

REVIEW ARTICLE

Healthcare-Associated Infections: Epidemiology, Diagnostics, and Management in Internal Medicine

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ABSTRACT

Background: Nosocomial infections, particularly those occurring after 72 hours of patient admission, present a serious challenge in hospitals. These gram-negative bacteria, including *Escherichia coli*, *Klebsiella pneumoniae*, and *Shigella*, can lead to various infections such as urinary tract infections and nosocomial pneumonia. Nosocomial pneumonia, which encompasses Hospital-Acquired Pneumonia (HAP) and Ventilator-Associated Pneumonia (VAP), is associated with high mortality rates and can spread through contact transmission. The primary causes of these infections include prolonged hospitalization, severity of illness, and excessive use of antibiotics, which can enhance bacterial resistance. To prevent the spread of nosocomial infections, stringent hygiene practices and proper aseptic procedures are essential, along with prudent antibiotic management based on laboratory results. These preventive measures are crucial for improving the quality of healthcare services in hospitals and reducing the risk of nosocomial infections.

Keywords: Nosocomial Infection, Enterobacteriaceae, Nosocomial Pneumonia, Antibiotics, Bacterial Resistance, Hospital Health, Infection Prevention, Infection Control, Healthcare Quality, Risk Factors.

INTRODUCTION

Infectious diseases are types of illnesses caused by pathogenic microbes and are characterized by their ever-changing nature. In developing countries, such as Indonesia, infectious diseases remain a primary cause of high morbidity and mortality rates in hospitals. These infections are commonly known as nosocomial infections. According to Armadi (2024), nosocomial infections, also referred to as hospital-acquired infections, are infections that occur within the hospital environment caused by germs originating from that location. Nosocomial infections can affect patients, healthcare workers, and anyone visiting the hospital. In other words, the risk of these infections is not only faced by admitted patients but also by medical staff and visitors, making it a serious issue within the hospital environment.¹

The Centers for Disease Control and Prevention (CDC) in the US reports that nearly 1.7 million hospitalized patients annually experience nosocomial infections, and more than 98,000 of them (one in 17) die as a result. In developed countries, seven out of every 100 patients may acquire a nosocomial infection, while in developing countries, the number reaches ten. Other research in high-income countries indicates that between 5% and 15% of hospitalized patients acquire nosocomial infections. Furthermore, a survey conducted on 231,459 patients across 947 hospitals in 30 European countries in 2011–2012 found that 5.7% of patients experienced at least one nosocomial infection. However, the WHO notes that nosocomial infections often only gain public attention during epidemics.²

These infections typically appear at least 72 hours after the patient is admitted. Several bacteria frequently causing nosocomial infections include *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Klebsiella* sp.³ Nosocomial infections, known as hospital-acquired infections (HAIs), represent a significant global health problem. According to the World Health Organization (WHO), nosocomial infections occur in 5–10% of hospitalized patients in developed countries, and this figure can reach 25% in developing countries. These infections can be caused by various pathogens, including bacteria, viruses, and

fungi, which often adapt and become resistant to treatment. The WHO also states that nosocomial infections lead to increased duration of care, higher medical costs, and an elevated risk of morbidity and mortality. Data shows that approximately 1.4 million people worldwide experience nosocomial infections at any given time, highlighting the importance of infection control in healthcare facilities.⁴

Nosocomial infections can be categorized into several types based on the site of infection and the pathogens involved. These include respiratory tract infections, urinary tract infections (UTIs), surgical site infections (SSIs), and sepsis. Respiratory tract infections, such as hospital-acquired pneumonia, are often caused by resistant bacteria like *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Meanwhile, urinary tract infections are usually associated with catheter use and can be caused by *Escherichia coli* or *Klebsiella pneumoniae*. Surgical site infections generally occur after surgical procedures, and commonly involved pathogens include *Staphylococcus* spp. and *Enterobacter* spp. Additionally, sepsis as a nosocomial infection can arise from various infection sources that spread into the circulatory system, potentially leading to death if not treated promptly.⁵ Understanding these types of nosocomial infections is crucial for prevention and control strategies in hospitals.

