The Relationship Of The Level Of Knowledge And The Application Of Infection Prevention By Anesthesia Personnel In The Preparation Room And In The Operating Room

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Keywords:

Anesthesia infection control, hand hygiene, prevention of nosocomial infections, operating room safety.

Abstract

The operating room environment presents a significant risk for microbial transmission, which can compromise patient safety due to contamination of the anesthesia work area. This study examines the relationship between the level of knowledge of anesthesia personnel and the implementation of infection prevention measures in the preparation room and operating room. The descriptive-analytic method was used in this study, with primary data collected through a structured questionnaire that assessed the level of knowledge and practice of infection prevention among anesthesia staff at RSUP Dr. Wahidin Sudirohusodo Makassar. This research involved 88 anesthesia personnel, with data analysis using statistical methods to determine the relationship between variables. The results showed that although basic infection prevention practices such as hand hygiene and use of gloves have been implemented well, compliance with equipment disinfection protocols is still low. A significant relationship ($p < 0.01$) was found between the level of knowledge and implementation of infection prevention, where anesthesia personnel with a higher level of knowledge showed better compliance with infection prevention measures. These findings emphasize the need for increased infection prevention training as well as stricter enforcement of equipment disinfection protocols. Implementation of targeted education programs and strengthening standard operational procedures can improve infection control in the anesthesia environment, thereby reducing the rate of nosocomial infections and improving patient safety.

INTRODUCTION

The potential for transmission of clinically significant microbes in the operating room environment is a threat to patient safety. Much literature indicates the presence of contamination in anesthesia work areas, incl Hand Hygiene (HH), ABHR (Alkohol Based Hand Rub), anesthesia medical work baskets, masks, gloves and laryngoscope blades, touch screens, and keyboards, as well as the hands of healthcare providers, resulting in the transmission of infections that can increase the risk of patient death.[2]

The researchers stated that the operating room or Operation Room (OR) is an important environment to research to improve infection prevention and control to become ideal. Additionally, infection prevention and control policies specific to the anesthesia area of the OR are not universal; audits of infection prevention practices were not conducted routinely; and as a result, anesthesia providers may lack clarity regarding expected practices and behaviors. Several studies have reported practice problems by anesthesia providers, including use of multiple-dose vials for more than 1 patient, use of gloves for airway management, negligence in performing hand hygiene. (Hand Hygiene = HH)

after removing gloves, and taking the instruments into the anesthesia basket drawer without performing HH.[2]

The source of infection in the anesthesia work area indicates that the anesthesia work area may be contaminated with pathogens.[1-7] Hall[8] confirmed the presence of blood contamination on 33% of surfaces in direct contact with patients (e.g., blood pressure cuffs and oximeters), and found that visual inspection of anesthesia work area surfaces was insensitive for detection. In 2001, Miller et al[9] reported the presence of proteinaceous material, even after cleaning, in most laryngeal masks and laryngoscope blades. Maslyk et al[20] identified a significant environmental bioburden with commensal and pathogenic bacteria, including coagulase-negative Staphylococcus, Bacillus spp, Streptococcus, S. aureus, Acinetobacter and other gram-negative bacilli. With the use of double gloves by providers for airway management, contamination of the anesthesia work area is reduced but not eliminated.[10]

Fukada et al[11] reported significant contamination of computer keyboards in the OR with commensals and pathogens such as S. aureus and MRSA due to the HH practices of anesthesia providers. The intraoperative environment poses a clinically significant threat of bacterial transmission. Loftus et al[12] studied the impact of bacterial contamination of patients, providers' hands, and the environment on contamination in the OR. The care provider's hands and, in particular, the surrounding environment, are important drivers of bacterial transmission, which is associated with increased patient mortality within 30 days.[13] In subsequent research, Loftus et al[14] demonstrated that bacterial transmission in the anesthesia work area in the OR was associated with infection 30 days post-operatively, impacting 16% of patients undergoing surgery. Loftus et al found that contamination of anesthesia providers' hands was a proximal source of enterococci and staphylococci transmission in the anesthesia work area.[15,16] Birnbach dkk[17] reported high levels of fluorescent marker spread after simulated airway management, including fluorescence on the surfaces of the mannequin, IV hub, and keyboard, representing the potential for cross-transmission of bacteria during anesthesia care.[17]

A number of bacteria such as coagulase-negative staphylococci, Bacillus spp, and MRSA are found in the anesthesia work area, including computer touch screens and keyboards.[18] The anesthesia computer mouse is one of the most contaminated surfaces in the OR, followed by the OR bed, the nurse computer station mouse, the OR door, and the surface of the anesthesia medical work cart.[19] Moist surfaces, such as damp gloves or a computer keyboard, increase the risk of transmitting S. epidermidis from one surface to another.[20] Other areas of concern are semi-enclosed parts of anesthesia equipment and areas that are not easily cleaned, where bacteria can chronically colonize surfaces and microbial growth goes undetected.[21]

