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Original Research

Hospital-Acquired Infections: A Literature Review.

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Abstract

Background: *Objective:* To review the epidemiology, risk factors, transmission pathways, prevention strategies, and the role of infection control committees in reducing hospital-acquired infections (HAIs) and improving patient safety in healthcare settings. *Materials and Methods:* A narrative review was conducted using published literature on hospital-acquired infections, infection prevention, and antimicrobial resistance. Relevant studies, guidelines, and reports addressing the incidence, causes, risk factors, occupational exposure, and prevention of HAIs were analyzed. Major HAIs reviewed included catheter-associated urinary tract infections, surgical site infections, ventilator-associated pneumonia, bloodstream infections, and infections caused by multidrug-resistant organisms such as methicillin-resistant *Methicillin-resistant Staphylococcus aureus*, vancomycin-resistant *Enterococcus*, and carbapenem-resistant Gram-negative bacilli. *Results:* Hospital-acquired infections remain a major global public health challenge associated with increased morbidity, mortality, prolonged hospital stay, and rising healthcare costs. Intensive care unit patients and immunocompromised individuals were identified as high-risk groups. Key contributing factors included invasive procedures, prolonged hospitalization, poor hand hygiene, antimicrobial misuse, overcrowding, and environmental contamination. Healthcare workers were also found to be vulnerable to occupational exposure to blood-borne infections such as hepatitis B, hepatitis C, and human immunodeficiency virus through needle-stick injuries and contaminated body fluids. Evidence from recent studies demonstrated that comprehensive infection prevention and control programs, including hand hygiene, environmental cleaning, sterilization practices, surveillance systems, antimicrobial stewardship, and staff education, significantly reduced infection rates and antimicrobial resistance. *Conclusion:* Hospital-acquired infections continue to pose serious challenges to healthcare systems worldwide. Effective prevention requires a multifaceted infection control approach involving strict hygiene practices, rational antimicrobial use, continuous surveillance, environmental sanitation, and regular training of healthcare personnel. Strengthening infection control committees and implementing comprehensive prevention programs are essential for reducing the burden of HAIs and improving patient outcomes.

Keywords: *Hospital-acquired infections, Nosocomial infections, Healthcare-associated infections, Infection control, Antimicrobial stewardship, MRSA, Hand hygiene, Antibiotic resistance.*

Introduction

Hospital-acquired infections (HAIs), also known as nosocomial infections or healthcare-associated infections, are infections that occur during the process of receiving healthcare and were neither present nor incubating at the time of admission.[1] Traditionally, infections appearing after 48 hours of hospitalization are considered hospital acquired.[1] The term "nosocomial" is derived from the Greek words *nosos* meaning disease and *komeion* meaning to care for. Florence Nightingale, who laid the foundation for modern infection control practices, emphasized that hospitals should "do the sick no harm," highlighting the importance of preventing infections within healthcare settings.

HAIs continue to represent one of the most important complications of modern healthcare systems worldwide. According to the World Health Organization (WHO), hundreds of millions of patients are affected by HAIs every year, making them a major cause of morbidity, mortality, and economic burden.[7] The prevalence of HAIs is estimated to range from 5-15% among hospitalized patients globally, with significantly higher rates reported in intensive care units.[7] In low- and middle-income countries, the burden is even greater because of overcrowding, inadequate infrastructure, poor sanitation, and limited infection control resources.[2].

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The emergence of antimicrobial resistance (AMR) has further complicated the management of HAIs. Infections caused by multidrug-resistant organisms (MDROs) such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus faecium* (VRE), extended-spectrum beta-lactamase (ESBL)-producing *Enterobacteriales*, carbapenem-resistant *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* are increasingly encountered in healthcare settings.[9,10] These organisms are associated with increased mortality, prolonged hospitalization, limited therapeutic options, and higher healthcare expenditures.

Healthcare workers are also vulnerable to occupational exposure to infectious agents through contact with contaminated blood, body fluids, respiratory secretions, and sharp instruments.[2] Needle-stick injuries are among the most common occupational hazards in hospitals and can result in transmission of hepatitis B virus, hepatitis C virus, and human immunodeficiency virus (HIV).[2] Consequently, prevention and control of HAIs remain an essential component of patient safety and quality healthcare delivery.

