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The Relationship between Sevoflurane Volatile and Time to Recover from Consciousness in Patients After General Anesthesia

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Rahmadiya Hadi Putri[1*], Asmat Burhan[1], Feti Kumala Dewi[2]

[1]Anesthesiology Nursing Study Program Applied Undergraduate Program, Faculty of Health Harapan Bangsa University, indonesia
[2]Midwifery Study Program Associate Degree Program Faculty of Health, Harapan Bangsa University, indonesia

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***Corresponding author:**
Rahmadiya Hadi Putri

Anesthesiology Nursing Study Program Undergraduate Program Faculty of Health Harapan Bangsa University, Indonesia Jl. Raden Patah No.100, Ledug, Kembaran, Banyumas, Indonesia.

Email: rahmadiya19@gmail.com

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Abstract

Background: Prolonged recovery time following anesthesia is one of the most common complications, so it is essential to prevent delayed recovery of consciousness because it is crucial for improving patient outcomes. Volatile sevoflurane is generally a good anesthetic because of its safety profile and relatively quick recovery time post-anesthesia. **Purpose:** The study aims to assess the relationship between the use of volatile sevoflurane and the time taken by patients to regain consciousness after general anesthesia in Kardinah Hospital, Tegal City. **Methods:** This study used a descriptive correlational design with a cross-sectional approach where a total of 128 subjects was obtained using consecutive sampling, and data needed at the inpatient and outpatient surgery were collected using a questionnaire between June 1 and June 20 about the year 2024. The main data collection instruments were Observation sheets and Spearman correlation analysis sets. **Results:** Findings indicate that most of the patients regain consciousness in 25 minutes following general anesthesia using 2%-2.5% volatile sevoflurane (36 patients, 28.1%). Only a small number of patients had to wait up to 45 minutes to regain consciousness, with just one patient (0.8%) having this lengthy delay. Analyzed statistically, this showed that the use of volatile sevoflurane related significantly to the time of recovery of consciousness, with a p-value of 0.028 ($p < 0.05$) and a contingency coefficient of 0.105. **Conclusion:** In conclusion, it can be said that the study found a significant relationship between the use of volatile sevoflurane and the time for patients to regain consciousness after general anesthesia in Kardinah Hospital, Tegal City.

Keywords: anesthesia, inhalation; general anesthesia; recovery of consciousness; sevoflurane

Introduction

One common type of anesthesia is inhalation; this type of anesthesia is often used because it is easy to administer and can reduce side effects. In clinical practice, various anesthetic agents are used, one of which is sevoflurane. Sevoflurane is a volatile anesthetic agent known for its rapid onset and offset and good safety profile. The easily detectable mixed gas, also called anesthetic and oxygen, dissolves the epidermis, and lung cavity, and undergoes diffusion from the lung alveoli with the specific physical characteristics of each gas. The smallest amount of anesthetic drug delivered to the alveoli has been shown to have an analgesic effect with international minimal alveolar concentration (MAC)[1].

According to WHO data, the use of general anesthesia continues to increase along with the increasing number of surgical procedures worldwide. In 2019, it

was reported that more than 300 million surgeries were performed using general anesthesia globally each year [2].

Sevoflurane is an anesthetic agent that is neuroprotective. Sevoflurane is odorless and causes little airway irritation, making it suitable for induction of general anesthesia. Due to its soluble nature, the induction time is shorter and recovery of consciousness occurs immediately after its administration is stopped [3].

According to the results of research by Rosana et al (2019), the recovery time in the sevoflurane group was faster than the propofol group because sevoflurane has a smaller volatile partition coefficient after desflurane so that it quickly reaches equilibrium and is quickly eliminated through lung tissue. Inhaled anesthetics with low blood gas partition coefficients, such as sevoflurane, show a faster decrease in alveolar concentration after inhaler closure than isoflurane and halothane. Hexafluoroisopropanolol, the major metabolite of Sevoflurane, conjugates rapidly with inert compounds, resulting in rapid recovery [4].

Delayed recovery of consciousness is established when the patient fails to regain understanding within 30-60 minutes after anesthesia, is the residual impact of anesthetic, sedative, and analgesic drugs. Factors that cause delayed recovery of consciousness can be caused by patient aspects, drug aspects, surgical aspects, metabolic aspects and neurological abnormalities, advanced age, renal disorders and hepatic disorders can cause delayed post-anesthesia recovery of consciousness [5].

