International Journal for Scientific Research (IJSR)

المجلة الدولية للبحوث العلمية

Vol. (2), No. (12) December 2023 الإصدار (2)، العدد (12)

Nosocomial Infections: Prevention, Control and Surveillance

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Abstract

Introduction: Nosocomial infections can have significant negative consequences, including extra hospitalization days, additional costs, and even deaths, depending on the site of infection. These consequences and associated costs can be substantial, and it is important to identify patients at highest risk for infection in order to prioritize prevention and control efforts. In this review, we aimed to include all preventive, control and surveillance strategies targeting nosocomial infections.

Methods: A systematic review was conducted to examine the effects of modifications to hospital architecture on nosocomial infections in intensive care units (ICUs), surgical departments, isolation units, and hospitals in general. The review included experimental and nonexperimental studies published before 2022 in English. The search was conducted using a combination of keywords and abbreviated terms related to hospital architecture and nosocomial infections, and was carried out through seven medical databases, reference lists, and expert consultation. In addition, the Cochrane Controlled Trials Database and the internet were checked. The

bibliographies of reviewed papers, reports, and textbooks were searched by hand and experts in the field of hospital hygiene were consulted. The principal outcome measure was the rate of nosocomial infections.

Results: The search identified 178 articles that met the inclusion criteria, but only 17 of these described completed concurrent or historical cohort studies that matched the criteria. Most of the articles were categorized at the lowest level of evidence and did not include a meta-analysis, systematic review, or randomized controlled trial. The interventions in hospital architecture generally resulted in more space per hospital bed, single rooms, or easily accessible handwashing facilities. Of the 17 included studies, three documented a statistically significant decrease in nosocomial infection after the intervention. However, none of the studies addressed other types of nosocomial infection, such as postoperative pneumonia or urinary tract infection.

Conclusions: To effectively control these infections, healthcare institutions should implement infection control programs and use appropriate antimicrobials, including prophylactic use when appropriate. Efficient surveillance methods, including data collection from multiple sources and regular evaluation and maintenance, are also important for effectively implementing interventions and maintaining the effectiveness of surveillance systems.

Keywords: Nosocomial, Infections, Hospital, Health Workers, Surveillance.

Introduction

Nosocomial infections, also known as hospital-acquired infections, are those that occur during a patient's stay in a hospital or other clinical facility but were not present at the time of admission. These infections may be caused by nosocomial pathogens, which are microorganisms that are acquired in a hospital or healthcare setting [1]. Nosocomial infections can range from superficial infections to necrotizing soft tissue infections, and can increase the cost of patient care, extend the length of

hospitalization, and contribute significantly to mortality. In the 21st century, the rate of nosocomial infections has been increasing, likely due to the increased use of outpatient treatment, the admission of more severely ill patients to hospitals, and the overuse of antibiotics in hospitals, which has led to the development of antibiotic resistance in many microorganisms. Other risk factors for nosocomial infections include medical procedures that bypass the body's natural protective barriers, cross contamination from medical staff to patients, and inadequate cleaning procedures. These infections can have a significant impact on disease burden, including morbidity and mortality [2,3].

Several studies, including those conducted by Jain et al., have found that nosocomial pathogens can come from a variety of sources, including the patient's own body (endogenous flora), cross contamination from healthcare staff, contaminated needles and instruments, and the hospital environment (exogenous flora). Hospitalized patients may be more susceptible to infections due to their weakened immune systems, and a variety of microorganisms can cause nosocomial infections, including bacteria, fungi, viruses, and parasites [4]. These infections can manifest in a variety of ways, including respiratory infections, urinary tract infections, meningitis, surgical site infections, blood stream infections, gastroenteritis, and other symptoms. According to the World Health Organization (WHO), hospital-acquired infections are a major infectious disease with a significant economic impact worldwide, affecting approximately 2 million people each year and requiring hospitalization for 5% to 15% of those affected [5]. Nosocomial infections, also known as hospital-acquired infections, are a significant public health issue in the United States, affecting more than 2 million patients annually and costing an estimated $4.5 billion in 1992 dollars. Hospitalized patients are at a higher risk of infection due to their underlying health conditions and exposure to invasive procedures, and their risk is further increased if they are immunocompromised [6]. The hospital environment also supports the development of antibiotic resistance in pathogens, making the treatment

