Research Article

The Study of Airborne Germ Numbers in Delivery Room

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ABSTRACT

Hospital facilities, such as delivery rooms, can potentially cause nosocomial infections caused by germs, one of which is through the spread of germs in the air. Various factors, such as temperature, humidity, lighting, and occupancy density, can affect the presence of airborne germs. This study aimed to determine the quality of airborne germ numbers in the delivery room and the effect of occupancy density and physical environment on airborne germ numbers. The method used is the univariate analysis and Spearman's Rank test. This type of research includes descriptive research with laboratory tests, using data from examining air germ numbers. The tools used are MAS 100 NT and ThermoHygrometer. The average result of the number of airborne germs was 202.08 CFU/m3. Temperature and humidity obtained an average of 23.53°C and 65.68%. The analysis results of occupancy density and airborne germs are p=0.742; rho = 0.071, room temperature and air germs, namely p = 0.806; rho=-0.053, room humidity and air germs, namely p=0.284; rho=-0.228. The factors in this study showed an insignificant relationship to airborne germs (p value> 0.05).

Keywords: Airborne germs, occupancy density, physical environment, delivery room

INTRODUCTION

A hospital is a healthcare facility where sick and healthy people congregate, potentially causing disease transmission, environmental damage, and health issues. Hospitals, as healthcare institutions aiming for optimal health, are never free of pathogenic microorganisms. Hospital sanitation, as an environmental health effort, is focused on monitoring the physical, chemical, and biological environments that can have a negative impact on human health and the hospital environment.[1] There are numerous ways to promote health, including maintenance, disease prevention, health improvement, disease healing, and recovery.[2]

The quality of a healthy environment reflects the majority of the health sector. One of them is air quality as an important factor in life.[3] Based on the Decree of the Minister of Health of the Republic of Indonesia Number 1204/Menkes/SK/X/2004, high-risk areas should have circulation and an air conditioner with filters, including delivery rooms, emergency rooms, operating rooms, oral surgery rooms, pathology rooms, and dental treatment rooms. The air must be odorless, with a dust content of no more than 150 g/m^3 and no asbestos dust. According to the World Health Organization, indoor air pollution poses a greater risk than outdoor pollution.[4]

According to the United States Environmental Protection Agency (US EPA) research on activity patterns, humans spend nearly 90% of their time indoors, so indoor air quality is very important to consider. If the air quality falls below the minimum, the ambient air is said to be polluted. In developing countries, 400 to 500 million people are frequently exposed to indoor air pollution.[5] Offices, schools, hospitals, transportation hubs, retail stores, and houses are among the locations where indoor air pollution may occur.[6]

The presence of indoor air pollution is influenced by humidity, temperature, dust particles, fungi, bacteria, and viruses that can cause nosocomial infections.[4] Nosocomial infections are common globally, particularly in poor and developing countries. Nosocomial infections in hospitals can affect patients, healthcare workers, and anyone who visits the hospital. The global incidence of nosocomial infections is quite high, with 9 million out of 190 million patients treated suffering from them.[7] According to Ministry of Health Number 129 of 2008, the occurrence of nosocomial infections in hospitals must be less than 1.5%. If the incidence rate is high, hospital operating permits may be revoked.[8]

Airborne germs are the number of pathogenic or non-pathogenic microorganisms carried by droplets or dust particles in the air.[9] Germs in the air can cause a variety of health problems, including rapid food spoilage, bacteremia infection, bone infection, digestive disorders, central nervous system disorders, skin damage, respiratory problems, intestinal inflammation, meningitis, Guillain-Barre Syndrome (GBS), vomiting, diarrhea, Tuberculosis, Pneumonia, soft tissue infections, and fainting. Germs found in the air include Pseudomonas sp, Salmonella typhimurium, Micrococcus sp, Staphylococcus sp, Corynobacterium sp, Campylobacter, Bacillus sp, Acinetobacter sp, Mycobacterium tuberculosis, Salmonella typhimurium, Escherichia coli, Shigella sp, Streptococcus beta haemolyticus, Klebsiella sp, and Azotobacter.[10]

Temperature is one of the factors that can cause a high concentration of germs in the air, a rise in the temperature inside can affect how quickly microorganisms grow. High temperatures will speed up the process of water evaporation and increase the number of water particles that can move dust particles, whereas dust carries bacteria with it. Additionally, high temperatures can interfere with the comfort and result in heat stress.[11]