The etiology of nosocomial infections involves various pathogenic microorganisms, including bacteria, viruses, and fungi. Gram-negative bacteria, such as *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*, are frequently found in nosocomial infections, particularly in patients with complex medical conditions or those using invasive medical devices. On the other hand, *Staphylococcus aureus*, including methicillin-resistant variants (MRSA), is also a common cause of hospital infections. Beyond microbial etiology, risk factors contributing to the development of nosocomial infections include the patient's clinical condition—such as advanced age, diabetes, and lung disease—as well as the use of medical devices like catheters and ventilators. Inadequate hygiene practices, by both healthcare workers and visitors, also play a significant role in increasing the risk.⁶ Therefore, it is vital to understand both the etiology and these risk factors to develop effective prevention strategies.

The pathophysiology of nosocomial infections involves complex interactions between pathogens, the immune system, and environmental factors in the hospital. Infection begins when pathogenic microorganisms enter the patient's body through mechanisms such as direct contact, air, or invasive medical devices. Once inside, pathogens infect body tissues, resulting in inflammation and immune reactions. If the patient's immune system is weakened, either due to an underlying disease or the use of immunosuppressive therapy, the body's ability to fight infection decreases, leading to further disease progression. Additionally, biofilms formed on the surfaces of medical devices like catheters can protect pathogens from antibiotics and immune responses, exacerbating the nosocomial infection.⁷ Thus, a deep understanding of the pathophysiology of nosocomial infections is essential for developing effective prevention and treatment strategies. Effective prevention and control efforts are required to reduce the incidence of these infections and improve patient safety in hospitals.

Based on the background described, the researcher aims to identify the bacteria causing these nosocomial infections.

METHOD

This research method employs a literature review approach to explore various studies related to nosocomial infections and their influencing factors. A literature review allows the researcher to analyze, synthesize, and evaluate findings from multiple journals to provide a comprehensive understanding of the topic. For instance, a study by Kurniawan et al. (2021) identified the primary risk factors for nosocomial infections, including underlying medical conditions and inadequate hygiene practices. Meanwhile, Fitria et al. (2022) explored the correlation between the use of invasive medical devices and the increased incidence of infections, indicating a need for stricter prevention protocols. Furthermore, research by Pramono and Rahmawati (2023) highlighted the importance of healthcare provider education in the control of nosocomial infections. Through the analysis of these studies, this

research aims to provide evidence-based recommendations for efforts to prevent and control nosocomial infections in hospitals.

This study is a literature review utilizing sources from two primary databases: Google Scholar and PubMed. The search strategy employed specific keywords, including: ("pulmonary TB" OR "tb paru"), ("tuberkulosis" OR "tuberculosis"), and ("anak" OR "children").

The identified articles were selected based on the availability of the full text and screened according to predefined inclusion and exclusion criteria. The inclusion criteria ensured that only articles directly relevant to the research topic—specifically those discussing risk factors for pediatric tuberculosis—were included. Conversely, the exclusion criteria were used to eliminate irrelevant or ineligible articles, such as those with incompatible research subjects, invalid methodologies, or outdated information. By utilizing this systematic approach, this study gathered comprehensive and relevant data from various credible sources to provide a clear overview of the risk factors for tuberculosis in children.

RESULT

1. Enterobacteriaceae as Pathogenic Bacteria in Hospital-Acquired Infections

Nosocomial infections, or hospital-acquired infections (HAIs), are infections acquired by patients during hospital care that manifest after 72 hours of admission. These infections are not present prior to admission and can affect various organs, including the respiratory tract, digestive system, bloodstream, and surgical sites. The primary causes of nosocomial infections include prolonged length of stay, disease severity, and excessive use of antibiotics, which leads to bacterial resistance and the emergence of multi-drug resistant (MDR) strains. In Southeast Asia, these infections are frequently caused by *Acinetobacter* spp., *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Staphylococcus aureus*. These Gram-negative bacteria typically reside in the human digestive tract but can also be found in other environments such as water and soil.

