

ROOM AIR QUALITY AT HUSADA PRIMA HOSPITAL, EAST JAVA PROVINCE

Afifah Kartika Sari Cahyaningtyas, Khambali, Ernita Sari, Rachmaniyah

Surabaya Ministry of Health Polytechnic, Department of Environmental Health

Jl. Pucang Jajar Tengah No. 56 Surabaya East Java 60282

Email: afifahkartikasr@gmail.com

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ABSTRACT

Room Air Quality at Husada Prima Hospital, East Java Province. The microbiological quality of the air in the NICU and surgical rooms exceeds standards. The physical quality of the NICU and operating room exceeds the standard. This study aimed to determine the microbiological and physical quality of hospital room air (NICU room and surgical rooms) at Husada Prima Hospital, East Java Province. This research design was descriptive. Observation, field measurements, and laboratory tests collected data. The measurement results will be compared with RI Minister of Health Regulation No. 2 for 2023. The results of air microbiology sampling in the NICU, surgical room 1, and surgical room 2 still need to meet the requirements. The results of physical air quality measurements, namely temperature in the three rooms, humidity in the NICU room, lighting, and ventilation rate in the three rooms, must meet the requirements. The variables that meet the requirements are humidity in both operating rooms and lighting in the surgical room (Table 2). The condition of hospital facilities and buildings in the three rooms has met the requirements. The conclusion is that the room's air quality at Husada Prima Hospital, East Java Province, did not meet the criteria. The condition of the facilities and buildings was good. The hospital is advised to clean and repair air conditioners regularly, use humidifiers to maintain humidity in the room and increase or decrease lighting according to each room's needs.

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INTRODUCTION

The air needed by living creatures is healthy and clean. Polluted air can harm living things, especially humans. Apart from that, there is also dust, bacteria, and spores in the air that have the potential to spread airborne diseases ⁽¹⁾. Based on the 2016 World Health Organization (WHO) report, poor indoor quality caused 3.8 million people to die ⁽²⁾. Poor air flow and an increase in air temperature can cause discomfort in the room, leading to restlessness among those occupying it ⁽³⁾.

A hospital is a health service institution that provides complete individual health services, A hospital is a health care institution that provides complAccording to the United States Environmental Protection Agency (US EPA), indoor air pollutants in humans can pose a risk of exposure 2–5 times more, even experiencing a 100-fold increase in risk compared to the level of air pollution when outside ⁽⁵⁾.pose a risk of exposure 2–5 times more, even experiencing a 100-fold increase in risk compared to the level of air pollution when outside ⁽⁵⁾.

Nosocomial infections are caused by bacteria or germs and can occur in sufferers, visitors, and medical personnel in hospital areas. Patients hospitalized for a minimum period of 3x24

hours are at risk of infection ⁽⁶⁾. Based on data from the Centers for Disease Control and Prevention (CDC) in 2012, the incidence of healthcare-associated infections (HAIs) or nosocomial infections in 50 countries was found to be in treatment rooms (45%), intensive care units (ICUs) (41%), and neonatal intensive care units (NICUs) (8%).

The RII Minister of Health Regulation No. 24 of 2016 divides the risk of disease transmission into four areas: low, medium, high, and very high-risk zones. The NICU room falls under the category of rooms with a high risk of disease transmission, while the operating room is classified as having a very high risk of disease transmission. ⁽⁸⁾ However, this regulation has been revoked since the enactment of RI Minister of Health Regulation No. 14. However, this research continues to reference the Republic of Indonesia Minister of Health Regulation No. 24 of 2016 for the division of risk zones for disease transmission's regulation. The NICU room's quality standard is approximately 200 CFU/m³ ⁽¹⁰⁾. The latest regulations have not re-regulated quality standards other than operating rooms, so researchers use NICU room quality standards in these regulations even though the decision is no longer valid and has been revoked. Furthermore, the decision above was clarified or updated to state that the quality standard for empty operating rooms with microbiological parameters is 35 CFU/m³. The physical air quality standards for the NICU room are temperature 24–26°C, humidity 40–60%, noise 65 dBA, minimum lighting of 100 lux, and air flow speed 0.15–0.25 m/sec, while for the operating room it is temperature 22–27°C, humidity 40–60%, noise 65 dBA, lighting 300–500 lux, operating table 10,000–20,000 lux, and air flow speed 0.3–0.4 m/sec ⁽¹¹⁾.

