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THE SPREAD OF NOSOCOMIAL INFECTION IN INTENSIVE CARE UNITS AND THE ROLE OF THE INFECTIOUS DEPARTMENT IN CONTROLLING IT IN TERTIARY CARE HOSPITALS

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ABSTRACT

Illnesses that contract while seeking treatment at a healthcare facility or from a healthcare worker are known as healthcare-acquired illnesses (HAIs). In the 48 hours after being admitted to the hospital, symptoms typically start to appear. Viral, fungal, and bacterial infections are among common nosocomial illnesses. Other common hospital-acquired diseases are pneumonia, meningitis, and gastroenteritis. Exogenous transmission results from interpersonal contact and environmental pollution, whereas endogenous transmission is caused by the inappropriate or excessive use of broad-spectrum antibiotics. In the intensive care unit (ICU), patients use ventilators, central venous catheters, and Foley catheters. High-risk groups include the elderly and people with compromised immune systems. Multiple comorbidities and frequent hospital visitsare additional concerns. If the person become ill if these infections enter into bloodstream, lungs, skin, urinary tract, or digestive tract. These infections can, in the worst situations, be fatal. For eg: When bacteria from Methicillin-resistant Staphylococcus aureus (MRSA) enter into circulation via a catheter or medical tube put into vein, they can result in a bloodstream infection. In hospitals across the United States, catheter-associated urinary tract infections (CAUTIs) make up 35% of all healthcare-associated illnesses. HCAIs pose a serious risk to patients, staff, and visitors. Infection management and prevention should therefore be given top importance.

KEYWORDS: Healthcare-acquired illnesses, Sepsis, Antimicrobial resistance, Antiseptics and Disinfectants.

1. INTRODUCTION

Nosocomial infections, also called hospital-acquired infections (HAIs) or health-care-associated infections, occur when a patient develops an infection during their stay at a healthcare facility. It is well known that these infections are a major cause of morbidity and mortality in critically ill patients. Several reasons for hospital-acquired infections include urinary tract infections, bloodstream infections (BSIs), the incidence of multidrug-resistant bacteria, etc.MDR bacteria caused about one-third of the infectious episodes. Critically ill patients with COVID-19 are at high risk of HAIs, especially VAP and BSIs, which are frequently brought on by MDR bacteria.[1,11]

Other uncommon causes include the use of antibiotic drugs, catheters that line the urinary and central venous systems, and equipment like ventilators. ICUs have been found to have a high incidence of nosocomial infections (NI). Patients in the intensive care unit (ICU) who exhibit clinical symptoms of a secondary infection but lack microscopic evidence (e.g., a new fever, increased tracheal secretion that is purulent, bronchoscopy findings of purulent or hemorrhagic secretions or aspiration, or bacterial pneumonia) are thought to have culture-negative respiratory infections.

The most frequent causes of community-acquired bacterial pneumonia were Streptococcus pneumoniae and Staphylococcus aureus, whereas the leading causes of hospital-acquired infections were Enterobacteriaceae and non-fermenters.[1-5]

2. ETIOLOGY

Why do hospital-acquired infections occur? Healthcare providers may help spread infections from patient to patient. For instance, everyday items like stethoscopes can get dirty and cross-contaminate patients. Inadequate staff training, overcrowding, and ignorance are among additional factors that might contribute to the spread of illnesses. Another way that germs can enter the body and cause an infection is through a surgical incision, breathing tube, or urine catheter. (8)HAIs are frequently linked to hard-to-treat pathogens like methicillin resistant

Staphylococcus aureus (MRSA), gram-negative bacteria that produce extended-spectrum beta-lactamases (ESBLs), including multi-drug-resistant (MDR) Acinetobacter spp., Pseudomonas spp., and Enterobacteriaceae. (10) The most frequent gram-positive bacterium was S. aureus, while the most frequent infection was VAP caused by Enterobacterales.[6-9]