Drugs used in anesthetic practice can become contaminated during use and support the growth of microorganisms, including bacteria and fungi.[22] Mahida et al[23] assessed the frequency of bacterial contamination of intravenous fluids and drugs used, found in 101 surgeries performed in one hospital. Of the 426 used syringes, 15% of syringe tips and 4% of syringe contents became sites for bacterial growth, especially low numbers of colonies of skin organisms (coagulase-negative Staphylococcus spp, Micrococcus, and Kocuria). Contamination of syringe contents is significantly more common in emergencies than in elective surgery. As mentioned previously, Gargiulo et al[24] found bacterial growth in 10 of 197 syringes (5%), 5 of 17 syringes (35%), and 5 of 38 IV fluid bags (13%) into which the drug was injected, and gram-positive bacteria were most frequently isolated. The researchers observed that HH was never performed before admission to the simulation center or before preparing medication, and that drug vial septa and IV injection ports were never disinfected with alcohol before use. They also observed non-sterile equipment, including stethoscopes and medical records, placed over syringes, in-use and uncapped medications, but these researchers did not report the frequency of these observations. clinical anesthesia setting or practice, the same group of researchers found similar results in a follow-up study of actual patients in the OR.[25]

According to WHO, the incidence of surgical wound infections in the world is 5-34%. According to the NHS (National Health Scotland) there is a 15.9% incidence rate. The data obtained is based on hospital infection control and prevention data. Wahidin Sudirohusodo, the incidence of surgical site infections (SSI) in 2022 is 1.7%, and in 2023 it will increase by 1.9%.

The information above proves that the anesthesia area, especially in the operating room, has the potential for infection. This attracts all of our attention to find out the extent of infection prevention in

the operating room in the anesthesia area in hospitals in Indonesia, especially in hospitals that are partners of the Department of Anesthesia, Faculty of Medicine, Hasanuddin University.

We hypothesize that the level of knowledge and application of infection prevention by anesthesia personnel preoperatively and in the operating room still needs to be improved. In this study we wanted to determine the level of knowledge and application of infection prevention by preoperative anesthesia staff and in the operating room.

Based on the results of a literature search, the level of knowledge and application of infection prevention by preoperative anesthesia staff and in the operating room has never been done in Makassar. Therefore, this study is interested in analyzing the level of knowledge and application of infection prevention by anesthesia personnel preoperatively and in the operating room.

Library Review

1. Hand Hygiene (HH)

Hand hygiene (HH) is the main step in preventing nosocomial infections, especially in the anesthesia environment in the operating room (OR). The study by Muñoz-Price et al demonstrated that increased access to alcohol-based hand sanitizers (ABHR) contributed to the increased frequency of HH among anesthesiology staff during surgical procedures. In addition, other studies have shown that the use of wearable ABHR dispensers by anesthesia personnel improves compliance with HH, thereby reducing the level of bacterial contamination of anesthesia equipment and work areas.

Koff et al investigated the impact of installing a portable ABHR dispenser equipped with sensors capable of recording HH events. In a randomized, multisite trial, they found that installing a personal ABHR dispenser increased the frequency of HH up to eightfold compared with rooms that provided only a wall-mounted ABHR dispenser.

2. Use of Gloves in Anesthesia Practice

To reduce the risk of contamination in the OR, anesthesia personnel are advised to use double gloves during airway management. After the airway manipulation procedure is complete, the outer glove must be removed immediately, and as soon as possible the medical personnel must remove the inner glove and then perform HH.

Research shows that anesthesia personnel's hands are frequently contaminated by upper airway secretions during endotracheal intubation procedures. In these situations, HH practices are often neglected due to time constraints, thereby increasing the risk of cross-contamination to the anesthesia work area and medical tools in the OR.

3. Placement of ABHR Dispensers to Improve Hand Hygiene Compliance

Installing ABHR dispensers at strategic points in the OR can increase medical personnel's compliance with HH. Hospitals are advised to place ABHR dispensers at OR entrances and near anesthesia personnel during procedures. Several studies have shown that installing ABHR dispensers equipped with audible alarms can increase the frequency of HH and reduce the incidence of healthcare-associated infections (HAI).

Although the specific devices used in some of these studies are not yet commercially available, the recommendation to use wearable ABHR dispensers as automatic reminders when medical personnel miss HH procedures has been widely considered in the development of infection prevention policies in healthcare facilities.

4. Disinfection of Gloves

CDC and WHO recommend using ABHR to disinfect gloves as an alternative in emergency situations or under certain conditions, such as during an infectious disease outbreak. Recent studies show that multiple applications of ethanol-based hand sanitizer do not cause degradation of nitrile and latex glove materials. However, some types of gloves may become sticky after repeated use of ABHR.

The dilemma that arises in the current HH approach is that gloved hands are often assumed to be contaminated hands, while empty hands are considered clean after HH. Therefore, the application of ABHR to gloves requires further research to assess its effectiveness and impact in preventing infections.

5. Laryngoscope Blade and Handle

Several studies have found bacterial, blood, and lymphoid tissue contamination of laryngoscope blades and handles after low-level decontamination. Outbreaks of infectious disease have been associated with the use of inadequately disinfected laryngoscopes.

Laryngoscopes are categorized as "semi-critical" devices in anesthesia practice, so a high level of sterilization or decontamination must be performed before reuse. Regulations in some hospitals require that reusable laryngoscope blades must undergo a sterilization process and be packaged in a sterile container until use.

6. Five Moments for Hand Hygiene oleh WHO

WHO guidelines on Five Moments for Hand Hygiene emphasizes the importance of HH in five main situations, namely:

1. Before contact with patients.
2. Before performing aseptic procedures.
3. After contact with patient body fluids or secretions.
4. After direct contact with the patient.
5. After touching the patient's surroundings.