According to data obtained from Husada Prima Regional Hospital, there has not been an examination of the microbiological quality of the air in the NICU room in 2022. The results of physical air quality measurements show that the temperature in both operating rooms in September did not meet the requirements, the humidity in the NICU room in March exceeded quality standards, and the lighting standards in March in operating rooms 1 and 2 exceeded quality standards. The research aims to determine the microbiological and physical quality of hospital room air (NICU room and operating room) at Husada Prima Hospital, East Java Province. The research's goal is clear, but it can be further clarified how the results will contribute to the field of environmental health or hospital management.

MATERIALS AND RESEARCH METHODS

Descriptive research is a type of research that aims to describe room air quality by measuring the physical quality of the air and measuring the microbiology of the air in hospital rooms (NICU rooms and operating rooms) based on the division of risk areas for disease transmission as well as direct observation of the condition of the facilities and buildings on the premises. The study took place at the Husada Prima Regional Hospital in the East Java Province. The research was conducted at Husada Prima Hospital, located on Jl. Coral Wall No. 39, Surabaya, East Java Province.

The research began by processing research permits from the hospital. Next, we conducted a preliminary survey to determine the number of research samples needed. After obtaining data from the preliminary survey, prepare a research proposal. Research data collection was carried out after preparing the proposal. The collected data is then managed and compared with the relevant regulations. Finally, we prepare scientific papers based on the obtained research results.

Research data was collected by direct observation using an observation sheet, measuring temperature using a thermometer, humidity using a hygrometer, measuring lighting using a lux meter, measuring wind speed using an anemometer, and taking air microbiology samples using a Microbiology Air Sampler (MAS). The secondary data used comes from the Husada Prima Regional Hospital, East Java Province, which includes the hospital profile and results of microbiological and physical air quality measurements in March and September 2022.

A descriptive analysis of the data was done by describing the thing being studied and including a table of the data's results. This was then compared to the rules in Republic of

Indonesia Minister of Health Regulation No. 2 of 2023 using the criteria for evaluation. The condition of facilities and buildings is classified into three categories: the good category if the score is 71 of the total score; the adequate category if the score obtained is between 35 and 70%; and the poor category if the score is less than 34% of the total score. Room air quality in the NICU and operating rooms meets requirements if the score is more than 60% of the total and does not meet requirements if the score is below 50% of the total.

RESEARCH RESULTS AND DISCUSSION

Air Microbiological Quality

Taking air microbiological samples in the operating room, namely in the corner area of the room where the operating equipment is placed and on the operating table. In the NICU room, samples were taken in the corners of the room, in the middle of the room, and near the entrance to the NICU room. The results of the air microbiological quality sample examination are as follows:

Table1. Air Microbiology Sample Examination Results

No.	Room Name	Sampling Point	Quality Standard Standard (cfu/m3)	Measurement Results (cfu/m3)	Note.
1.	NICU	Point 1	200	556.6	TMS
		Point 2		266.6	
		Point 3		490	
2.	Operation 1	Point 1	Empty operating rooms: 35	133.1	TMS
		Point 2		233.3	
3.	Operation 2	Point 1		133.3	TMS
		Point 2		90	

Source: Primary Data

According to Table 1, the number of germs in the NICU room continues to exceed the quality standards set by the Republic of Indonesia Minister of Health Decree No. 1204 of 2004. The number of germs in operating rooms 1 and 2 still exceeds the quality standards of the Republic of Indonesia Minister of Health Regulation No. 2 of 2023.

The findings of this research align with the observations made at Hospital "X" in Depok City, demonstrating that the overall condition of the building facilities satisfies the required standards. This is due to the condition of the floors, walls, ceilings, and doors, all of which adhere to the applicable regulations. ⁽¹²⁾ Lighting and temperature have an influence on the number of germs ⁽¹³⁾. A high number of germs in a room may indicate air pollution, which can increase the risk or impact of nosocomial infections ⁽¹⁴⁾.