Types include the following

S. NO.	Types
1	Catheter-associated urinary tract infections.
2	Sepsis
3	Central line-associated bloodstream infection.
4	Ventilator-associated pneumonia
5	Surgical site infection
6	Clostridium difficile infection

1. Cauti

CAUTI stands for catheter-associated urinary tract infections. Urinary tract infections caused by catheter use are known as CAUTIs. These types are frequently observed. These conditions affect the urethra, kidneys, bladder, and ureters (tube-like structures). A few of the hypothesized pathways for the emergence of CAUTI include intraluminal colonization, retrograde intraluminal ascent, extraluminal periurethral distribution, and biofilms attached to the urinary catheters.

2. Sepsis

Also called Bacteraemia, is a clinical syndrome caused when bacteria enter the bloodstream. Septic shock is a life-threatening condition characterized by hypotension, in addition to organ dysfunction.[7, 8] Patients with HAIs worsened by shock had mortality rates that were almost two times higher, and infected patients experienced longer hospital stays and IMV (mechanical ventilation). As long as 48 hours have passed since the admission, it is considered to be a hospital-acquired bloodstream infection.[13-15]

3. Clabsi

Central line-associated bloodstream infection is referred to as CLABSI. Worldwide, these results in countless fatalities. The medical industry should adhere to some precise rules to put an end to this. Monitoring, Identification and tracking of device-related infections, such as BSIs linked to central lines, are the first steps in the monitoring strategy.[7]

4. Vap

Patients who need oxygen support can develop a lung infection called ventilator-associated pneumonia. The most frequent causes are non-pseudomonal Gram-negative bacteria, Methicillin-resistant Staphylococcus aureus (MRSA), Pseudomonas aeruginosa, and others.

The following are the risk factors for MDR-VAP:

- Length of hospitalization and the presence of septic shock at the time VAP began,
- Acute respiratory distress syndrome and
- Prior to the start of VAP, acute renal replacement treatment.[15]

According to research by Grasselli et al. on COVID-19 hospitalized patients in the ICU, the incidence of HAI (46%) and ventilator-associated pneumonia (VAP) (50%) is very high.

Pneumonia occurring 48 hours or more after hospitalization or endotracheal intubation, respectively, was classified as hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP).Exercises that involve coughing and deep breathing can help avoid lung infections. These exercises can aid in maintaining an open airway and preventing the deterioration of the breathing muscles.[10-12]

5. SSI

Surgical site infection (SSI) is the term for a post-operative infection.

It frequently takes place on the body portion where surgery has been done. Common causative organisms for SSI include-S. aureus, coagulase-negative staphylococcus, Enterococcus, E. coli, Pseudomonas aeruginosa, Enterobacter, and Klebsiella pneumonia. While deep-seated infections are serious and injure tissues, organs, or transplanted material beneath the skin, surface infections only affect the skin.

Prevention: This involves keeping an eye on and avoiding surgery site infections. Surgical site infections (SSI) develop 30 days after the operation.

6. Clostridium difficile infection (cdi)

Clostridium difficile is now understood to be the primary reason for infectious diarrhea linked to healthcare. The intestinal tract is where C. diff is found, and it can spread to infected surfaces. The most significant bacterial cause of gastroenteritis connected to healthcare is Clostridium difficile. One may experience nausea, anorexia, and

abdominal pain with loose, watery stools or bloody stools.

Types of nosocomial infections

There are several types of common nosocomial infections, including bacterial infections, fungal infections, and viral infections.

