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The Most Popular Air Microorganisms in the Operating Room in Indonesia: A Literature Review

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ABSTRACT

Patient safety and prevalence of nosocomial infections are directly related to the problem of airborne germs in the operating room. If not properly controlled, airborne microorganisms can increase the risk of surgical problems and prolong the recovery period, thus jeopardizing patient safety. This disease can also be the cause of nosocomial infections. The main purpose of this study was to determine the most common microorganisms found in operating rooms in Indonesia. By collecting and analyzing data from a variety of literature sources, the study provides a deeper understanding of the composition of airborne microorganisms, the factors that influence them, and their implications for clinical practice and hospital policy. This study collected 37 articles filtered according to inclusion and exclusion criteria using the preferred reporting items for systematic review and meta-analysis (PRISMA) model. It was found that *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* became the most frequently occurring microorganisms. The results of this study have consequences that emphasize the need for better hygiene habits, efficient ventilation systems, and increased awareness of infection risks among medical personnel. The findings of this study are expected to contribute to improving the standard of safety and patient care in hospitals in Indonesia.

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INTRODUCTION

When performing invasive medical operations, the operating room is a very important place. Microbes present in the air are one of the main sources of possible contamination in the operating room, and maintaining cleanliness is essential to prevent infection in patients^{[1],[2],[3]}. Gaining an understanding of airborne microbes typically found in operating theatres is critical to improving hygiene and patient safety standards in Indonesia, a country with a large population and diverse health system^[4]. Because airborne microorganisms have the potential to cause nosocomial infections in patients recovering from surgery, they are the main focus of efforts to ensure cleanliness and sterilization in the operating room^[5]. The main problem facing the healthcare system is nosocomial infections, which not only increase patient morbidity and mortality but also increase the length of treatment and pose a significant financial burden on patients and the system^[6].

Various types of bacteria, viruses, and fungi that can be transmitted through the air, surfaces, or medical workers are microorganisms most commonly found in the air in operating rooms^[7]. Finding microorganisms that are most common and may be harmful to patients is an important first step in creating an efficient infection

control plan^[8]. The problem of managing airborne microorganisms in the operating room persists despite numerous attempts made in this direction. Some examples of factors that cause infection control efforts to be less successful are lack of resources, lack of knowledge about good hygiene practices, and lack of adequate health infrastructure. However, many hospitals are able to lower the incidence of nosocomial infections and improve patient safety by implementing appropriate hygiene measures and gaining better knowledge of the nature and behavior of airborne microorganisms^[9].

The main objective of this study was to determine which microorganisms are most commonly found in operating rooms in Indonesia. The research is expected to help health professionals to better understand the types of microorganisms that predominate, where they are found, and how the environment affects their growth. This will help them make operating room cleaning and sterilization efforts more effective and reduce the rate of nosocomial infections in Indonesia. Therefore, this study is believed to significantly improve patient safety and health service standards in Indonesia.

METHOD

PRISMA (Preferred Reporting Items for Systematic Review and Meta-analyses) is the approach used in this study, namely by conducting a systematic review. This approach is applied methodically by following the appropriate steps or protocols for the study. There are several phases in this systematic review process, namely: (1) compiling background and objectives, (2) developing research questions, (3) literature search, (4) Selection Criteria, (5) practice screens, (6) Quality Procedures and Checklists, (6) Data extraction strategies, and (7) Data synthesis strategies^[10].

To collect the data and materials needed for the writing of this publication, the study will analyze a number of literature studies on airborne microorganisms in the operating room using PRISMA techniques and Publish or Perish software version 7 using electronic databases such as; google scholars and pubmed. This research will be conducted in January 2024 in Yogyakarta. The main keywords and vocabulary of this study include English and Indonesian. In English it is; air microorganisms, surgery room, nosocomial infections, sterilization of the operating room, environmental hygiene, hospital cleanliness standards, and infection control. In Indonesian are : mikroorganisme udara, ruang operasi, infeksi nosokomial, sterilisasi ruang operasi, kebersihan lingkungan, standar kebersihan rumah sakit, dan pengendalian infeksi.

The inclusion criteria for this literature review research include scientific publications published in the previous ten years, namely 2014 to 2023, as well as articles that are only carried out in Indonesia. The airborne microorganism in the operating room acted as the subject of the study. Regarding airborne microorganisms in operating rooms, full-text articles are required in scientific publications other than abstracts (full text is available). Article inclusion and exclusion criteria are also determined using the PRISMA model (<http://www.prisma-statement.org/>).

