https://dx.doi.org/10.22161/ijels.46.31 ISSN: 2456-7620

Indoor Air Microbial Profile of General Hospital in Kudus, Central Java, Indonesia

Yuni Saptorini, Nurjazuli, Mursid Raharjo

Department of Environmental Health, Faculty of Public Health, Diponegoro University, Semarang, Indonesia

Abstract— *Microbes in the air found in the form of bioaerosol. Air contaminated with microbes become medium for transmission of disease. This study aimed to identify the profile of airborne microbes in Kudus General Hospital. The study conducted in Kudus Regency, Central Java, Indonesia in 2019. The research used cross sectional design. The number of samples was 30 rooms. The analysis carried out quantitatively and qualitatively to showed the number and types of microbes found. The results showed an average airborne microbes count of 309.6 CFU / M³. The most common bacteria found were Staphylococcus epidermidis and Bacillus subtilis. The most commonly found fungus was mold (33.3%). The finding of microbes in the air showed that hospital air was polluted and had the potential to the disease transmition. Therefore, the hospital needs to make effective control efforts.*

Keywords— ***air microbal counts, general hospital, microbes, fungus.***

I. INTRODUCTION

The hospital environment has a risk to be contaminated with pathogenic microorganisms. Microorganisms can be transmitted from their source to hosts through direct or indirect contact either in the air or through vectors [1]. Regulation of the Minister of Health of the Republic of Indonesia Number 7, 2019 concerning Hospital Environmental Health article 2 states that a healthy environment for a hospital is determined through the achievement or fulfillment of environmental health quality standards and health requirements. One of the environmental health parameters used in hospital environmental health requirements is air quality [2].

Hospitals as one of the public facilities certainly have the potential for microbiological air pollution. This is also supported by activities in hospitals that are very close to microbes. Interaction between visitors can increase the potential for microbial contamination in the air. Dropet in sick patients can sprinkle fluids that contain microbes. A study shows microbes in the air are in the form of bioaerosol where they contribute 5-34% of air pollution in the room [3].

Human health is influenced by various factors including microorganisms that exist in the environment where people spend most of their lives (around 90%) [4]. The study of microorganisms in the air environment in the room is important because it provides information and understanding of microbes found in the hospital environment. The hospital is a place where patients are treated which has an influence on the health of patients who are recovering or contracting infections which can complicate or improve the patient's condition [5]. Therefore it is necessary to monitor and control indoor air microbes for occupational safety and public health, especially patients in hospitals.

The presence of *Staphylococcus aureus* and *Streptococcus pyogenes* in hospitals is a very serious global public health problem. The most common bacterial skin infections are caused by *Staphylococcus aureus* and *Streptococcus pyogenes*. *Staphylococcus aureus* and *Streptococcus pyogenes* are common pathogens found in hospitals that can cause severe invasive infections [6].

This study aimed to identify the number of airborne microbes and types of microbes at the Regional General Hospital Dr. Loekmono Hadi Kudus. In this study, the types of microbes identified were *Bacillus subtilis*, *Staphylococcus epidermidis, Escherichia coli, Klebsiella, Staphylococcus aureus*, mold and penicillium.

II. METHODOLOGY

This type of research was observational analytic with cross sectional approach. The room to be taken as a sample of 30 samples. The study conducted at the Regional General Hospital Dr. Loekmono Hadi Kudus, Central Java, Indonesia in 2019. The number of airborne microbes defined as the number of airborne microbes at the time the measurements were made at the sampling points determined in this study. The number of airborne microbes measured by omega air test in units of CFU/m^3.

The microbes identified were bacteria and fungi. The types of bacteria identified included *Bacillus subtilis, Staphylococcus epidermidis, Escherichia coli, Klebsiella*,

https://dx.doi.org/10.22161/ijels.46.31 *ISSN: 2456-7620*

and *Staphylococcus aureus*. The types of mold identified were mold and penicillium. The type of bacteria in the air is also identified based on air conditioning or ventilation. Quantitative analysis used to show the number of air microbes that are indicated. It described by mean, standard deviation, minimum and maximum values. Qualitative analysis used to describe the species of bacteria and fungi found. It described by frequency and percentage.