1. Bacterial infections:

Bacteria are the most common cause of nosocomial infections. common bacteria that are responsible for HAIs are listed below:[2]

Bacteria	Infection type
Staphylococcus aureus (S. aureus)	blood
Escherichia coli (E. coli)	UTI
Enterococci	blood, UTI, wound
Pseudomonas aeruginosa (P. aeruginosa)	kidney, UTI, respiratory

2. Fungal infections: These cause contagious infections. The most common fungi that cause nosocomial infections are Candida and Aspergillus.
3. Viral infections: Viruses can cause severe sickness. Examples include influenza (flu) and respiratory syncytial virus. Children under the age of 3 are most susceptible to developing acute gastroenteritis from rotavirus, which continues to be a cause of gastroenteritis in hospitalized children.[14-16]

Symptoms of nosocomial infections

Patients complain of chills, rigors, giddiness, palpitations, and tiredness. Some people may have no symptoms at all, and regular blood tests that reveal elevated inflammatory markers reveal the infection. Depending on the organ involved, the signs and symptoms may be more specific in other cases.

The HAI infection takes place:

- 48 hours after being admitted to the hospital.
- 3 days following discharge is possible.
- Up to 30 days following surgery

Each form of HAI has a different set of symptoms. The most typical HAI kinds are:

- UTIs (urinary tract infections)
- Pneumonia,
- Meningitis,
- Gastroenteritis, and
- Surgical site infections

These infections' signs and symptoms include:

- Release from the wound
- Heat, Cough, Breathlessness
- Difficulties urinating or a burning sensation when urinating
- Headache
- Diarrhea, vomiting, and nausea
- Inflammation and pain

People who develop new symptoms during their stay may also experience pain and irritation at the infection site. Many people will show obvious signs of illness.[17-18]

Risk factors

Certain factors increase a person's risk of developing a hospital-acquired infection. For instance, there is a higher risk of hospital-associated infections in the elderly and those with weakened immune systems, such as those receiving chemotherapy. Hospital-acquired illnesses can have a number of negative effects, including lengthier hospital stays, higher costs, lost income, and occasionally even death.[8]

Other risks include

- Frequent visits to healthcare facilities,
- Numerous underlying comorbidities,
- Recently performed invasive surgeries,
- Indwelling devices,
- Prolonged ICU stay, and mechanical ventilatory support.[15]

Infections occur about a week after intubation, and their frequency rises with longer stays in the ICU.

Pathophysiology

Some of the proposed mechanisms of CAUTI

The catheter and drainage system's luminal and outer surfaces promote an adhering biofilm of bacteria that ascends into the bladder. Bacteria colonize the catheter and cause infection when the bladder's protective mucous layer is damaged. Bacterial development within these densely packed cohesive biofilms confers a significant degree of relative resistance to antibiotics, which explains why antibiotic therapy has failed.[18]

Some of the proposed mechanisms of CLABSI

Bloodstream infections linked to central lines can spread by

- Colonization,
- Biofilm development, and
- Extraluminal migration.

The femoral site should be avoided if feasible since it carries a higher risk of infection. The biofilm-forming bacteria Staphylococcus aureus and Staphylococcus epidermidis are frequently found on catheters.

Strategies Based on Evidence to Reduce CLABSI

1. Wash your hands with soap and water
2. Full barrier measures for sterile insertion, including a cap, mask, sterile gown, sterile gloves, and a full sterile draping
3. Utilizing a 2% chlorhexidine solution and
4. Avoiding the femoral site for catheterization with sufficient air drying before insertion
5. Timely removal of pointless catheters.[19]

Mode of transmission

1. **Contact transmission:** Direct-contact transmission and indirect-contact transmission are two subcategories of contact transmission.

a. Direct contact transmission- In a clinical environment, direct contact transmission refers to the physical transfer of viruses from an infected person to a susceptible host by direct surface-to-body contact. Direct touch is the most typical HAI transmission method.

b. Indirect contact transmission- A vulnerable host can contract an infection by indirect contact with a contaminated intermediary object, such as contaminated medical equipment.