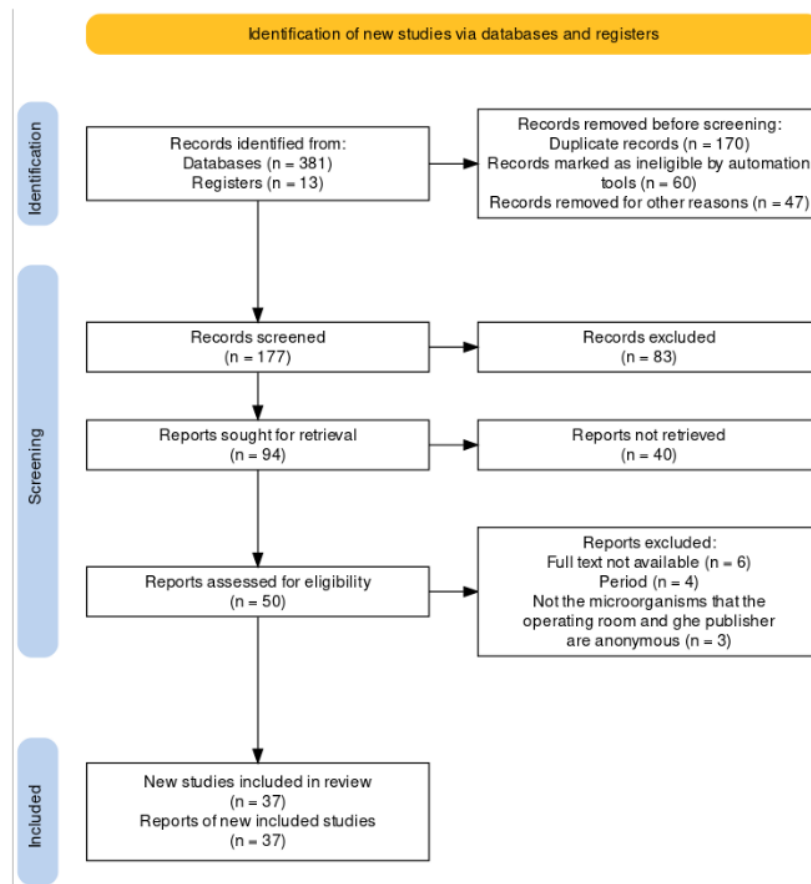


Figure 1. Modified from the PRISMA flow diagram to filter the most popular airborne microorganism articles in operating rooms in Indonesia

RESULT

Table 1. Ranking chart of Indonesian Microorganisms Most often Identified in the Operating Room or Found in Research Based on the Results of Literature Review

No	Microorganism	Frequency of occurrence (%)	Number of Journals	Characteristics
1	Staphylococcus aureus	24	9	Infection can occur as a result of gram-positive cocci.
2	Pseudomonas aeruginosa	19	7	Stems are resistant to antibiotics, Gram-negative, and are often associated with nosocomial diseases
3	Escherichia coli	17	6	Urinary tract infections can be caused by gram-negative rods, which are a sign of fecal contamination.
4	Klebsiella pneumoniae	14	5	The stems are Gram-negative and are often associated with nosocomial diseases
5	Acinetobacter baumannii	11	4	stems that are Gram negative and often resistant to the drug
6	Candida albicans	7	2	The fungus can cause infection of the respiratory system or surgical incisions.
7	Streptococcus spp	2	1	Gram-positive bacteria of round or chain shape can cause various diseases.

		10		
8	Enterococcus spp	2	1	Gram-positive bacteria can cause intra-abdominal infections, endocarditis, and urinary tract infections.
9	Aspergillus spp	2	1	Fungal infections in people with weak immune systems can be caused by fungi.
10	Mycobacterium tuberculosis	2	1	The main cause of tuberculosis, acid-resistant bacteria, can spread through the air.
Total		100	37	

DISCUSSION

According to a literature review, bacteria including *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* are some of the commonly recognized pathogens. In addition, operating room air often contains *Klebsiella pneumoniae*. These results highlight a wide range of microorganisms, both pathogenic and non-pathogenic, that can contribute to air pollution in sensitive environments such as operating rooms. It is worth mentioning that the success of medical treatment and patient safety are greatly influenced by the presence of certain bacteria in the operating room air^[11]. Certain bacteria are known to be sources of nosocomial infections, which can pose a significant risk to surgical patients^[12]. Therefore, a deeper understanding of the types of bacteria often detected in operating room air in Indonesia is essential to create an efficient prevention and control plan that reduces the risk of infection and proves patient safety^[13].