Observational studies found that anesthesia workers had a fairly high HH failure rate, reaching 82%. In certain situations, such as when losing a lot of blood or facing serious airway problems, the number of HH events recommended by WHO can reach 54 times per hour. Other research shows that installing an ABHR dispenser on an anesthesia machine can increase the frequency of HH anesthesia from 0.5 to 0.8 times per hour.

7. Contamination of drugs and intravenous injections

Research shows that intravenous tube plugs and injection ports are often contaminated with bacteria during intraoperative use. A prospective study found that approximately 30% of stopcock samples tested showed bacterial contamination, including Staphylococcus aureus and gram-negative bacteria.

The level of compliance with injection site disinfection practices before injection is still low. Only about 20.9% of anesthesiologists in several hospitals always disinfect with alcohol before injecting intravenous drugs. This low compliance is one of the factors that increases the risk of nosocomial infections.

8. Anesthesia Environment Cleaning

Anesthesia work areas are often contaminated with pathogens, including Staphylococcus aureus and Acinetobacter. Several studies have shown that surfaces frequently touched by anesthesia personnel, such as computer touch screens and anesthesia machines, have high levels of contamination.

To reduce the risk of infection transmission, several main recommendations that need to be implemented are:

- Perform routine cleaning and disinfection of anesthesia machines, IV poles, pressure limiting valves, and other work surfaces.
- Uses no-touch disinfection technologies, such as ultraviolet-C light or hydrogen peroxide cleaning systems, to reduce bacterial contamination of anesthesia equipment.

9. Airway Management

Unhygienic airway management practices can increase the risk of nosocomial infections. Several studies have shown that laryngoscope blades and handles that have been disinfected can still carry bacteria and residual blood from previous patients. This increases the risk of cross-contamination between patients.

Additionally, some studies recommend wearing double gloves when performing intubation to reduce the risk of cross-contamination. Simulation studies with fluorescent markers show that wearing double gloves and immediately discarding the outer glove after airway management significantly reduces the spread of microorganisms to the surrounding environment.

METHOD

Research Design

This research is a descriptive-analytical study with primary data collection techniques through knowledge-level questionnaires and infection prevention questionnaires for anesthesia staff in the preparation room and in the operating room. Research data will be described using tables and graphs according to the variables identified during the research.

Place and Time of Research

The research was conducted in the Operating Room of RSUP Dr. Wahidin Sudirohusodo Makassar. The research will begin in October 2024.

Population and Sample

The research population was anesthesia staff who worked in the anesthesia area in the operating room at the hospital, and prepared patients for planned surgery at Wahidin Sudirohuso General Hospital. The research sample is part of the research population, namely anesthesia staff at a hospital that is a partner of the Department of Anesthesia, Faculty of Medicine, Hasanuddin University.

Sampling Technique

Sampling was carried out using the purposive sampling method, namely a technique for determining samples with certain considerations, without randomization. In this research, the sample size was determined using the Normogram technique Harry King. How to determine samples using the Normogram technique Harry King is by drawing a straight line from the line on the right which is the population outline, through the middle line which is the line of the desired error rate and will arrive at the line on the left which shows the percentage of the sample size. Once the sample percentage is known, the next step is to multiply the sample percentage by the population size and the multiplying factor. The results of the multiplication are then rounded off to make it easier for researchers to determine sample members. The population in this study was 88, which came from the number of residents and operating room nurses at Dr Wahidin Sudirohusodo Hospital. The confidence level used is 95% or an error rate of 5%, and the multiplier factor for the 5% confidence level is 1.195. Calculation of sample size using Normogram Harry King This is done by drawing a line from a population of 101, passing an error level of 5%, then a point will be found below approximately 80%, then the calculation to take the sample size taken is 0.7 X 101

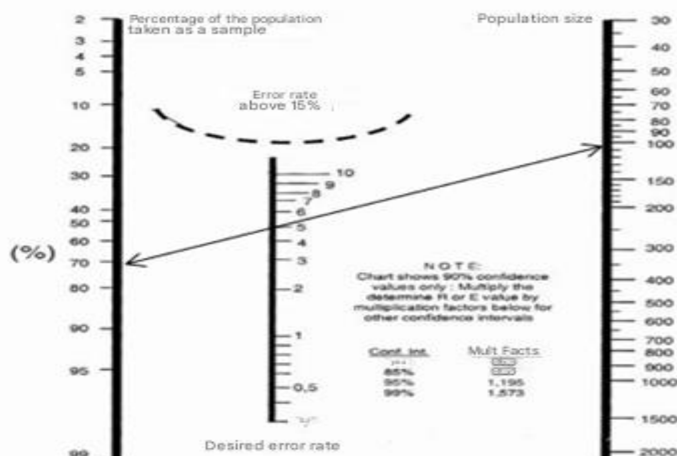

Figure 1 Normogram Harry King

Data Collection

To collect data and information about infection prevention and control policies and practices for anesthesia providers in the operating room (OR.), a survey will be conducted. The survey was carried out using a Google form in the form of a questionnaire. This questionnaire will be filled out by the surveyor. Surveyors or data and information collectors are anesthesia staff who have received training

to fill out questionnaires. The anesthesia staff in question are anesthesia residents and anesthesia staff on duty in the anesthesia area of the operating room, at the time this research took place.