2. **Airborne transmission:** The infectious agent can be carried by dust particles or airborne droplet nuclei to disseminate an infection. An infected host may breathe in pathogens transported in this way within the same room as the source patient or farther away. Airflow can distribute them broadly.
3. **Common vehicle transmission:** It refers to the spread of microscopic organisms to the host through infected substances such as food, water, drugs, gadgets, and equipment.
4. **Vector-borne transmission:** This happens when pests like rodents, flies, mosquitoes, and other insects spread bacteria.
5. **Droplet transmission:** Transmission happens when the source person produces droplets, primarily through talking, coughing, and sneezing.[20]

Antimicrobial resistance

Antimicrobial resistance (AMR) is the ability of a microbe to resist the effects of medication previously used to treat them.

Mechanism:

1. Large population of microorganisms. Some of them develop antibiotic resistance.
2. Both the disease causing bacteria and the helpful bacteria defending the body against infection are killed by antibiotics.
3. The resistant bacteria now have preferred conditions to grow and take over.
4. It's even possible for bacteria to spread medication resistance to other bacteria.[9]

Treatment for resistant microorganisms becomes more and more challenging, necessitating different drugs or greater dosages. One of the primary risk factors for the emergence of antimicrobial resistance to several medications is a person's recent use of intravenous antibiotics (within the last 90 days). Antibiotics are frequently used in hospitals, which promotes the growth of resistant strains.

Treatment and Management

1. Urinary tract infection

- If at all possible, indwelling catheters should be removed to prevent the spread and persistence of infection.
- In rare circumstances, the removal of the catheter may cause bacteraemia to resolve on its own.
- Consider using empiric antibiotics and antifungal therapy to prevent serious side effects such as pyelonephritis, kidney damage, and bloodstream infections.
- For kids with sepsis, pyelonephritis, or anomalies of the urinary tract, the majority of doctors advise at least 10–14 days of therapy.

2. Bloodstream infections

- Antiviral medication, such as Ganciclovir and Acyclovir, can be utilized to treat suspected disseminated viral infections while antifungal therapy is added to empiric antibiotic coverage.
- It is best to start using antibiotics that have both gram-positive and gram-negative coverage empirically and later adjust them in accordance with the susceptibility patterns of isolated organisms.
- If the line is no longer required, it should be removed.

3. Surgical site infection

- Surgery and antibiotic therapy should be used in conjunction to treat surgical-site infections (SSIs).
- Once culture results are obtained, antibiotic coverage should be adjusted.
- An intensive surgical approach is required for severe infections.
- When care for surgical sites after surgery, effective infection control techniques and good hand hygiene must be used. Additionally, skin decontamination and antibiotic prophylaxis are crucial elements in the prevention of SSI.

4. Pneumonia

- Sputum, endotracheal suction material, and bronchial lavage wash should all be examined and cultured.
- The risk of multidrug-resistant (MDR) infections should be considered while choosing an empiric antibiotic regimen.

5. Clostridium difficile infections

- The medicine of choice is often oral vancomycin.
- An alternative medication is metronidazole. One of the most recent drugs is fidaxomicin. Teicoplanin

and other antibiotics are being considered as alternatives.[15]

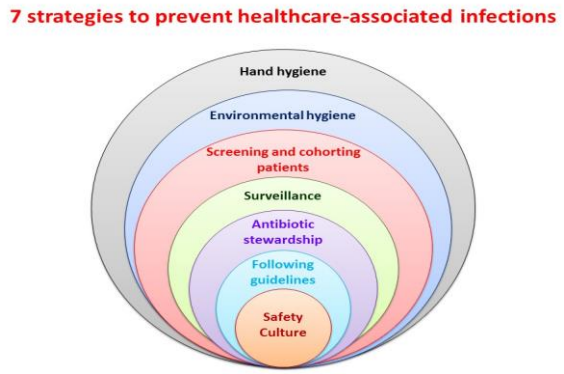
Role of infectious department

Infection control is responsible for preventing and lowering the risk of hospital-acquired infections. Studies show that using adequate hand hygiene reduces the pathogen burden and prevents the spread of HAIs. Ineffective infection control practices increase infection rates, the chance of multidrug-resistant microorganisms, and the potential for outbreaks in certain departments.