Factors Influencing Hospital-Acquired Infections

The development of hospital-acquired infections is influenced by a complex interaction between microbial virulence, host susceptibility, environmental conditions, and healthcare practices.[1] The characteristics of the infecting microorganism play a crucial role in determining whether infection occurs. Pathogens with greater virulence, higher infective doses, and enhanced resistance to antimicrobial agents are more likely to establish infection.[1] Many HAIs are caused by opportunistic bacteria and fungi that are normally harmless commensals but become pathogenic under favorable conditions.

Patient-related factors significantly contribute to susceptibility to infection. Extremes of age, particularly neonates and elderly individuals, are associated with reduced immune defenses.[1] Patients suffering from chronic illnesses such as diabetes mellitus, malignancy, chronic kidney disease, acquired immunodeficiency syndrome (AIDS), and hematological disorders are at increased risk because of impaired immunity.[1] Immunosuppressive therapy, chemotherapy, radiation therapy, and corticosteroid use further weaken host defenses. Invasive diagnostic and therapeutic procedures such as urinary catheterization, central venous catheter insertion, mechanical ventilation, endotracheal intubation, and surgical interventions breach natural protective barriers and provide direct access for microorganisms into sterile body sites.[8]

Environmental factors within healthcare settings also facilitate the spread of infections. Overcrowding, inadequate ventilation, poor sanitation, frequent patient transfers, contaminated medical equipment, and improper waste disposal contribute to microbial transmission.[2] Hospital surfaces, linen, air-conditioning systems, humidifiers, and healthcare devices may act as reservoirs for pathogenic organisms including *Pseudomonas* spp. and *Acinetobacter* spp.

Sources of Hospital-Acquired Infections

Hospital-acquired infections may arise from endogenous or exogenous sources.[1] Endogenous infections originate from the patient's own microbial flora. Under normal circumstances these microorganisms coexist harmlessly with the host; however, disruption of natural barriers or impaired immunity can allow them to invade sterile tissues and cause infection.[1] Surgical procedures, indwelling catheters, implants, and immunocompromised states facilitate endogenous infections.

Exogenous infections, also known as cross infections, occur through transmission from external sources such as other patients, healthcare workers, visitors, or the hospital environment.[2] Contaminated medical instruments, improperly sterilized equipment, hospital linen, food, water, and airborne particles can serve as vehicles for transmission.[7] Environmental persistence of pathogens plays a significant role in maintaining hospital reservoirs of infection.

Modes of Transmission

Transmission of nosocomial infections occurs through multiple routes.[1] Direct contact transmission is the most common mechanism and usually involves contaminated hands of healthcare workers, infected clothing, or contact with contaminated surfaces and instruments.[4] Failure to perform appropriate hand hygiene remains one of the leading causes of cross transmission in hospitals.[7]

The oral and fecal-oral routes contribute to the spread of gastrointestinal infections, especially in settings with inadequate sanitation or contaminated food and water.[1] Airborne transmission occurs through inhalation of droplet nuclei or aerosols containing infectious agents. Diseases such as tuberculosis, measles, and varicella spread efficiently through airborne routes, particularly in poorly ventilated environments.[7] Aerosols generated by humidifiers, nebulizers, and air-conditioning systems may also disseminate microorganisms.

Parenteral transmission occurs through contaminated blood products, infusion fluids, tissue transplantation, and needle-stick injuries.[2] Healthcare workers handling sharp instruments are particularly vulnerable to blood-borne infections including hepatitis B, hepatitis C, and HIV.