The emergence of germs can be caused by poor physical air quality and poor maintenance of supporting facilities, which include the condition of the facilities and buildings in the room as well as the air circulation system.

Physical Air Quality

The physical quality of the air that is measured consists of temperature, humidity, lighting, and ventilation rate. The Republic of Indonesia Minister of Health Regulation No. 2 of 2023 governs the measurement of physical air quality in research. The measurement results are as below:

Temperature

Table2. Temperature Measurement Results

No.	Room Name	Quality Standards (°C)	Measurement Results (°C)	Note.
1.	NICU	24 - 26	23.9	TMS
2.	Operation 1	22 - 27	17.2	TMS
3.	Operation 2		17	TMS

Source: Primary Data

According to Table 2, the temperature measurements in the NICU room, Operation 1, and Operation 2 do not meet the requirements.

The higher the temperature, the higher the number of germs in the room ⁽¹⁵⁾. There are differences in measurement results in the morning, afternoon, and evening. As a result, the measurement time affects the high and low temperatures in the room ⁽¹⁶⁾.

Indoor activities can also contribute to increasing the temperature of the room or environment. Mechanical ventilation can also help to control indoor temperatures.

Humidity

Table3. Humidity Measurement Results

No.	Room Name	Quality Standards (%)	Measurement results (%)	Note.
1.	NICU	40 – 60	64.32	TMS
2.	Operation 1	40 – 60	47.8	M.S
3.	Operation 2	40 – 60	46	M.S

Source: Primary Data

The table above demonstrates that the humidity measurement results in the NICU room do not meet the requirements, while the humidity in operating rooms 1 and 2 meets the requirements, with both rooms having a humidity level of at least 40% and not exceeding 60%.

Low humidity, namely below 20%, can cause this in mucous membranes, but high humidity also causes increased microorganism growth. ⁽¹⁷⁾. Apart from temperature, the lack of natural ventilation and the condition of the paint in the room, which has the potential for microbial growth, can affect humidity ⁽¹⁸⁾.

Monitoring room temperature is one effort to maintain stable indoor air humidity.

Lighting

Table4. Lighting Measurement Results

No.	Room Name	Sampling Point	Quality Standards (lux)	Measurement results (lux)	Note.
1.	NICU	Point 1		52.85	TMS
		Point 2	Minimum 100 lux	104.85	
		Point 3		82	
2.	Operation 1	Point 1 (operating table)	a. Operating table: 10,000 – 20,000	38,175	TMS
		Point 2 (general operating room)	b. General operating room: 300 – 500	955.5	TMS
3.	Operation 2	Point 1 (operating table)		16,625	M.S
		Point 2 (general operating room)		770	TMS

Source: Primary Data

Based on table 4, the lighting in the NICU room, operating table 1, and operating room 2 does not meet the requirements because it exceeds the standards of RI Minister of Health Regulation No. 2 of 2023.

Lighting does not have a significant relationship with the number of microorganisms because the lighting in the operating room at Sumber Hidup Hospital already meets quality standards, so it is not in line with the results of this study. ⁽¹⁹⁾.

The light intensity can be adjusted by reducing or increasing the number of lights in the room and natural light, namely sunlight entering the room.

Air Flow Rate

Table5. Air Flow Rate Measurement Results

No.	Room Name	Sampling Point	Quality Standards (m/sec)	Measurement Results (m/sec)	Note.
1.	NICU	Point 1	0.15 – 0.25	0	TMS
		Point 2		1.7	
		Point 3		0.7	
2.	Operation 1	Point 1	0.3 – 0.4	0.3	TMS
		Point 2		0.6	
3.	Operation 2	Point 1		1,2	TMS
		Point 2		2.9	

Source: Primary Data

The air ventilation rate measurements in Table 5 show that in the NICU room, operations 1 and 2 did not meet the requirements.

There is an influence and relationship between the growth of germ numbers and the speed of ventilation ⁽²⁰⁾. Changes in temperature cause wind movement from high to low pressure, thus affecting wind speed. Microorganism growth in a room can be caused by a lack of ventilation maintenance or cleaning ⁽¹⁶⁾.