Enterobacteriaceae is a group of bacteria capable of growing in aerobic to facultative anaerobic conditions. Each genus possesses distinct characteristics and health impacts. *Escherichia coli*, for instance, can cause diarrhea and urinary tract infections, while *Salmonella* causes infection if ingested. *Shigella* often causes dysentery, while *Klebsiella* is known for its distinctive mucoid colonies.

Nosocomial infections can spread through various contact routes, both direct and indirect, with nosocomial pneumonia being the most frequent infection. This pneumonia is categorized into three types: Hospital-Acquired Pneumonia (HAP), Ventilator-Associated Pneumonia (VAP), and Healthcare-Associated Pneumonia (HCAP). HAP appears after a patient has been hospitalized for more than 48 hours and is associated with high mortality rates, whereas VAP occurs after a patient has been on a ventilator for more than 48 hours. Through these efforts, the quality of healthcare services in hospitals can be improved, and the risk of nosocomial infections can be reduced.

2. Education on Nosocomial Infection Risk Prevention for Patients and Families at Limboto Health Center, Gorontalo Regency

Prior research supporting this study focuses on the link between knowledge and infection prevention, particularly in healthcare facility environments. A study by Heriyati et al. (2020) highlighted the importance of education in enhancing the knowledge of patients and medical staff regarding nosocomial infection prevention in hospitals. They found that increased knowledge correlates with the effectiveness of infection prevention measures. Furthermore, research by Hermawan (2009) demonstrated that nurses' knowledge of infection prevention methods directly impacts their behavior in controlling the spread of infection. This study indicates that sufficient knowledge among medical personnel can influence infection prevention practices, which is a crucial element in nosocomial infection control. These studies support the notion that education and knowledge enhancement play a

significant role in reducing the risk of infection transmission in healthcare facilities.

3. Microbial Patterns on Sphygmomanometer Cuffs: A Descriptive Study at Mangusada Regional Hospital

Previous research indicates that sphygmomanometer cuffs used in the wards of Mangusada Regional Hospital, Badung Regency, were contaminated with various pathogenic microbes. The identified microbial types include *Staphylococcus xylosum* (46%), *Staphylococcus haemolyticus* (23%), *Bacillus* spp. (15%), *Acinetobacter baumannii* (8%), and *Enterobacter cloacae* (8%). This study illustrates the potential of sphygmomanometer cuffs as a medium for infection transmission, primarily due to their alternating use among multiple patients. The bacteria found consist of both commensal and pathogenic types that can cause infections, particularly in immunocompromised patients. Therefore, the evaluation and cleaning standards for these devices must be improved to prevent nosocomial infections or Healthcare-Associated Infections (HAIs).

DISCUSSION

Nosocomial Infections: Clinical Characteristics and Classification

These infections manifest after 72 hours of hospitalization and are typically absent upon admission. Organs commonly affected include the respiratory tract, digestive system, and surgical sites. Enterobacteriaceae are Gram-negative bacteria that naturally inhabit the human digestive tract but can spread to environments such as water and soil. This family consists of several genera, including *Escherichia coli*, *Klebsiella pneumoniae*, *Shigella*, and *Enterobacter*, which cause various infections. For example, *E. coli* is known to cause urinary tract infections and diarrhea, while *Shigella* causes dysentery, and *Klebsiella* is notorious for nosocomial pneumonia.