High humidity also plays an important role in the growth of bacteria because the water vapor contained can be used as a place to survive for bacteria in the air. The ideal air humidity level is 40-60%. When the humidity falls below 40%, it causes discomfort and irritation.[3]

The light factor can also influence or even inhibit bacterial growth. Lighting is divided into two, namely natural lighting sourced from the sun and artificial lighting from lamps. Natural lighting from sunlight is considered more effective than lighting from lamps. Sunlight contains ultraviolet which can kill germs, bacteria, viruses, and other microorganisms. Lighting from ordinary lamps is only able to illuminate but cannot reduce germs or microorganisms in a room. Microorganisms will die quickly when exposed to direct sunlight because they cannot carry out the photosynthesis process, therefore it is important to ensure sunlight enters the room. Microbial growth occurs in the absence of sunlight in the room.[12]

The density of occupants and the equipment used, including hospital equipment (medical or non-medical), equipment carried, and visitors, can all have an impact on airborne germs.[13] Airborne germs can be spread by the wind, water droplets, splashes from coughs and sneezes, and conversation.[14]

The delivery room, as one of the hospital's service facilities, is classified as a high-risk area because the patients in the delivery room are extremely susceptible to infection.[6] Raharja (2015) researched the number of germs in the delivery room, and the results showed that only 29.4% of the number of airborne germs in the delivery room met the standards, while the remaining 70.6% did not.[15] Nugroho's (2015) study on factors influencing the number of airborne germs found a relationship between temperature, humidity, and lighting and the number of airborne germs in the inpatient room. However, there is no correlation between the number of visitors, the frequency of sterilization, the condition of the trash, linen, and the patient's personal hygiene, and the number of airborne germs.[16] Meanwhile, other studies show that room humidity is directly related to a significant increase in the number of airborne germs ($p = 0.023$) and that temperature, lighting, and the number of visitors indirectly affect the number of germs through air humidity.[14]

Given the above context, the urgency of this study is to determine the quantity of airborne germs in the delivery room and the impact of residential density and the physical environment, including temperature and humidity, on the quantity of airborne germs in the delivery room of RSUD Dr. Moewardi.

METHOD

Research is carried out using descriptive research with laboratory tests, specifically research using data on examining air germ numbers. This research was conducted in the sanitation laboratory of RSUD Dr. Moewardi from January to March 2022. The population in this study is the number of airborne germs in the Ponek room, with a sample of the number of airborne germs in the delivery room or Ponek 1.

The following materials and tools were used in this study: alcohol, distilled water, Plate Count Agar (PCA), autoclave, patry dish, colony counter, cool box, erlenmeyer, incubator, glass beaker, electric stove, bunsen lamp, MAS 100 NT, glass rod stirrer, Thermohygrometer, and analytical balance. The design of observational data analysis in this study can be seen in table 1.

Table 1. Design of Observation Data

	Occupancy Density (X_1)	Physical Environment	
		Temperature (X_2)	Humidity (X_3)
Air Germ (Y)	(Y, X_1)	(Y, X_2)	(Y, X_3)

The research phase begins with the preparation of agar media. Plate Count Agar (PCA) in the amount of 7 grams was dissolved in 400 ml of distilled water and autoclave sterilized. Then place 15-20 ml in a sterile petri dish. MAS 100 NT with a sampling volume of 500 liters was used during the sampling stage. The PCA-containing petri dish was inserted into the MAS 100 NT and left there until the sampling time was up. After that, samples in petri dishes were incubated in an incubator inverted at 35-37°C for 24 hours. The principle of airborne germ examination is to count the colonies that grow on PCA. The growing colonies were observed on the colony counter and calculated using the equation.[1]

$$Number of\ Germs = \frac{CFU\ \Pr}{Volume\ Sampling} \times 1000 \quad (1)$$

ThermoHygrometer with direct reading method was used to measure room temperature and humidity. While the number of patients, visitors, and health workers in the room indicates the density of occupancy. To determine the distribution and relationship between variables, data were analyzed using univariate and Spearman rank tests. The results of the airborne germ analysis are also compared to the applicable quality standards, namely the Ministry of Health RI No. 1204/Menkes/SK/X/2004.

RESULT AND DISCUSSION

Table 2 shows the results of a univariate analysis of observations and measurements of airborne germs in the delivery room.