RESULT AND DISCUSSION

a. Result

Normality of Sociodemographic Characteristics

Table 1 Normality of sociodemographic characteristics of anesthesia staff at RSUP. DR. Wahidin Sudirohusodo, 2024

Variable	Characteristics	Frequency	Percentage (%)	p
Gender	Man	66	75	<0.01*
	Woman	22	25	
Age (Years)	21-30	13	14.8	
	31-40	70	79.5	
	41-50	4	4.5	
	51-60	1	1.1	
Profession	Resident	73	83	
	Stylist	15	17	
Length of Service (Years)	0-10	80	90.9	
	11-20	3	3.4	
	21-30	5	5.7	

Data on gender, age, profession, length of work are displayed with frequency and percentage. *<0.05 significant in Kolmogorov Smirnov test

Table 1 above shows the sociodemographic characteristics of anesthesia staff at RSUP. Dr. Wahidin Sudirohusodo in 2024 shows that the majority of anesthesia staff are male, namely 66 people (75%), while female staff are 22 people (25%). Based on age group, the majority were in the 31-40 year age range with 70 people (79.5%), followed by the 21-30 year age group with 13 people (14.8%), 4 people aged 41-50 years (4.5%), and only 1 person (1.1%) who was 51-60 years old. In terms of profession, the majority of anesthesia staff are residents, namely 73 people (83%), while the remaining 15 people (17%), are anesthetists. Based on length of work, the majority of anesthesia staff had work experience of 0-10 years with a total of 80 people (90.9%), followed by 5 people (5.7%) who had work experience of 21-30 years, and 3 people (3.4%) who had work experience of 11-20 years.

Knowledge related to occupational risks of anesthesia

Table 2 Knowledge related to occupational risks of anesthesia

Variable	Response	Frequency (N)	Percent (%)
Knowledge of infection prevention guidelines	Of	41	46.6
	No	47	53.4
Knowledge of the existence of an Infection prevention Committee	Of	45	51.1
	No	43	48.9
	Of	45	51.1

Infection prevention Training History	No	43	48.9
Vaccine history hep. B	Of	88	100
	No	0	0
History of needle stick injury	Of	66	75
	No	22	25

Data is displayed with frequency and percentage.

Based on Table 6.2 above, it shows the supporting factors and risks related to Anesthesia work at Dr. RSUP. Wahidin Sudirohusodo. The majority of respondents admitted that they had been pricked by a needle while working, namely 66 respondents (75%), and all respondents admitted that they had been vaccinated against Hepatitis B while working. The majority of respondents admitted that they were aware of the existence of infection prevention committees and guidelines in hospitals, namely 85 and 41 respondents (96.9% and 46.6%). And the majority of respondents admitted that they had attended training related to infection prevention, namely 45 respondents (51.1%).

Anesthesia Professionals' Knowledge of Infection Prevention

Table 3 Knowledge of anesthesia staff regarding infection prevention

No	Knowledge Questions	Of (%)	No (%)
1	Did you know that pathogens can be found on healthy skin	48 (51.1)	40 (42.6)
2	Do you believe washing your hands can reduce the risk of healthcare-associated infections?	88 (100)	-
3	Did you know that unsterile equipment can cause nosocomial infections	88 (100)	-
4	Are you aware of any infection prevention guidelines in your workplace	41 (46.6)	47 (53.4)
5	Did you know the Hepatitis B vaccine is important to prevent infection in health workers	88 (100)	-
6	Do you realize the importance of training to improve infection prevention	88 (100)	-
7	Did you know there is an infection prevention committee at your workplace	45 (51.1)	43 (48.9)
8	Did you know that poor hygiene practices increase the risk of nosocomial infections	88 (100)	-
9	Do you believe that surgical patients are at high risk for nosocomial infections	88 (100)	-
10	Did you know that contamination of anesthesia equipment can cause infection	88 (100)	-
11	Do you believe that strong infection prevention policies can reduce nosocomial infections	48 (54.4)	40 (45.6)
12	Did you know that washing your hands is the most important step to prevent infection	88 (100)	-
13	Have you received training on infection prevention	45 (51.1)	43 (48.9)
14	Did you know that needle injuries can cause disease transmission	83 (94.3)	5 (5.7)
15	Are you aware that infection prevention training is important for healthcare workers	88 (100)	-

Data is displayed with frequencies and percentages.

Based on table 6.4 above, it shows the level of knowledge of anesthesia staff at RSUP Dr. Wahidin Sudirohusodo regarding infection prevention, the majority of anesthesia workers (51.1%) know that pathogens can be found on healthy skin, and all respondents (100%) are aware that washing hands can reduce the risk of healthcare-related infections, unsterile equipment can cause nosocomial infections, as well as the importance of the Hepatitis B vaccine and training to prevent infection. In addition, anesthesia professionals also understand that poor hygiene practices, contamination of anesthesia equipment, and needle injuries can increase the risk of nosocomial infections. As many as 48% of respondents also believe that strong infection prevention policies can reduce nosocomial infections, and hand washing is the most important step in such prevention.

However, there is a weakness in awareness of workplace infection prevention guidelines and structures. Only 46.6% of respondents were aware of infection prevention guidelines, while 53.4% did not know. In addition, 51.1% of respondents reported having received training related to infection prevention, while 48.9% had never received such training. Overall, the level of knowledge of anesthesia personnel is very high, however, efforts to increase awareness of official guidelines and training need to be increased to ensure more effective implementation.