Nosocomial infections spread through various contact routes, including both direct and indirect contact. Nosocomial pneumonia is among the most frequent infections in hospital settings. There are three common

types of pneumonia: Hospital-Acquired Pneumonia (HAP), Ventilator-Associated Pneumonia (VAP), and Healthcare-Associated Pneumonia (HCAP). HAP appears after more than 48 hours of hospitalization and carries a high mortality rate. VAP occurs when a patient has used a ventilator for more than 48 hours, while HCAP affects patients who frequently interact with healthcare providers. Preventing the spread of these infections requires strict hygiene practices and proper aseptic procedures.

The use of antibiotics is often necessary to manage nosocomial infections; however, their administration must be based on laboratory results to prevent resistance. Wise antibiotic stewardship is a critical factor in resistance prevention. Prevention requires not only good hygiene and strict control of high-risk medical procedures but also proper education for medical staff and patients regarding the importance of preventive measures. These efforts can improve the quality of healthcare services while reducing the risk of HAIs.

Epidemiology of Nosocomial Infections

Nosocomial infections are a serious global issue, increasing mortality rates and causing significant financial losses. According to WHO reports, it is estimated that approximately 15% of all hospitalized patients experience these infections. HAIs contribute to 4%–56% of total neonatal deaths, with incidence rates reaching 75% in Southeast Asia and Sub-Saharan Africa. This high incidence is not limited to low-income countries; in high-income countries, the incidence ranges from 3.5% to 12%, while in low-and-middle-income countries (LMICs), it varies between 5.7% and 19.1%.⁸

A stark contrast is observed in the frequency of infections; low-income countries experience an incidence three times higher than high-income countries. In neonates, the comparison is even more dramatic, with incidence rates 3 to 20 times higher in low-income regions. This indicates that while HAIs are a significant health problem globally, their impact is far more severe in areas with limited healthcare resources. Limited access to adequate

facilities, poor hygiene, and inappropriate antibiotic use exacerbate the situation in developing countries.⁹

Diagnostics of Nosocomial Infections

The diagnostic process for nosocomial infections is vital for identifying pathogens in hospitalized patients. Diagnosis begins with a clinical examination, including observations of symptoms such as fever, elevated white blood cell counts (leukocytosis), or signs of localized inflammation. The next step involves laboratory testing by collecting specimens from infected areas, such as blood, urine, sputum, or surgical wounds. These specimens are analyzed through microbiological culture to identify the causative pathogen and perform antibiotic sensitivity testing (AST).

In the last decade, molecular diagnostic technologies such as Polymerase Chain Reaction (PCR) have been increasingly used for faster and more accurate detection. Beyond PCR, Next-Generation Sequencing (NGS) is being applied to identify new pathogens or antibiotic-resistant variants directly from clinical specimens. Furthermore, imaging techniques such as radiography or Computed Tomography (CT) are used to detect pneumonia or organ abscesses. Current diagnostics also integrate testing for enzymes such as Extended-Spectrum Beta-Lactamase (ESBL) and Carbapenemase to address rising antibiotic resistance.¹⁰

Management in Internal Medicine

Management within internal medicine involves a multidisciplinary approach encompassing prevention, early detection, and targeted therapy. Prevention is the primary step, emphasizing hand hygiene, equipment sterilization, and patient isolation for high-risk individuals.¹¹ Judicious and timely antibiotic use is essential to prevent the development of multi-drug resistant (MDR) bacteria.¹² Tight monitoring of early infection signs is required, especially in immunocompromised patients or those on immunosuppressive therapy.¹³

Once a diagnosis is confirmed, therapy is based on culture results and sensitivity tests to ensure effective and specific treatment. In cases involving resistant bacteria such as Methicillin-resistant *Staphylococcus aureus* (MRSA) or ESBL-producing organisms, therapeutic approaches may require broad-spectrum antibiotics or combination therapy. Supportive care,

including fluid administration and symptom management (fever and pain), is also vital for patient stability.¹⁴ Finally, a team-based approach involving doctors, nurses, and support staff is necessary to ensure that infection control protocols are applied consistently across all hospital units.¹⁵

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