The identification of microorganisms present in the operating room air is an important phase in the creation of a successful infection control plan in a medical environment. Hospitals and other healthcare facilities can create effective prevention strategies to lower the risk of nosocomial infections by understanding common and potentially harmful types of bacteria in operating room air^[14]. Prevention efforts should focus on specific measures such as wider surface cleaning, air quality monitoring, and graft treatment, for example if *Staphylococcus aureus* or *Pseudomonas aeruginosa* are found in abundance^[15]. Moreover, the identification of microorganisms helps in prioritizing infection control measures in the area of operation. Medical professionals can deploy resources and prevention efforts more effectively if they know which microorganisms are most commonly identified and have the potential to cause disease. To reduce air pollution and stop the spread of disease, preventive measures can be taken, such as increased ventilation, use of appropriate antimicrobial materials, sterilization methods and use of personal protective equipment^[16].

Many variables affect the spread of microorganisms in the operating room in Indonesia. First, the main elements affecting the breeding of microorganisms are hygienic conditions and cleanliness of the room. Maintaining optimal humidity, temperature, and ventilation conditions can reduce the development of potentially infectious bacteria^[17]. In addition, sterilizing medical instruments and equipment is an important technique in limiting the spread of pathogens^[18]. Strict hygiene practices and the application of cutting-edge technology can lower the chances of microbial contamination that can harm patients and medical personnel^[19]. The distribution of microbes in the operating room is also influenced by external variables such as population density, air pollution, and personal hygiene habits^{[20],[21]}. The spread of harmful germs in operating rooms is also increasing in densely populated and contaminated areas^[22]. To ensure the safety of operating rooms, it is important to provide education and training on personal hygiene and basic sanitation techniques. Overall, a thorough understanding of these variables can help establish guidelines and best practices to maintain operating room hygienic standards and lower the risk of microbial-induced infections in Indonesia^[23].

Geographical gaps and clusters of infections that appear in different locations are factors that influence the spread of microorganisms through the air in Indonesian operating rooms. Variations in terrain, climate, and vegetation can all have an impact on environmental factors that facilitate the development and spread of microorganisms. The humid tropics usually have high relative humidity, so conditions are perfect for microbial development [24]. In addition, compliance with medical equipment sterilization protocols, sanitary standards, and hygiene practices can impact clusters of infections in the operating room. These variables can differ across hospitals and geographic regions, thus impacting the incidence of infection. For example, operating rooms in hospitals may be more susceptible to clusters of infections due to inadequate hygiene standards^{[25],[26]}.

One of the important tasks in ensuring the safety of patients and medical personnel in the operating room is to manage and stop the transmission of airborne germs. Installing a good ventilation system is just as important as regularly cleaning the operating room. Ventilation systems need to be built with the best air circulation in mind, to minimize the risk of harmful microorganisms polluting the air. In addition, to identify pollution as soon as possible and implement appropriate safety measures, regular monitoring of air quality is required^{[27],[28]}. Medical personnel should also receive instruction and training on appropriate sterilization procedures in addition to good hygiene standards. Reducing the danger of spreading harmful germs in the operating room can be achieved by increasing awareness of the importance of personal hygiene and the

operating environment. In addition, separating patients who are sick or at risk of infection is very important to stop the transfer of germs from one patient to another^[29].

CONCLUSION

In the operating room, there are a variety of microorganisms in the air, with some species—such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *E. Coli*—tending to dominate. The study shows how geographic environment affects the makeup of airborne bacteria, which can affect a patient's susceptibility to disease. Given the types of bacteria most commonly found in surgery in Indonesia, the implications of this data emphasize the need to improve infection prevention and control strategies to lower the risk of infection during surgical operations.

These results can be the foundation for improving surgical process hygiene and sterilization protocols. Hospitals can leverage this data to assess and improve operating room hygiene standards as well as sterilization techniques for medical equipment and devices. Furthermore, the results of this study could motivate the creation of stricter regulations governing ventilation and air quality monitoring in operating rooms. Understanding the types of bacteria that are most common in surgical environments can also help medical personnel get better training and be more alert to the dangers of infection. Therefore, the findings of this study have the potential to improve patient safety, lower the incidence of infection after surgery, and improve hospital care standards.

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