This delay is one of the unexpected complications in anesthesia procedures. Results from a prospective study involving 18,000 patients in the recovery room showed that about 24% of these patients experienced anesthesia-related problems. One of the common complications is the prolongation of the patient's recovery time [6].

Based on preliminary observations at Kardinah Hospital in Tegal City in January 2024, it was found that the recovery time of patients' consciousness after general anesthesia showed variations. Of the 215 cases undergoing general anesthesia, 99 of them used inhalation techniques with volatile sevoflurane, with 30% of patients experiencing delays in recovery of consciousness. This situation encouraged researchers to explore the relationship between the use of volatile sevoflurane and the duration of recovery of consciousness of patients after general anesthesia, as an effort to improve the quality of health services in the hospital.

The general objective of this study was to determine the relationship between Volatile Sevoflurane and the time to recover consciousness in patients after general anesthesia at Kardinah Hospital, Tegal City.

Material and Methods

This research is a quantitative study with a correlational analytic research design with a cross-sectional approach. This research was conducted in June 2024 with a sample size of 128 respondents. Sampling using consecutive sampling technique with criteria: patients willing to become respondents, patients aged 17-65 years, patients with a full level of consciousness during preoperative, inhalation general anesthesia patients, general anesthesia patients draw, general anesthesia patients who are given volatile sevoflurane, patients with ASA physical status 1 and 2.

This study uses observation techniques, and the title of this study is “The Relationship between volatile sevoflurane and Time to recover consciousness in post-general anesthesia patients”. This research instrument uses an observation sheet to identify the

relationship between sevoflurane volatiles and conscious recovery time containing risk factors for patient recovery time such as length of anesthesia, age, body mass index (BMI), type of surgery, ASA physical status, sevoflurane dose used. Aldrete score and stopwacth as a tool to measure the recovery time of patients after general anesthesia which is measured including measurement of consciousness, activity, respiration, circulation (blood pressure and respiratory rate), and skin color. After sufficient data, univariate test (frequency test) and bivariate test (spearman) were conducted to measure the average frequency in respondents and determine the correlation between variables. Triangulation was performed by collecting data from various sources such as direct observation during the action, and collecting data from medical records. This study was approved by the Research Ethics Committee of Harapan Bangsa University with approval number B.LPPMUHB/540/06/2024.

Result

a. Characteristics of Respondents

This study involved 128 patients who underwent surgery with general anesthesia at RSUD Kardinah Kota Tegal, who met the inclusion criteria. Respondents' characteristics were observed based on the length of anesthesia, age, BMI, type of surgery, and ASA physical status. The frequency distribution of respondents' characteristics is presented in the following table.

Table 1. shows that based on the length of anesthesia, most respondents with anesthesia duration < 60 minutes, namely 71 (55.5%) and a small part with anesthesia duration > 120 minutes, namely 4 (3.1%). Based on age, most respondents were aged 56-65 years, namely 37 people (28.9%) and a small proportion were aged 17-25 years, namely 16 people (12.5%).

Table 1 Frequency of Respondents (n= 128)

Respondent Characteristics	Frequency	Presented (%)
Duration of anesthesia		
a. < 60 minute	71	55.5
b. 60 - 120 minute	53	41.4
c. > 120 minute	4	3.1
Age		
a. 17 – 26 Years	16	12.5
b. 26 – 35 Years	23	18.0
c. 36 – 45 Years	24	18.8
d. 46 – 55 Years	28	21.9
e. 56 – 65 Years	37	28.9
BMI		
a. < 18.5	2	1.6
b. 18.5 – 22.9	51	39.8
c. 23 – 24.9	35	27.3
d. 25 – 29.9	40	31.3
e. ≥ 30	0	0
Type of surgery		
a. Oncology	6	4.7
b. Bone surgery	25	195
c. General surgery	77	60.2
d. Throat surgery	3	2.3
e. oral surgery	8	6.3
f. Urology surgery	4	3.1
g. Eye surgery	5	3.9
ASA physical status		
a. ASA I	76	59.4
b. ASA II	52	40.6

Based on Body Mass Index (BMI) most of the 51 (39.8%) respondents had BMI 18.5 - 22.9 and a small proportion of 2 (1.6%) respondents had BMI <18.5. Based on the type of surgery, the majority of respondents were with the type of general surgery 77 (60.2%) respondents, and the least was the type of ENT surgery 3 (2.3%) respondents. Based on the type of ASA physical status, most of the respondents with ASA 1 physical status were 76 people (59.4%) and a small proportion with ASA 2 physical status of 52 people (40.6%).