Implementation of infection prevention by anesthesia personnel

Table 4 Implementation of infection prevention by anesthesia personnel

No	Implementation Questions	Of (%)	No (%)
1	Do you always wash your hands before and after contact with patients?	88 (10)	-
2	Do you use alcohol-based antiseptic to wash your hands	88 (100)	-
3	Do you clean your stethoscope after each use?	63 71.6)	25 (28.4)
4	Do you disinfect the anesthesia machine after each procedure	15 (17)	73 (83)
5	Do you always use aseptic technique during invasive procedures	88 (100)	-
6	Do you wear gloves when in contact with body fluids	88 (100)	-
7	Do you wear gloves when performing tracheal intubation	88 (100)	-
8	Do you ensure all medical equipment is disinfected before reuse	53 (60.2)	35 (39.8)
9	Do you use 0.5% chlorine solution to disinfect equipment	15 (17)	73 (83)
10	Do you clean the breathing circuit filter after each use	62 (70.5)	26 (29.5)
11	Do you wear a surgical mask when in the operating room	88 (100)	-
12	Do you always change gloves for each patient	88 (100)	-
13	Do you report any incidents of needle injuries to superiors	65 (73.9)	23 (26.1)
14	Do you re-cap the syringe with one hand	66 (75)	22 (25)
15	Did the patient have skin hair shaved at the surgical site, before the operation was carried out?	71 (80.7)	17 (19.3)
16	Have the patient bathed in the room before being wheeled into the operating room	44 (50)	44 (50)
17	Do you always clean the drug injection hole on the threeway before inserting the drug	62 (70.5)	26 (29.5)
18	Do you check the expiration date of the drug before using the drug?	62 (70.5)	26 (29.5)

Data is displayed with frequencies and percentages.

Based on table 6.3 above, it shows the level of implementation of infection prevention by anesthesia staff at Dr. RSUP. Wahidin Sudirohusodo. Basic practices such as washing hands before and after contact with patients, using alcohol-based antiseptics, applying aseptic techniques during invasive procedures, wearing gloves when in contact with body fluids and during tracheal intubation, using surgical masks in the operating room, and changing gloves for each patient are carried out completely by all anesthesia staff (100%).

Additionally, several other practices demonstrated fairly high levels of compliance, such as cleaning stethoscopes after use (71.6%), ensuring medical devices are disinfected before reuse (60.2%), and cleaning breathing circuit filters after each use (70.5%). Reporting needle injury incidents to superiors (73.9%) and recapping needles with one hand (75%) also had good compliance rates, as did shaving hair at the surgical site before the procedure (80.7%).

However, there are practices with low levels of compliance, such as disinfecting anesthesia machines after each procedure (17%) and using 0.5% chlorine solution to disinfect equipment (17%). In addition, only half of the anesthesia staff bathed the patient in the room before being transferred to the operating room (50%). These results indicate that although anesthesia personnel have implemented basic infection prevention practices well, there is still a need to increase awareness and compliance with equipment disinfection practices to minimize the risk of nosocomial infections.

The relationship between the level of knowledge and the level of implementation of infection prevention

Table 5. Relationship between level of knowledge and level of implementation of infection prevention

		Implementation level		Total	p
		Apply	Not implementing enough		
Knowledge level	Extensive Knowledge	46	2	48	<0,01*
	Limited knowledge	0	40	40	
Total		46	42	88	

*significant p <0.05 tested with chi square

Based on table 5 above, it shows that of the total 48 respondents with extensive knowledge, 46 people (95.8%) implemented infection prevention well, while only 2 people (4.2%) did not implement it well. In contrast, of the 40 respondents with limited knowledge, none (0%) implemented infection prevention, and all of them (100%) were in the group that did not implement it enough. Overall, out of a total of 88 individuals, 46 people implemented infection prevention, while 42 people did not implement it enough. Then the relationship between the level of knowledge and the level of application of infection prevention was obtained ($p < 0.01$), this shows that the level of knowledge and the level of application have a significant relationship to infection prevention.

b. Discussion

Normality of Sociodemographic Characteristics

Sociodemographic characteristics of anesthesia staff at Dr. Wahidin Sudirohusodo in 2024, based on the Kolmogorov-Smirnov statistical test on the variables gender, age, profession and length of work, it was found that the data distribution was not normal with $p<0.01$. This is related to the gender distribution which is dominated by men (75%), which reflects the dominance of the male workforce in

the field of anesthesia. Meanwhile, the proportion of women is only 25%, this is due to perceptions or challenges in the anesthesia profession, such as physical demands and long working hours.

Based on age group, the majority of anesthesia staff are in the productive age range, namely 31-40 years (79.5%). This shows that the anesthesia staff at RSUP Dr. Wahidin Sudirohusodo is mostly at the peak of productivity and work experience. The young age group (21-30 years) reached 14.8%, which reflects the presence of new workers or residents who are in the early stages of their careers. The number of workers aged 41 years and over is relatively small, only 5.6%, which indicates a potential shortage of experienced workers at a more mature age.