III. RESULT

The results showed that the types of bacteria found were *Bacillus subtilis, Staphylococcus epidermidis, Escherichia coli, Klebsiella*, and *Staphylococcus aureus*. The average number of *Bacillus subtilis* found was 17.33 ± 8.503 CFU / cm². The average number of *Staphylococcus epidermidis* found was 20.30 ± 15.979 CFU / cm². The average amount of *E. coli* found was 1.20 ± 2,280 CFU / cm². The average number of *Klebsiella* found was 4.70 ± 5.025 CFU / cm². The average number of *Staphylococcus aureus* found was 1.60 ± 1.754 CFU / cm² (Table 1). The fungus found was mold and penicillium. Mold was found at 33.3% of the total 30 rooms sampled. Penicillium is found in 10% of the sample (Table 2).

Table 1. Descriptive analysis of types of bacteria

Bacteria species	Mean±Std Dev (CFU/cm²)	Min - Max (CFU/cm²)
Bacillus subtilis	17,33±8,503	4-35
Staphylococcus epidermidis	20,30±15,979	5-74
E. coli	1,20±2,280	0-9
Klebsiella	4,70±5,025	0-16
Staphylococcus aureus	1,60±1,754	0-5

Table 2. Frequency distribution of fungus species

Fungus types	Frequency (n)	Percentage (%)
Mold	10	33,3
Penicillium	3	10,0
Negatif	17	56,7
Total	30	100

In air-conditioned rooms the average *Bacillus subtilis* colony was found to be smaller than in a ventilated room. In the air-conditioned room the most microbes found were *Staphylococcus epidermidis* and the least found is *E. coli*. In a ventilated room, the most common type of airborne microbes found was *Bacillus subtilis* and the least found was E. coli (Table 3).

Table 3. Bacteria in the Air in a Room Using Air Conditioning and Ventilation

Bacteria species	Mean±Std Dev (CFU/cm²)	Min - Max (CFU/cm²)
In air-conditioned room		
Bacillus subtilis	14,53±8,235	4-35
Staphylococcus epidermidis	20,37±15,406	7-74
E. coli	1,42±2,479	0-9
Klebsiella	4,89±5,238	0-16
Staphylococcus aureus	1,47±1,679	0-4
In the ventilated room		
Bacillus subtilis	22,18±6838	12-32
Staphylococcus epidermidis	20,18±17,696	5-69
E. coli	0,82±1,940	0-6
Klebsiella	4,36±4,864	0-16
Staphylococcus aureus	1,82±1,940	0-5

IV. DISCUSSION

Microorganisms that come from the air not only come from humans (including patients), but also are produced by various characteristics of indoor hospitals and outdoor environment sources. The average airborne microbes count was 309.6 CFU / M³. An airborne microbes count of at least 81 CFU / M maksimal and a maximum of 1067 CFU / M³.

The most common types of bacteria were *Staphylococcus epidermidis* and *Bacillus subtilis*. The most common type of fungus was mold. In three different hospitals in Iran, nasal swabs were collected from 163 health workers; 96 were cultured and the results were positive for *S.epidermidis* [7]. In addition, a study conducted in Brazil showed that 2.7% of S. epidermidis strains were isolated from hospital treatment waste, indicating a potential risk of spread in the hospital environment [8].

Staphylococcus epidermidis is currently seen as an important opportunistic pathogen. *Staphylococcus epidermidis* is the most common cause of nosocomial infection. In particular, *S. epidermidis* become the most common source of infection found in medical devices. *S. epidermidis* is a bacterium found on human skin, and is likely to cause contamination of medical equipment [9].

The results of this study were in accordance with previous studies which also found *Staphylococcus* sp, *Bacillus* sp, and *Escherichia* sp. The study was conducted by Sivagnanasundaram et al in 2019 where the types of

https://dx.doi.org/10.22161/ijels.46.31 *ISSN: 2456-7620*

microbes found in hospitals were *Bacillus* sp, *Micrococcus* sp, *Pseudomonas* sp, *Staphylococcus* sp, *Escherichia* sp, *Exiguobacterium* sp, *Enterobacter* sp, *Staphylococcus* sp, *Sphingomonas* sp, *Massilia* sp, *Kocuria* sp, *Fusarium* sp, and *Aspergillus* sp [10]. Other research conducted at the University of Benin City Teaching Hospital in Nigeria showed that microbes found in hospital airways were *Staphylococcus aureus, Staphylococcus epidermis, Escherichia coli, Proteus mirabilis* and *Bacillus* sp. Fungal isolates found were *Penicillium* spp., *Aspergillus* spp., *Mucor* spp., *Verticillium* spp. and *Candida* spp [11]. In line with this study where *E. coli* was found in air samples, previous studies conducted by Shiferaw et al (2016) showed *Escherichia coli* and *Klebsiella* in air samples in hospital rooms in Ethiopia [12].