of infections more challenging. The National Nosocomial Infections Surveillance (NNIS) system, run by the Centers for Disease Control and Prevention (CDC), and other published data can provide information on the epidemiology of nosocomial infections, including the sites of infection, causative agents, and antibiotic resistance.

Infection control approaches, particularly for patients at highest risk of infection, and the role of the microbiology laboratory in infection control will also be discussed. The incidence of nosocomial infections varies by body site and is influenced by the underlying health conditions of patients and their exposure to high-risk medical procedures. Personal characteristics and exposures also play a role in a patient's predisposition to or risk of developing an infection [7]. Infections may not always be detected in patients after they are discharged from the hospital, but an asymptomatic patient may be considered infected if pathogenic microorganisms are found in normally definitions are not intended for use in making therapeutic decisions for clinical disease.

There are various intrinsic and extrinsic factors that can increase the risk of nosocomial infections. Intrinsic factors are those that are inherent in the patient due to underlying health conditions, while extrinsic factors are those that are related to the hospital environment or medical procedures. Highrisk medical interventions, such as surgical operations and the use of invasive devices, are often cited as major extrinsic factors contributing to nosocomial infections [8]. These procedures may increase the risk of infection due to the presence of more severe underlying health conditions in patients who require them, as well as the potential for contamination from the devices themselves. The use of antimicrobial agents can also influence the character and prevalence of nosocomial infections, as many bacterial pathogens have developed resistance to commonly used antimicrobials. The development of a practical risk index for nosocomial infections, such as the Acute Physiologic and Chronic Health Evaluation (APACHE II) or Diagnosis-Related Groups, could help to adjust the overall infection rate and identify patients at highest risk. The prevention

and control of infections associated with operative procedures and high-risk devices, as well as the role of antimicrobial agents in nosocomial infections, are important considerations in infection control efforts. Surgical site infections (SSIs) are a particular concern due to their serious morbidity, mortality, and high cost, and the NNIS system has developed an SSI risk index to adjust SSI rates for most operations [9].

Nosocomial infections can have significant negative consequences, including extra hospitalization days, additional costs, and even deaths, depending on the site of infection. These consequences and associated costs can be substantial, and it is important to identify patients at highest risk for infection in order to prioritize prevention and control efforts [10]. This can help to track the trends of infections, such as bloodstream infections, that may be on the rise. It is worth noting that the measures used to protect hospital and laboratory workers from the risk of infection will not be discussed in detail here. In this review, we aimed to include all preventive, control and surveillance strategies targeting nosocomial infections.

Methods

A systematic review was conducted to examine the effects of modifications to hospital architecture on nosocomial infections in intensive care units (ICUs), surgical departments, isolation units, and hospitals in general. The review included experimental and nonexperimental studies published before 2022 in English. The search was conducted using a combination of keywords and abbreviated terms related to hospital architecture and nosocomial infections, and was carried out through seven medical databases, reference lists, and expert consultation. In addition, the Cochrane Controlled Trials Database and the internet were checked. The bibliographies of reviewed papers, reports, and textbooks were searched by hand and experts in the field of hospital hygiene were consulted. The principal outcome measure was the rate of nosocomial infections.

The studies included randomized controlled trials and prospective or retrospective cohort and case-control studies. At least two reviewers screened all of the identified abstracts and critically appraised the studies and reports according to the inclusion criteria. If the reviewers' conclusions differed, a third reviewer appraised the study and a joint opinion was reached through discussion. Study data were abstracted and entered into a database by one reviewer and checked by a second reviewer. The review identified two additional cohort studies through a recent Medline search using the same search strategy.