Age is an important factor in infection prevention practices, showing that health workers aged over 30 years or older are twice as likely to practice infection prevention activities well when compared to those aged less than 30 years. This is comparable to other studies[57, 58]. This could be due to the fact that as people age, years of service increase which in turn improves their practice over time. In terms of education level, health workers with higher levels of education were positively associated with better practice of infection prevention activities than health workers with lower levels of education. These results conflict with research conducted in the Amhara region[57]. These differences may be due to sample size, differences in study participants and reporting errors or self-reporting.

In terms of profession, the majority of anesthesia staff are residents (83%), while only 17% are anesthesia practitioners. This resident dominance could indicate that RSUP Dr. Wahidin Sudirohusodo also acts as an education center for anesthesia staff. However, dependence on residents can pose challenges regarding continuity of service once the resident completes their education.

Based on length of work, the majority of anesthesia staff had work experience of less than 10 years (90.9%). This is in accordance with the dominance of young and resident age groups in the workforce. However, the proportion of workers with more than 10 years of experience is quite small, namely only 9.1%. This condition indicates the need to maintain experienced workers to ensure service quality remains optimal. This study revealed that work experience was another factor significantly associated with the practice of infection prevention activities. Health workers who have work experience of more than ten years are three times more likely to carry out infection prevention activities, which is in line with research in Bahirdar city [59].

As many as 89.8% of anesthesia staff have participated in infection prevention training, showing the hospital's commitment to developing workforce competency in preventing infections. However, there are still 10.2% of workers who have not received training. This shows that there is an opportunity to increase workforce capacity through comprehensive training, especially in facing the growing challenge of infections. Apart from that, it is in line with other research[59,60], these findings suggest that healthcare workers who have undergone infection prevention training and have infection prevention supplies readily available are more likely to have good infection prevention practices. A possible explanation for this finding is the fact that training on current guidelines can improve HCWs' knowledge and skills as they will easily understand the basic principles, standards of practice, and apply them consistently. Additionally, up-to-date knowledge and skills regarding infection prevention can also increase HCWs' confidence in adhering to recommended guidelines and available supplies.

Overall, these sociodemographic characteristics show the predominance of young workers, especially residents, with relatively short work experience. Hospitals need to strengthen continuity of education and capacity development, especially in infection prevention, to maintain the quality of long-term health services.

Knowledge related to occupational risks of Anesthesia

Anesthesia work background at RSUD DR. Wahidin Sudirohusodo provided a fairly clear picture of various aspects related to infection prevention and work safety among the respondents. First, the data shows that 75% of respondents experienced needle stick injuries, while 25% did not. The high proportion of respondents who experienced needle stick injuries reflects the existence of quite serious work safety risks, especially in the management of sharp tools. This condition demands more effective prevention efforts, such as special training on techniques for safe use of sharp tools, procurement of better personal protective equipment, and increased compliance with work safety protocols.

Then, all respondents (100%) have a history of Hepatitis B vaccination. This shows a very high level of compliance with the vaccination program which is designed to protect health workers from the risk of Hepatitis B infection. This high vaccination coverage can be an indicator of the success of

preventive health programs in the respondents' work environment, as well as showing the commitment of the relevant institutions in providing vaccinations to health workers.

Regarding the infection prevention committee, 96.9% of respondents stated that they knew or had access to this committee, while only 3.34% of respondents did not know. This very high proportion indicates that there is an established infrastructure for managing the risk of infection in the work environment, including the possibility of policies or procedures facilitated by the committee. However, the small group being unaware of the committee's existence indicates an information gap that needs to be addressed so that all health workers can take advantage of the facilities and support available.

One weakness seen in this data is the implementation of infection prevention guidelines. Only 46.6% of respondents said they followed these guidelines, while 53.4% did not. This is a serious concern because it shows that more than half of respondents have not implemented the guidelines which should be a reference in preventing the spread of infection. This low level of implementation may be due to a lack of distribution of information, lack of access to guideline documents, or lack of socialization about the importance of implementing these guidelines. More massive educational efforts, accompanied by the provision of guidance materials in formats that are easy to access and understand, could be an important step to increasing compliance.

In the aspect of infection prevention training, 51.1% of respondents had attended training, while 48.9% had not. The high coverage of this training indicates that the majority of health workers are equipped with the relevant knowledge and skills to prevent infections. However, the presence of respondents who have not participated in training indicates that there is an opportunity to improve the quality and coverage of the training program. Ensuring that all healthcare workers receive adequate training is critical to achieving uniform implementation of infection prevention practices.

Overall, these data illustrate success in several aspects, such as Hepatitis B vaccination coverage and infection prevention training. However, major challenges remain, especially related to the high incidence of needle stick injuries and the low level of implementation of infection prevention guidelines. More coordinated efforts are needed to address these weaknesses, including strengthening occupational safety training, increasing access to guidelines, and monitoring implementation of infection prevention guidelines in the field. With these steps, work safety and protection of health workers can be further improved.

Level of Application of Anesthesia Staff in Infection Prevention

The level of application of anesthesia staff to prevent infection at RSUP Dr. Wahidin Sudirohusodo is very good at basic infection prevention practices. All anesthesia staff (100%) carry out actions such as washing hands before and after contact with patients, using alcohol-based antiseptics, applying aseptic techniques during invasive procedures, using gloves when in contact with body fluids or performing tracheal intubation, using a surgical mask when in the operating room, and changing gloves for each patient. This compliance reflects a good understanding of the importance of basic infection prevention practices in reducing the risk of nosocomial infections.