Common Types of Hospital-Acquired Infections

The most frequently encountered HAIs include catheter-associated urinary tract infections (CAUTI), central line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP), and surgical site infections (SSI).[8,10] Catheter-associated urinary tract infections account for nearly 40% of all HAIs worldwide.[8] Surgical site infections remain a significant postoperative complication and are associated with increased morbidity and prolonged hospital stay.[6]

Ventilator-associated pneumonia is common among critically ill patients receiving mechanical ventilation and carries high mortality rates.[10] Bloodstream infections related to intravascular catheters are also major contributors to hospital mortality.[8] Other important HAIs include skin and soft tissue infections, antibiotic-associated diarrhea caused by *Clostridioides difficile*, conjunctivitis, sinusitis, infective endocarditis, and viral hemorrhagic fevers.[10]

Prevention and Control of Hospital-Acquired Infections

Prevention of HAIs requires interruption of the chain of infection involving the infectious agent, mode of transmission, portal of entry, and susceptible host.[1] Hand hygiene remains the cornerstone of infection prevention. The WHO "Five Moments for Hand Hygiene" emphasizes hand cleansing before touching a patient, before aseptic procedures, after exposure to body fluids, after touching a patient, and after touching patient surroundings.[7] Studies have demonstrated that proper hand hygiene alone can reduce HAIs by up to 50%.[2,7]

Standard precautions should be applied to all patients regardless of diagnosis.[7] These precautions include hand hygiene, use of personal protective equipment (PPE), respiratory hygiene, injection safety, and proper handling of contaminated equipment.[2] Gloves, gowns, masks, goggles, and face shields provide protection against exposure to infectious materials.

Transmission-based precautions are additional measures implemented for patients infected with highly transmissible pathogens.[7] Contact precautions are used for infections such as MRSA, while droplet precautions are recommended for influenza and meningococcal infections.[10] Airborne precautions involving negative-pressure isolation rooms and N95 respirators are essential for diseases such as tuberculosis, measles, and chickenpox.[7]

Environmental cleaning and disinfection are critical components of infection prevention.[1] Regular cleaning of frequently touched surfaces, sterilization of medical instruments, and proper biomedical waste management reduce environmental contamination. Common hospital disinfectants include sodium hypochlorite, glutaraldehyde, hydrogen peroxide, and phenolic compounds.[7]

Antimicrobial Stewardship

The irrational use of antibiotics has accelerated the emergence of antimicrobial resistance worldwide.[9] Antimicrobial stewardship programs aim to optimize antibiotic selection, dosing, duration, and route of administration while minimizing unnecessary antibiotic exposure.[9] Evidence suggests that hospitals implementing antimicrobial stewardship programs experience reduced antimicrobial resistance, shorter hospital stays, lower healthcare costs, and improved patient outcomes.[9]

The primary objectives of antimicrobial stewardship include ensuring appropriate antibiotic therapy, reducing adverse drug reactions, preventing secondary infections such as *Clostridioides difficile* colitis, and limiting the spread of resistant organisms.[9] Effective stewardship programs require collaboration between clinicians, microbiologists, pharmacists, infection control teams, and hospital administrators.

Infection Control Committee

Every hospital should establish an Infection Control Committee (ICC) responsible for developing and implementing infection control policies.[1,7] The committee typically includes physicians, surgeons, microbiologists, infection control nurses, pharmacists, and representatives from housekeeping and central sterilization departments.

The ICC is responsible for surveillance of HAIs, outbreak investigation, monitoring antimicrobial resistance patterns, policy development, staff education, and implementation of corrective measures.[1] Surveillance systems may be active, passive, laboratory-based, or clinical-based. Continuous monitoring enables early identification of outbreaks and evaluation of infection control interventions]

Conclusion

Hospital-acquired infections remain a major challenge to healthcare systems worldwide and significantly contribute to patient morbidity, mortality, antimicrobial resistance, and economic burden.[1,2] Increasing use of invasive procedures, prolonged hospitalization, and widespread antimicrobial misuse have further intensified the problem.[9] Multidrug-resistant organisms such as MRSA, VRE, ESBL-producing Enterobacteriales, and carbapenem-resistant Gram-negative bacteria are increasingly associated with severe healthcare-associated infections and poor clinical outcomes.[10]

Effective prevention and control of HAIs require a multidisciplinary and evidence-based approach involving strict hand hygiene, adherence to standard and transmission-based precautions, environmental disinfection, sterilization practices, surveillance programs, and rational antibiotic use.[1,7] Infection control committees and antimicrobial stewardship programs play a vital role in minimizing transmission and reducing antimicrobial resistance within healthcare settings.[7,9] Continuous education and training of healthcare workers, combined with strong institutional policies and surveillance systems, are essential for improving patient safety and reducing the global burden of hospital-acquired infections.

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