One way to prevent the AC or fan from becoming a breeding ground for microorganisms is to perform regular maintenance and cleaning.

Factors Affecting Air Quality

What is observed is the floor, door, ceiling, and walls in the room that are the object of research. The following are the results of the observations conducted on facilities and buildings:

Table6. Recapitulation Results of Assessment of Facilities and Building Conditions

No.	Room Name	Variable	Maximum Value	Earned Value
1.	NICU	a. Floor	5	5
		b. Door	3	3
		c. Palate	5	5
		d. Wall	4	4
		Total	17	17
		Assessment Category		Good
2.	Operation 1	a. Floor	5	3
		b. Door	3	3
		c. Palate	5	4
		d. Wall	4	4
		Total	17	14
		Assessment Category		Good
3.	Operation 2	a. Floor	5	5
		b. Door	3	3
		c. Palate	5	5
		d. Wall	4	4
		Total	17	17
		Assessment Category		Good

Source: Primary Data

Table 7 results indicate that the three rooms fall into the good category. The overall score for observing facilities and buildings is 48 out of 51. The assessment of observation facilities and buildings refers to Republic of Indonesia Minister of Health Regulation No. 40 of 2022 ⁽²¹⁾.

The research results contradict each other, indicating that the high number of germs in the room can also be attributed to the condition of the facilities and the physical quality of the air, both of which are not meeting the required standards. ⁽²²⁾. The condition of the facilities and buildings in the room has an impact on the performance of health workers ⁽²³⁾.

Regular monitoring of cooling towers in central ACs is carried out to ensure that they do not become breeding grounds for legionella bacteria.

Room Air Quality Assessment Results

Room air quality assessment is based on the results of microbiological and physical air quality measurements using an assessment form. If the measurement results meet the standards according to the Republic of Indonesia Minister of Health Regulation No. 2 of 2023, then they are rated 1, and those that are not suitable are rated 0. The assessment of the air quality in the three rooms yielded the following results:

Table 7. Recapitulation Results of Room Air Quality Assessment

No.	Room Name	Variable	Component	Maximum Value	Earned Value
1.	NICU room	Air microbiological quality	Number of germ numbers	1	0
			Temperature	1	0
		Physical quality of air	Humidity	1	0
			Lighting	1	0
			Air ventilation rate	1	0
		Total			5
Assessment criteria			TMS		
2.	Operating room 1	Air microbiological quality	Number of germ numbers	1	0
			Temperature	1	0
		Physical quality of air	Humidity	1	1
			Lighting	2	
			a. surgery room		0
			b. operating table		
			Air ventilation rate	1	0
		Total			6
Assessment criteria			TMS		
3.	Operating room 2	Air microbiological quality	Number of germ numbers	1	0
			Temperature	1	0
		Physical quality of air	Humidity	1	1
			Lighting	2	
			a. surgery room		1
			b. operating table		
			Air ventilation rate	1	0
		Total			6
Assessment criteria			TMS		

Source: Primary Data

The table above indicates that the assessment results, which are based on the examination of air microbiology samples and measurements of physical air quality, do not meet the requirements. This is because 14 out of the 17 variables still do not meet the standards set out in the regulations.

Air quality is influenced by the physical, chemical, and microbiological quality of the air, as well as the condition of facilities and buildings. However, previous research did not find a relationship between lighting and germ numbers ⁽²⁴⁾. This is inversely proportional to the results, which state that there is an insignificant relationship between temperature, dust particles, humidity, lighting, and occupancy density with germ numbers ⁽²⁵⁾.

Poor air quality can cause nosocomial infections for medical personnel, patients, and visitors, so indoor air quality needs to be monitored both microbiologically, physically, and chemically. To reduce the growth of bacteria in the room, clean the floors and furniture with disinfectant.

CONCLUSIONS AND RECOMMENDATIONS

The physical and microbiological quality of the air in the three rooms does not meet the requirements of the Republic of Indonesia Minister of Health Regulation No. 2 of 2023. The facilities and buildings in the NICU and surgery rooms are in good condition. Suggestions for

hospitals are to regularly clean and repair ACs, use humidifiers to maintain humidity, and increase or decrease lighting according to the needs of each room.

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