The results of this study are in line with research conducted by Lowman et al[36] who stated that several times administering ethanol-based hand sanitizer did not show signs of degradation of nitrile and latex glove materials; however these studies did not test all available gloves and mostly evaluated tensile strength or permeability, which can serve as indicators of glove degradation. Additionally, investigators reported that some types of glove materials may become sticky to the touch after repeated administration of ABHR, but this is not considered a problem in clinical use.

The degree of compliance with other practices shows variation. The majority of anesthesia staff cleaned stethoscopes after use (71.6%), cleaned breathing circuit filters after each use (70.5%), ensured medical equipment was disinfected before reuse (60.2%), and reported needle injury incidents to superiors (73.9%). In addition, shaving hair at the surgical site before the procedure has a high compliance rate (80.7%), which reflects the fairly good implementation of preoperative standards. In contrast, there were practices with low levels of compliance, such as disinfecting anesthesia machines after each procedure (17%) and using 0.5% chlorine solution to disinfect equipment (17%). Compliance with patient bathing before surgery also only reached 50%, indicating the need for more attention to this procedure. Low compliance with these practices has the potential to increase the risk of contamination and spread of infection.

Practices for cleaning, handling, and processing of anesthesia equipment have been published by Association of erioperative Registered Nurses (AORN).[2] Martin dkk[66] reported a significant reduction in CLABSIs with improved practices in the OR including HH, strategic gloving, and standardized cleaning of anesthesia baskets, IV poles, stopcock clamps, anesthesia machines, computers, monitors, knobs, surfaces, and laryngoscope handles). Clark et al[14] trained a group of anesthesia providers to keep anesthesia equipment baskets clean, placed a placard on the top of the basket stating "clean hands only," marked the surface of the anesthesia machine for materials used during the case, and placed separate containers on the anesthesia equipment. anesthesia machine for contaminated items. Locations known to be contaminated are cleaned with an ammonium chloride based wipe. After performing this intervention, the number of colonies decreased significantly on the adjustable pressure limiting valve, oxygen control knob, anesthetic agent control button, and the first and second drawers of the anesthesia equipment basket.[14]

Although several studies identified through the literature search demonstrated contamination of anesthesia equipment and work spaces, as well as the possible transmission of various microorganisms in the anesthesia environment, the search did not identify studies evaluating the impact of equipment enclosures on environmental contamination levels. Or at the risk of patient infection. Maslyk et al[39] swabbed surfaces of anesthesia machine tables located in randomly selected ORs and detected Acinetobacter and other gram-negative bacilli, S. aureus, and coagulase-negative staphylococci, before and after the device was used, despite routine cleaning. Baillie et al[3] obtain swabs from surfaces of anesthesia and monitoring equipment that do not come into contact with the patient but are routinely touched by anesthesia providers during surgical procedures, including oxygen, nitrous oxide and air flow control knobs, vaporizer buttons, respiratory system bags, adjustable pressure limiting valves, and monitoring control buttons. They detected the same types of bacteria as Maslyk et al.

Loftus et al assess[33] transmission of potentially pathogenic bacteria in the anesthesia work area by culturing intravenous stopcock sets and adjustable pressure limiting valve complexes, as well as agent buttons before starting the surgical procedure and after the case is completed. They noted a significant increase in the number of bacterial colonies per sample surface area at case conclusion and found bacterial contamination of intravenous stopcock sets in 32% of cases, as well as an association between the risk of stopcock contamination and anesthesia-level workspace contamination. In a series of follow-up studies, they evaluated the transmission dynamics of enterococci, S. aureus, and gram-negative organisms by comparing isolates found on patient screening cultures, anesthesia provider hands, and anesthesia provider hands and adjustable pressure limiting valves and agent buttons on anesthesia machines during first and second surgical cases (case pairs) performed on selected days at 3 academic medical centers. Isolate relatedness was based on species, antimicrobial susceptibility results, and temporal relationships.[32,33,34] For all three types of organisms, the possibility of transmission is common and appears to involve reservoirs of hand contamination from the environment and the anesthesia provider. Mahida et al[37] performed swab cultures on the outer surface of the syringe tip and syringe contents in addition to swabbing the surface of the ventilator machine and found that the same bacterial species were cultured from both the ventilator and the syringe tip in 13% of cases, as well as on the infusion. Fluid administration occurred in 4% of cases, indicating the potential for environmental contamination leading to contamination of intravenously administered drugs.[38]

Overall, these results suggest that although anesthesia personnel have implemented basic practices well, there is a need to improve compliance with equipment disinfection procedures and other preoperative measures. Advanced training and close supervision can help ensure comprehensive implementation of infection prevention measures to improve patient safety.

Level of Knowledge of Anesthesia Staff regarding Infection Prevention

The level of knowledge of anesthesia staff at RSUP Dr. Wahidin Sudirohusodo regarding infection prevention, the majority of anesthesia workers (51.1%) know that pathogens can be found on healthy skin, and all respondents (100%) are aware that washing hands can reduce the risk of health care-related infections, unsterile equipment can cause nosocomial infections, as well as the importance of the Hepatitis B vaccine and training to prevent infection. In addition, anesthesia professionals also understand that poor hygiene practices, contamination of anesthesia equipment, and needle injuries can increase the risk of nosocomial infections. As many as 100% of respondents also believe that strong

infection prevention policies can reduce nosocomial infections, and hand washing is the most important step in such prevention.