Table 2. Results of Univariate Analysis of Air Germs in the Delivery Room

Air germ	Frequency (N)	Percentage (%)
Qualified	16	66,7
Unqualified	8	33,3
Total	24	100

Table 2 shows the presence of airborne germs in the delivery room; the majority of them, 66.7%, met the requirements, while 33.3% did not. According to the research, the highest quality of germ numbers was 708 CFU/m^3, and the lowest was 13 CFU/m^3. While the average number of airborne germs in the delivery room is 202.08 CFU/m^3, this means that it exceeds or is not following the Indonesian Ministry of Health No. 1204/Menkes/SK/X in 2004, which is 200 CFU/m^3.

The presence of droplets in the air can influence the number of germs in the air. When talking, sneezing, or coughing, droplets are frequently used to spread bacteria through the mouth or nose. As a result of the numerous human activities, small droplets will always float in the air, carried away by the movement of the wind. Meanwhile, larger droplets will settle more easily and fall into dust.[17]

The graph of the results of observing the density of occupancy in the delivery room can be seen in Figure 1.

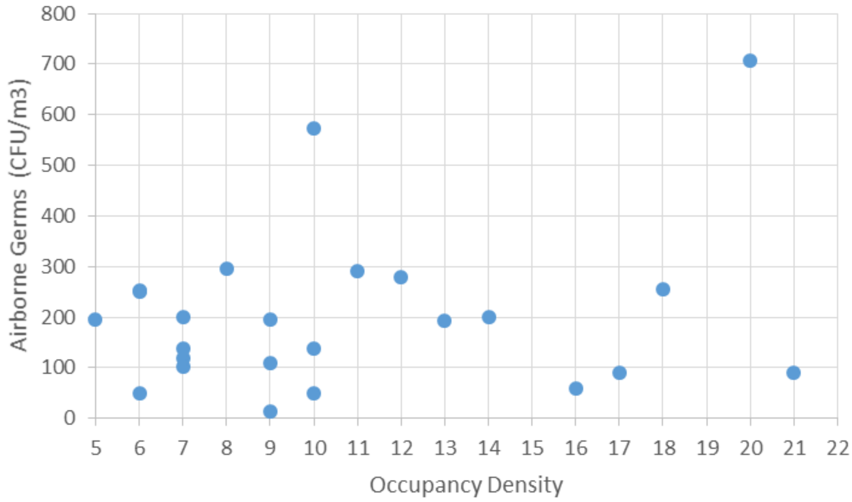

Figure 1. Occupancy Density Graph Towards Airborne Germs

Figure 1 shows that the occupancy density is not stable during the observation. The observation of occupancy density in the delivery room revealed the highest occupancy density of 21 people with an air germ number of 89 CFU/m^3 and the lowest occupancy density of 5 people with an air germ number of 196 CFU/m^3. This is insufficient evidence to support Clara's (2019) claim that the presence of people in a space will lead to an increase in the number of germs.[4] The highest number of airborne germs based on occupancy density is 708 CFU/m^3 with up to 20 people in the room. With 9 people in the room, the lowest is 13 CFU/m^3.

The results of temperature measurements in the delivery room can be seen in Figure 2.