How to lower the risk of UTIs

- To reduce infection, use the aseptic insertion technique.[2]
- For undisturbed urine flow, make sure the urinary catheter is fastened above the thigh and hangs below the bladder.
- Catheters should only be inserted when necessary and removed when no longer required.
- Only change catheters or bags when a doctor says to.

It is possible to do this by putting in place infection control strategies like:



1. Surveillance,
2. Outbreak control,
3. Isolation,
4. Environmental cleanliness (The spread of microorganisms like Clostridium difficile and multidrug-resistant organisms like methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant enterococci (VRE) is significantly aided by contaminated hospital surfaces) (30)
5. Screening and cohorting patients (Any infection control approach must include early detection of multidrug-resistant pathogens).
6. Employee well-being,
7. Guidelines, and
8. Policies and practices for managing infections are being developed, put into place, and evaluated with the goal of reducing the risk of HAIs.
9. Antimicrobial Stewardship: reducing antibiotic resistance, enhancing results.
10. Patient safety: It is defined as the absence of patient injury that could have been avoided during the course of medical treatment. A systematic approach is necessary to increase patient safety in hospitals around the world today.

Gram-negative bacterial growth in disinfectants and antiseptics

1. Invasive procedures like surgery (the insertion of intravascular and urinary catheters), or topical treatments like tracheotomies sometimes involve the local application of contaminated antiseptics that might result in infections.
2. Disinfectants spread illnesses when they come into touch with semi-critical (operating instruments, transfer forceps), as well as non-critical (thermometers, multidose vial septa) goods.
3. Hand-borne transmission occurs in the case of liquid soap, i.e., colonization of healthcare workers' hands followed by transfer to patients, resulting in colonization and subsequent infection.

In terms of medicine, an efficient infection control program lowers infection rates and the threat of the emergence of multidrug-resistant pathogens. According to recent studies, alcohol-based hand rubs may help improve hand hygiene practices, and multidisciplinary hand hygiene promotion programs are beneficial.[19-20]

4. CONCLUSION

Infections that typically develop in the hospital environment are called nosocomial infections, or more commonly, hospital-acquired infections. Symptoms are typically seen after 48 hours of admission to the hospital. Causative organisms can be bacteria, viruses, and fungi. Increased age, prolonged ICU stay, frequent hospital visits, a weakened immune system, post-surgery, and multiple comorbidities are considered the top-most risk factors for hospital-acquired infections. The most frequent bacteria found is Staphylococcus aureus, and there are various routes of transmission for these microbes. The signs and symptoms of different hospital-acquired infections (HAIs) differ and depend on the organ involved and the cause. Attachment, colonization, and migration/spread, followed by resistance to antibiotics, are the common pathophysiologies of these infections. Indwelling catheters should be removed when

not in use to prevent spread, and use empiric antibiotics and antifungal therapy for better patient outcomes. Effective infection control techniques and good hand hygiene must be used. Infection control is responsible for preventing and lowering the risk of hospital-acquired infections. It can be done by following certain instructions, like surveillance, outbreak control, isolation, and environmental cleanliness. Policies and practices for managing infections, antimicrobial stewardship, and patient safety. Complete equipment and skin sanitation, frequent hand washing, and wearing safety gear can be considered additional measures.

List of abbreviations

AMR- Antimicrobial resistance
BSIs- bloodstream infections
CAUTIs- Catheter-associated urinary tract infections
CDI- Clostridium difficile infection
ESBLs- Extended-spectrum beta-lactamases
HAIs- Healthcare-acquired illnesses
IMV- Invasive mechanical ventilation
ICU- Intensive care unit
MRSA- Methicillin-resistant Staphylococcus aureus
MDR- Multi-drug-resistant
NI- nosocomial infections
SSI- Surgical site infection
UTIs- Urinary tract infections
VAP- Ventilator-associated pneumonia.

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