Results and Discussion

The search identified 178 articles that met the inclusion criteria, but only 17 of these described completed concurrent or historical cohort studies that matched the criteria. Most of the articles were categorized at the lowest level of evidence and did not include a meta-analysis, systematic review, or randomized controlled trial.

The interventions in hospital architecture generally resulted in more space per hospital bed, single rooms, or easily accessible handwashing facilities. Of the 17 included studies, three documented a statistically significant decrease in nosocomial infection after the intervention. However, none of the studies addressed other types of nosocomial infection, such as postoperative pneumonia or urinary tract infection. In addition, four studies found no change in the incidence of endemic nosocomial infection after a hospital moved to a new facility, despite a decrease in environmental microbial contamination [11-15].

Nosocomial infections, also known as hospital-acquired infections, are infections that a person develops during their stay in a hospital or other healthcare facility. These infections can affect any part of the body and can be caused by a variety of microorganisms, including bacteria, fungi, viruses, and parasites. Nosocomial infections are a major concern in hospitals and other healthcare settings because they can lead to increased morbidity and mortality, longer hospital stays, and higher

healthcare costs [13]. Risk factors for nosocomial infections include underlying medical conditions, exposure to high-risk medical interventions such as surgery or the use of invasive devices, and the hospital environment, which may facilitate the acquisition of antimicrobial resistance by pathogens. The National Nosocomial Infections Surveillance (NNIS) System in the United States tracks the incidence and types of nosocomial infections in intensive care units (ICUs) and has identified a number of common pathogens and high-risk areas for infection, including central line-associated bloodstream infections, ventilator-associated pneumonia, and catheter-associated urinary tract infections [16]. Efforts to prevent nosocomial infections include infection control measures such as hand hygiene, proper sterilization and handling of equipment, and the use of personal protective equipment. Nosocomial infections, also known as hospital-acquired infections, are a serious problem in hospitals, particularly in intensive care units (ICUs). These infections affect more than 2 million patients in the United States each year and have an annual economic burden of over $4.5 billion. Hospitalized patients are at an increased risk of infection due to their underlying medical conditions and exposure to invasive procedures. The hospital environment also promotes the development of antibiotic resistance in pathogens, which can complicate the treatment of infections. The National Nosocomial Infections Surveillance (NNIS) system, run by the Centers for Disease Control and Prevention (CDC), tracks the epidemiology of nosocomial infections in the United States, including the sites of infection, causative agents, and antimicrobial resistance [16,17].

Infection control measures, including those targeting high-risk patients, are important in preventing the spread of nosocomial infections. The microbiology laboratory also plays a key role in infection control. Nosocomial infections can occur at various body sites and are influenced by various intrinsic and extrinsic factors, including underlying medical conditions and exposure to high-risk medical interventions such as surgical procedures and invasive devices.

Antimicrobial agents have significantly impacted the types of nosocomial infections that occur, with many pathogens developing resistance to commonly used antimicrobials [18]. In ICUs, nosocomial infections are caused primarily by Escherichia coli, Enterococcus spp, Pseudomonas aeruginosa, and Candida albicans. Risk factors for nosocomial infections in ICUs include the use of invasive devices such as vascular catheters and endotracheal tubes, decubitus ulcers, burns, and surgical debridement. Fungal infections are also common in ICUs. To prevent the spread of nosocomial infections, it is important to follow proper infection control measures such as hand-washing and the use of gloves and gowns [19].