Previous studies have shown *E. coli* can be found on aerosols. The survival of *E. coli* in aerosols depends on several factors such as relative humidity (RH), the nature of the gas environment, the solutes in aerosols. *E. coli* can last for hours in aerosol. The fastest death of *E. coli* was found at low humidity (less than 50%) at temperatures of 15 ^{o}C and 30 ^{o}C, with half-lives of 14 and 3 minutes, respectively. In humid conditions, the half-life becomes longer, about 83 and 14 minutes respectively [13,14].

V. CONCLUSION

The average airborne microbes count was 309.6 CFU / M^3. The lowest airborne microbes count is 81 CFU / M^3 and the highest is 1067 CFU / M^3. The most common types of bacteria are *Staphylococcus epidermidis* and *Bacillus subtilis*. The most common type of fungus is mold. The finding of microbes in the air showed that hospital air is polluted and has the potential to transmit disease. Therefore, the hospital needs to make effective control efforts.

REFERENCES

[1] World Health Organization. Hospital hygiene and infection control. Switzerland: World Health Organization; 2019. 148–158 p.

[2] Kementerian Kesehatan RI. Peraturan Menteri Kesehatan Republik Indonesia Nomor 7 Tahun 2019 tentang Kesehatan Lingkungan Rumah Sakit. 7 Indonesia; 2019.

[3] Gizaw Z, Gebrehiwot M, Yenew C. High bacterial load of indoor air in hospital wards : the case of University of Gondar teaching hospital, Northwest Ethiopia. Multidiscip Respir Med. 2016;11(24):1–7.

[4] Fujiyoshi S, Tanaka D, Maruyama F. Transmission of Airborne Bacteria across Built Environments and Its Measurement Standards : A Review. Front Microbiol. 2017;8.

[5] Fred E, Blessing O. Microbiological Indoor and Outdoor Air Quality of Two Major Hospitals in Benin City, Nigeria. Sierra Leone J Biomed Res. 2011;3(3):169–74.

[6] Catalanotti P, Catania MR, Lucido M, Martini S, Gallè F, Ortega de luna L, et al. T Serotyping and Genomic Profile of Erythromycin- Resistant or -Sensitive Streptococcus pyogenes Isolated in Campania Region, Italy. J Chemother. 2005 Apr 18;17(2):131–7.

[7] Pourmand MR, Abdossamadi Z, Salari MH, Hosseini M. Slime layer formation and the prevalence of mecA and aap genes in Staphylococcus epidermidis isolates. J Infect Dev Ctries. 2011;5(1):34–40.

[8] Nascimento TC, Silva VL da, Ferreira-Machado AB, Diniz CG. Potential spread of multidrug-resistant coagulasenegative staphylococci through healthcare waste. J Infect Dev Ctries. 2015;9(1):29–34.

[9] Otto M. Staphylococcus epidermidis — the “accidental” pathogen. Nat Rev Microbiol. 2009 Aug;7(8):555–67.

[10] Sivagnanasundaram P, Amarasekara RWK, Madegedara RMD, Ekanayake A, Magana-Arachchi DN. Assessment of Airborne Bacterial and Fungal Communities in Selected Areas of Teaching Hospital, Kandy, Sri Lanka. Biomed Res Int. 2019 Jun 12;2019:1–11.

[11] Saint T. Aladenika S, F. Olaniyan M. Indoor Airborne Microflora in Various Section of a Tertiary Healthcare Centre in Rural Area of Ovia Northeast Edo State. Am J Infect Dis Microbiol. 2014 Oct 20;2(4):86–90.

[12] Shiferaw T, Gebre-silasse L, Mulisa G, Zewidu A, Belachew F, Muleta D, et al. Bacterial indoor-air load and its implications for healthcare-acquired infections in a teaching hospital in Ethiopia. Int J Infect Control. 2016;12(1):1–9.

[13] C. S. COX. The Survival of Escherichia coli sprayed into Air and into Nitrogen from Distilled Water and from Solutions of Protecting Agents, as a Function of Relative Humidity. J gen Microb. 1966;43:383–99.

[14] Wathes CM, Howard K, Webster AJF. The survival of Escherichia coli in an aerosol at air temperatures of 15 and 30 °C and a range of humidities. J Hyg (Lond) [Internet]. 1986 Dec 19;97(3):489–96.