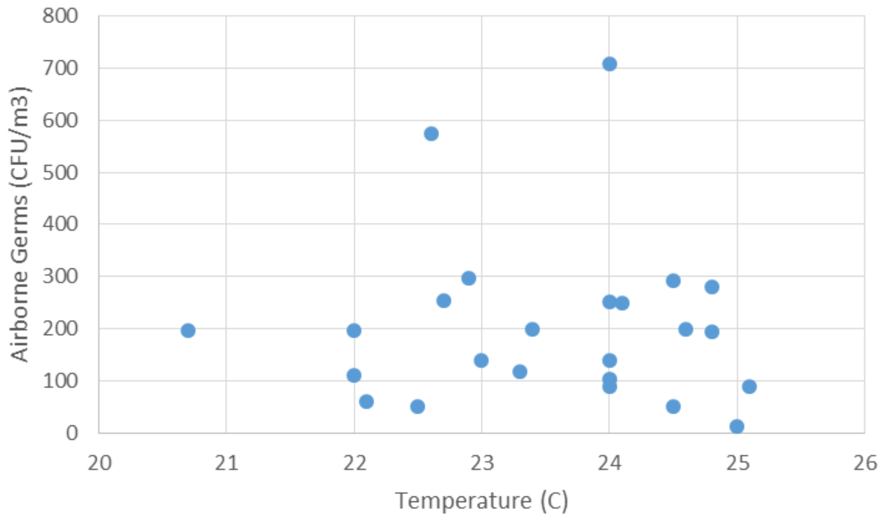

Figure 2. Temperature Graph Towards Airborne Germs

As seen in Figure 2, the measurement temperature was between 20-25 degrees Celsius. Each bacterium has an optimal temperature for growth; bacteria that do not grow will die. Bacteria will die if the surrounding temperature is higher than what it needs to be to survive. Similarly, bacterial growth will cease if the optimal temperature required for bacteria is lower than the ambient temperature.[(18)] The quality of the air germ number is 708 CFU/m^3 at 24°C, and the lowest germ number is 13 CFU/m^3 at 25°C.

In this study, factors that affect temperature variations include occupancy density, inadequate ventilation, and officer discipline in closing the door.

Table 3. Room Temperature Measurement Results Distribution

Room Temperature	Frequency (N)	Percentage (%)
Qualified	13	54,2
Unqulified	11	45,8
Total	24	100

Table 3 shows that the temperature in the delivery room that meets the requirements is 54.2%, while the temperature that does not meet the requirements is 45.8%.

According to Permenkes number 7 of 2019, the temperature requirement limit in the delivery room is 24-26°C.

The percentage of total water content in the air is referred to as air humidity. Air humidity is the percentage of the total water content in the air. Humidity in the delivery room can be seen in Figure 3.

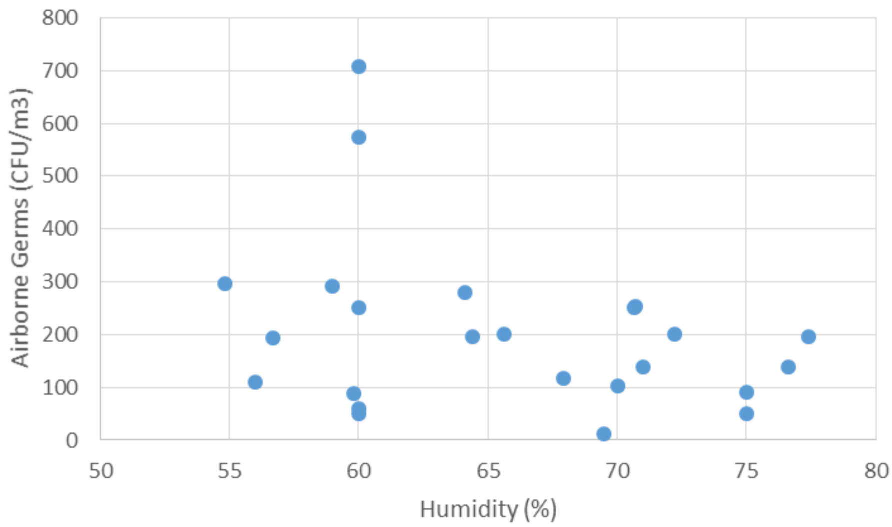

Figure 3. Humidity Graph Toward Air Germs

Figure 3 shows that the humidity during the measurement was between 54 and 78%. Meanwhile, according to Permenkes number 7 of 2019, the humidity requirement limit in the delivery room is 40-60%. The highest germ number in the air is 708 CFU/m^3 at 60% humidity, and the lowest germ number is 13 CFU/m^3 at 69.5% humidity. Bacteria thrive in environments with humidity levels above 85%.

Univariate analysis of humidity measurement results in the delivery room can be seen in Table 3.

Table 4. Space Humidity Distribution

Humidity	Frequency (N)	Percentage (%)
Qualified	10	41,7
Unqualified	14	58,3
Total	24	100

Table 4 shows that the majority of the room humidity does not meet the requirements, with only 41.7% meeting the requirements. The results of the humidity measurement in the delivery room that do not meet the requirements are relatively high, indicating that it has the potential to be used as a place for microorganism growth and should be handled further. While low humidity can result in symptoms of eye irritation, throat irritation and coughing. Low humidity can also cause asthma.

Extreme humidity can be related to air quality. Humidity in the room can be caused by several factors, including a lack of air circulation and sunlight entering the room. If the room air humidity is above 60% using a dehumidifier, while if the room air humidity is below 40% it is necessary to use a humidifier.