However, there is a weakness in awareness of workplace infection prevention guidelines and structures. There were 51.1% of respondents who were aware of infection prevention guidelines, while 48.9% did not know. In addition, 51.1% of respondents reported having received training related to infection prevention, while 48.9% had never received such training. Overall, the level of knowledge of anesthesia personnel is very high, however efforts to increase awareness of official guidelines and training need to be increased to ensure more effective implementation.

Additionally, this study showed that healthcare workers who adhered to the guidelines were more likely to carry out infection prevention activities than those who did not adhere to the guidelines. This is in line with other research in Nigeria[69] and Australia[70]. This is due to the fact that those who adhere to IP guidelines are aware of the latest information and are aware that they are exposed to HAIs, which validates their practices[60].

Although extensive efforts have been made to minimize possible shortcomings of this study, the findings can be interpreted in light of some inevitable limitations. The cross-sectional nature of this study would make it impossible to establish a temporal relationship between outcome and predictor variables. These studies are also susceptible to social desirability bias which can lead to overestimation or underestimation of research results.

The Relationship Between the Level of Knowledge and the Level of Implementation of Infection Prevention

The relationship between the level of knowledge and the level of application of infection prevention by anesthesia personnel. It was found that anesthesia personnel with a broad level of knowledge had a much higher tendency to implement infection prevention than those with limited knowledge. Of the 48 respondents who had extensive knowledge, 46 people (95.8%) succeeded in implementing infection prevention well. In contrast, none of the respondents with limited knowledge implemented infection prevention adequately; all of them (100%) are included in the group that does not implement enough. Statistical analysis shows a p value <0.01, which means there is a significant relationship between the level of knowledge and the implementation of infection prevention. These findings indicate that anesthesia personnel's level of knowledge directly influences their infection prevention practices in the workplace.

Extensive knowledge allows medical personnel to understand the importance of each infection prevention step, such as washing hands, using antiseptics, disinfecting tools, and implementing aseptic techniques. Conversely, limited knowledge may lead to a lack of awareness of the risks of nosocomial infections and the possible consequences of inadequate practice. The results of this study emphasize the need for interventions that focus on increasing the knowledge of medical personnel, such as regular training, seminars, and distribution of standard infection prevention guidelines. In addition, ongoing evaluation of infection prevention implementation is necessary to ensure that medical personnel not only understand, but are also consistent in implementing these measures. This is important to minimize the risk of nosocomial infections and ensure the safety of patients and medical personnel themselves.

These findings are in line with many similar and related studies in Zambia 74.4 [66] and Bahirdar city, 84.5% [58]. This finding is better than research conducted in Nigeria, 65% [64], Nepal, 22% [65], Palestine, 53.9% and Iranian hospitals, 57% (due to differences in Gengatharan values)[61,62] although lower than research conducted in Addis Abeba[68] and Dessie referral hospital, 95.7% [67]. These differences may be due to a lack of in-service training, sample size, and sociodemographic differences.

The proportion of healthcare workers practicing appropriate infection prevention activities was 52.3% which is in line with research conducted in hospitals in Egypt[63] and in Bahirdar town[58]. However, this figure is much lower compared to research[57,61,62]. This discrepancy may be due to differences in knowledge of infection prevention, methodology, sample size, socio-demographic differences, lack of in-service training and infection prevention supplies, and non-compliance of professionals with infection prevention.

In this study, the anesthesia workforce was dominated by old age, which was significantly related to knowledge. This could be a contributing factor as health workers age, tending to increase their knowledge through experience and working with senior staff. Male healthcare workers were found to

be twice as likely to be knowledgeable about infection prevention when compared with females. A possible explanation for this finding may be related to the educational status of the participants as most of the BSc or MSc degree holders were male. This finding is in line with other research [57,61,62].

Health workers with higher levels of education have higher knowledge scores compared to those with lower levels of education. This may be because health workers with higher levels of education may already have the necessary information, so they can receive infection prevention training [61]. Length of work was also another factor related to knowledge scores, which stated that health workers who had worked for more than 10 years were more likely to have better knowledge about infection prevention. This is in line with findings from Ethiopia[57, 59]. This may be because as the number of years in practice increases, healthcare workers are exposed to repeated exposure and become more experienced through working with senior staff.

In addition, knowledge of infection prevention was significantly associated with having attended infection prevention training. Health workers who have never attended training do not have better knowledge than their colleagues. This is similar to research in various countries [61,62]. This may be because those who have never attended training are less likely to be up to date with the latest information, which hinders updating their knowledge about infection prevention.

CONCLUSION

The level of implementation of infection prevention by anesthesia personnel in the OR is very good in basic practices, such as hand washing, use of antiseptics, and implementation of aseptic techniques. However, there are practices with low compliance rates, such as disinfection of anesthesia machines and the use of certain disinfection solutions, that require more attention to reduce the risk of nosocomial infections.

The level of knowledge of anesthesia staff regarding infection prevention is also very high, the majority of anesthesia staff understand the importance of hand hygiene, sterilization of equipment, and infection prevention policies. However, awareness of official guidelines and implementation of infection prevention training still needs to be improved.

There is a significant relationship between the level of knowledge and the level of implementation of infection prevention in the OR. Anesthesia personnel with extensive knowledge are more likely to implement infection prevention effectively.

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