Variable	Mean	Median	Range		*Std. deviation*
			Min	Max	
time to recover consciousness	24,72	25	15	45	6.409

b. Volatile Sevoflurane Dosing in Kardinah Hospital, Tegal City

The dose of volatile sevoflurane needs to be adjusted to the respondent's condition at the time of intra-anesthesia. According to the results of this study it was found that the highest dose was 2.5% and the lowest dose was 1.5%.

The dependent variable in the study in this study was the variable volatile sevoflurane as many as 128 respondents in the Central Surgical Installation room of Kardinah Hospital, Tegal City. Variable frequency distribution can be seen in the following table:

Table 2. Frequency of Volatile Sevoflurane (n=128)

Variable	Frequency	Presented (%)
Volatile sevoflurane		
a. 1% - 1,5%	2	1,6
b. 2% - 2,5%	126	98,4

The distribution of respondents based on volatile sevoflurane was 2 (1.6%) respondents with volatile sevoflurane 1% - 1.5% and most respondents as many as 126 (98.4%) respondents with volatile sevoflurane 2% - 2.5%.

c. Patient's Recovery Time after General Anesthesia at Kardinah Hospital Tegal City

The independent variable in this study was the variable of time to recover consciousness in 128 respondents in the Central Surgical Installation room of Kardinah Hospital, Tegal City. The frequency distribution of time to recover consciousness in patients after general anesthesia can be seen in the following table:

above illustrates data on the time to recover consciousness in patients after general anesthesia at Kardinah Hospital, Tegal City. The recovery time of post-general anesthesia patients had an average of 24 minutes 72 seconds with a median of 25 minutes and a range of 15 minutes to 45 minutes.

d. Relationship between volatile Sevoflurane and Time to Recover Consciousness in Post-General Anesthesia Patients at Kardinah Hospital Tegal City

The relationship between sevoflurane volatile and recovery time in post-general anesthesia patients at RSUD Kardinah Tegal was analyzed using Spearman correlation test. This was done because the normality test showed that the data was not normally distributed with a significance value of 0.00 <0.05. Given that the variables studied had a ratio scale and the data was not normal, the Spearman statistical test was chosen to analyze the correlation between the two variables.

Table 4. Cross tabulation. Relationship between sevoflurane volatiles and recovery time

Volatile sevoflurane	Time to recover consciousness (Minute)						*p-value*	*CC*
	15		35		45			
	f	%	f	%	f	%		
1%-1,5%	2	1,6	0	0	0	0	0,028	0,194
2%–2,5%	15	11,9	12	9,4	1	0,8		

Based on the probability of data with Spearman test, the significance value (p) 0.028 < 0.05. Because the significance <0.05, H_0 is rejected, meaning H_a is accepted, meaning that there is a

relationship between sevoflurane volatiles and the time to recover consciousness in patients after general anesthesia at the Kardinah Tegal Regional General Hospital. Based on the correlation test, the contingency coefficients value was 0.194. The positive sign indicates that the relationship that occurs is positive, meaning that the higher the volatile sevoflurane, the longer the time to recover consciousness in patients after general anesthesia. The contingency coefficients value of 0.194 means that the level of relationship closeness is very low, which is in the range of 0.00 - 0.199.

Discussions

Volatiles are liquids that evaporate easily at room temperature and require the use of vaporizers for inhalation administration such as halothane, isoflurane, sevoflurane, and desflurane [12] Sevoflurane is an inhalation anesthetic that can be used for induction and maintenance of general anesthesia in infant and adult patients. The formula of sevoflurane is C4H3F7O, with a molecular weight of 200.05 g/mol. Available in liquid form, colorless, does not contain additives, and is not corrosive to other materials, non-flammable, does not contain explosives, does not irritate, and is easy to manage [13]. Volatile sevoflurane in this study was not categorized because in giving a maintenance dose of volatile sevoflurane it needs to be adjusted to the respondent's condition during intra-anesthesia. According to the results of this study, it was found in this study that the highest maintenance dose of volatile sevoflurane was 2.5% and the lowest dose was 1.5%. With an average volatile sevoflurane dose of 2.078% and the most widely used is 2%.