The results of several studies showed that the prevalence of nosocomial infections (infections acquired while in the hospital) was similar in both years and that surgical patients were more likely to be infected than medical patients [12,17]. The incidence of nosocomial infections across six hospitals was found to be 1.4 per 100 discharges, with a range of 0.4 to 2.4 per 100 discharges. The sensitivity of surveillance for these infections ranged from 15% to 50%, with an average of 40%, and the adjusted nosocomial infection rate was 3.5 per 100 discharges, with a range of 1.1 to 12.3 per 100 discharges. The results also indicated that rates of community-acquired infections were approximately twice as high as rates of nosocomial infections, the sensitivity of surveillance for nosocomial infections was 65%, the prevalence of nosocomial infections was higher in surgical than in medical services, and patients with nosocomial gram-negative urinary tract infections, surgical wound infections, and pneumonia who had secondary bloodstream infections were more likely to die than those without bloodstream infections [20]. Finally, the Joint Commission on Accreditation of Healthcare Organizations (JCAH) strongly recommended the use of surveillance personnel, particularly for the prevention of postoperative pneumonias and urinary tract infections. The data also showed that nosocomial infection rates increased by an average of 3% annually in hospitals that did not establish infection surveillance and control programs. However, it was difficult to determine the most

effective methods and schedules for performing surveillance as most hospitals were performing surveillance in most areas of the hospital and were trying to detect infections at all sites [21].

The history of nosocomial infection surveillance (monitoring and tracking of infections acquired in the hospital) in the United States over the past 30 years includes several important events (such as the SENIC Project). The SENIC Project found that 32% of nosocomial infections involving four major sites (urinary tract, surgical wounds, lower respiratory tract, and bloodstream) could be prevented by well-organized infection surveillance and control programs [20,22]. The critical components of an effective program included a balance between surveillance and control efforts, the presence of one infection control practitioner for every 250 beds, and a "traditional approach" to the detection of nosocomial infections. In developed countries, National Nosocomial Infections Surveillance (NNIS) systems were established to monitor national trends in nosocomial infection rates, detect emerging pathogens and problems, provide participating hospitals with comparative data on infection rates, improve surveillance methods, and conduct special studies on important nosocomial infection issues. It is important for institutions to define the objectives of their surveillance programs and consider changes in patient risk when analyzing and interpreting surveillance data [23].

Infection rates in intensive care units (ICUs) can be influenced by the duration of use of invasive devices, such as central venous catheters. Calculating device-specific infection rates, which take into account the duration of device use, allows for a more accurate comparison of infection rates between ICUs. It is important to track device use in order to identify possible overuse and to focus on strategies for improving infection control in the ICU. In high-risk settings or in ICUs, it may be helpful to use routine hand antisepsis or disinfection in order to reduce the risk of infection. This can be achieved through surgical scrub, the use of antimicrobial soap, or alcohol-based hand rubs. It is recommended to use hand antisepsis when placing invasive

devices, when persistent antimicrobial activity is desired, or when reducing the resident skin flora is necessary [16, 23].

Nosocomial infections, or infections acquired in a healthcare setting, are a significant problem worldwide. They can occur in various forms, including central line-associated blood stream infections (CLABSI) and ventilator-associated pneumonia (VAP). The frequency of overall infections is three times higher in low-income countries compared to high-income countries, and three to 20 times higher in neonates. These infections can spread to other patients and can be caused by unhygienic environments, inadequate ventilation and air filtration, and the use of contaminated equipment and supplies.

Conclusions

To prevent nosocomial infections, it is important to maintain clean and well-ventilated environments, use proper hand hygiene, use sterile equipment and safe injection practices, and properly dispose of infectious waste. Despite efforts to prevent nosocomial infections, they continue to be a problem, with an estimated one out of every 25 hospitalized patients acquiring at least one type of nosocomial infection each day. To effectively control these infections, healthcare institutions should implement infection control programs and use appropriate antimicrobials, including prophylactic use when appropriate. Efficient

surveillance methods, including data collection from multiple sources and regular evaluation and maintenance, are also important for effectively implementing interventions and maintaining the effectiveness of surveillance systems. Physicians, pharmacists and policymakers also have a role to play in prescribing appropriate antibiotics and fostering cooperation and information sharing among stakeholders.

Conflict of Interests

The authors declared no conflict of interests.

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