To determine the relationship between variables, a bivariate analysis was performed using the IBM SPSS Statistics 23 program and the Spearman Rank test. Table 5 shows the results of Spearman's Rank analysis:

Table 5. The Results of Spearman Rank Analysis

No	Variable on Airborne Germs	R Value	P Value	Desc.
1	Occupancy Density	0,071	0,742	Not Significant
2	Temperature	-0,053	0,806	Not Significant
3	Humidity	-0,228	0,284	Not Significant

The analysis of the relationship between occupancy density and the number of airborne germs found that there is no relationship between the two variables (p = 0.752 > 0.05), indicating that the number of airborne germs in the delivery room is unaffected by occupancy density. The rho correlation coefficient is R = 0.071, which indicates a very weak relationship. According to this statistical test, there is no relationship between the number of airborne germs in the delivery room and occupancy density. The occupancy density measures how many people fit into a given amount of space in a building.[19]

This is consistent with Nugroho's (2016) research, which found no correlation between the number of visitors and the number of airborne germs in the third-class inpatient jasmine RSUD Dr. Moewardi.[16] This finding is consistent with Mayasari's (2019) finding that occupancy density in hospitals is not significantly related to the number of airborne germs (p = 0.193).[20] The absence of a relationship between occupancy density and airborne germ numbers can be explained by the presence of microorganisms from outside, such as splashes of water from human activities blown by the wind or soil carried by dust particles.

According to the findings of this study, the density of occupancy affects on the temperature and humidity of the room. Temperature and humidity, according to theory, can influence the number of airborne germs.

The relationship between temperature and airborne germ numbers was found to be p = 0.806 > 0.05, indicating that temperature does not affect on the number of airborne germs in the delivery room. The correlation coefficient between temperature rho and air germ numbers is R = -0.053, indicating that the relationship is very weak. These findings are consistent with Muntaha (2016) and Kasumawardhani (2019) that temperature and airborne germs are not significantly related.[21,22] However, it contradicts Nugroho's (2016) and Vidiyani's (2017) finding that temperature has no effect on the number of airborne germs in the treatment room of Bhayangkara H.S Samsoeri Mertojoso Hospital Surabaya.[23] This could be because all of the temperatures measured were still lower than the optimal temperature for germ growth. To prevent the growth of germs, room temperature must be monitored.

The analysis of the relationship between room humidity and airborne germ numbers obtained p = 0.284 > 0.05, indicating that humidity does not affect on the number of airborne germs in the delivery room. The correlation coefficient between rho humidity and airborne germ numbers is R = -0.228, indicating a weak relationship. This finding contradicts Ubaidillah's (2017) finding that air humidity has an effect on the number of airborne germs in the operating room of PKU Muhammadiyah Bantul General Hospital (p = 0.044).[24] According to Anggraini's (2020) research, there is also a significant relationship between humidity and airborne germ numbers in the inpatient room of the Faisal Islamic Hospital in Makassar (p = 0.034).[25]

Rooms with air conditioning have higher humidity levels than those without. Furthermore, when the air conditioner is turned off, it can become a breeding ground for germs and bacteria, allowing germs to escape into the air when the air conditioner is turned on. As a result, turning off and on the air conditioner while the door or window is closed is not advised.

The Spearman's Rank test revealed that room humidity had the highest correlation, ie -0.228, which was classified as a weak relationship level. Room temperature has the lowest correlation of -0.053, classifying it as a very weak relationship level. To ensure the quality of air germ numbers, it is hoped that air circulation will improve through the use of movable windows or an exhauster fan. The existence of air circulation will greatly affect other factors such as access to sunlight, air exchange, temperature, and humidity in a room. The function of the presence of ventilation in the room is to maintain the freshness of the air in the room.[26] Air conditioning service, replacement, and repair are also required. In addition to limiting the number of waiting patients and having cleaning staff clean the room regularly. And furthermore, similar research that can examine other factors related to the number of airborne germs is required.

CONCLUSION

Based on the findings of the study, it is possible to conclude that the quality of the airborne germ numbers in the delivery room met the requirements of the Ministry of Health RI No. 1204/Menkes/SK/X of 2004. The findings of this study revealed that occupancy density, temperature, and humidity did not affect on the number of airborne germs in the delivery room.

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