin. Dr. Poonam Khetrapal Singh, Regional Director of WHO South-East Asia Region, stated that "immediate action is needed to stop the world from heading towards pre-antibiotic era in which all achievements made in prevention and control of communicable diseases will be reversed."

**9.3. Antibiotic control policy :**

Antibiotic abuse and misuse are the primary causes of the global pandemic of antibiotic resistance, posing a threat to both illness prevention and treatment. The World Health Organization's global report on antibiotic resistance emphasises the need of immunisation to lower the need for antibiotics and the prevention of infection through improved hygiene, clean water, and vaccination. Healthcare facilities must create new diagnostics and other technologies in order to remain ahead of the emerging resistance. When an antibiotic is indeed needed, chemists should do their part to prescribe it, and legislators should encourage communication and collaboration among all parties involved.

**10. Surveillance of nosocomial infection**

Even if the goal of the infection prevention and control programme is to eliminate nosocomial infections, epidemiological surveillance is still necessary to show that performance improvement has occurred. Effective surveillance techniques involve having skilled data collectors gather information from a variety of sources. This information should include administrative data, patient histories, diagnostic testing, demographic risk factors, and data validation. After the data is extracted, the gathered information should be analysed, and this involves comparing incidence rates, describing the determinants, and determining the distribution of infections. Infection control committees, management, and laboratories should share feedback and reports following analysis while maintaining the privacy of individuals. The assessment of the reliability of monitoring systems is necessary for the efficient execution of interventions and their ongoing maintenance. Lastly, it should be mandatory to collect data at regular intervals in order to maintain the effectiveness of monitoring systems.

## CONCLUSION

The incidence of nosocomial infections and antibiotic resistance has increased, making it more challenging for infection control committees and healthcare administrations to achieve the objective of eliminating intervals. Nonetheless, the resistance of new pathogens to antibiotics can be readily decreased by implementing the safe and sound care delivery practices that infection control committees have established, limiting the spread of these illnesses through the use of the proper antimicrobial techniques. Healthcare facilities can create infection control programmes with the use of an effective surveillance technique that follows WHO guidelines. Reducing nosocomial infections can also be achieved through educating the public

about these endemic pathogens, educating hospital staff about biosafety, managing waste appropriately, and implementing healthcare reforms.

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