In this study, the distribution of 1.5% sevoflurane volatile dose was 2 (1.6%) respondents, 2% sevoflurane volatile dose was 104 (81.3%) respondents, dosing at this level was the majority given to respondents, and with 2.5% sevoflurane volatile dose was 22 (17.2%) respondents. An article in the Journal of Anesthesia explains that sevoflurane at low concentrations (1%-1.5%) is rapidly eliminated from the body, whereas at higher concentrations (2%-2.5%), the elimination time is longer, which may result in a slower recovery time (14). This study indicated a clear preference for the 2%-2.5% dose used in the majority of respondents as it provides an optimal balance between efficacy and safety and is used in special situations that require deeper and longer anesthesia. A dose of 1%-1.5% was used in a minority of respondents to obtain a fast recovery time.

The results of the analysis of the recovery time of 128 respondents in patients after general anesthesia at the Kardinah Tegal General Hospital on June 1-20, 2024. It was obtained that the recovery time of post-general anesthesia patients had an average of 24 minutes 72 seconds with a median of 25 minutes and a range of 15 minutes to 45 minutes. With the frequency of the dominant recovery time at 25 minutes with 36 (28.15) respondents, fast recovery time 20 minutes as many as 33 (25.8%) respondents, 15 minutes as many as 17 (13.3%) respondents, moderate recovery time 30 minutes as many as 26 (20.3%) respondents, longer recovery time 35 minutes as many as 12 (9.4%) respondents, 40 minutes as many as 2 (1.6%) respondents, 45 minutes as many as 1 (0.8%) respondents. The results of this study are in accordance with the definition of recovering consciousness from general anesthesia, namely a body condition where neuromuscular conduction, airway protective reflexes, and consciousness have returned after stopping the administration of anesthetic drugs, and the surgical process has been completed. Variations in recovery time can be influenced by various factors such as age, health condition, type of

surgical procedure, and the dose of anesthesia used.

Identifying factors that affect the time to recover consciousness is important to improve postoperative management and accelerate patient recovery. influenced by several factors, namely the factor of giving a dose of volatile sevoflurane and individual factors of the respondent, the length of anesthesia and the type of surgery, as well as the anesthesia protocol used can also make the time to recover consciousness in respondents vary [15]. Stated that recovery from general anesthesia is a time full of physiological stress for many patients. The recovery of consciousness of patients after general anesthesia should be slow in a controlled environment in the post-anesthesia care room (Recovery Room or Post Anesthesia Care Unit) with the aim of restoring the patient's consciousness as much as possible without complications and maintaining hemodynamics, oxygen needs and helping the healing process. It is often found that during this recovery period, patients experience various problems, such as airway obstruction, chills, agitation, nausea and vomiting, and hypothermia(11). The problem of recovering consciousness after general anesthesia is not only considered that the patient is conscious, but it takes time for the effects of anesthetic drugs to decrease or disappear. Therefore, anesthesia personnel, especially nurse anesthetists, are required to understand the factors that affect the recovery time of patients after general anesthesia, such as the effects of anesthetic drugs (premedication and induction), age, weight (body mass index), type of surgery, length of anesthesia, physical status (ASA) and acid-base/electrolyte disorders (16).

This study was conducted to evaluate the relationship between the use of volatile sevoflurane and recovery time in 128 patients after general anesthesia in the Central Surgical Installation Room of RSUD Kardinah Tegal. The results showed that the average recovery time was 24 minutes 72 seconds, with an average sevoflurane usage of 1.98%. The fastest recovery time was 15 minutes in 17 respondents, with 2 respondents using 1%-1.5% sevoflurane and 15 respondents using 2%-2.5%. The longest recovery time was 45 minutes in one respondent using 2%-2.5% sevoflurane. The Spearman test showed a significance value of 0.028, which was less than 0.05, so there was a significant relationship between sevoflurane use and recovery time. A positive correlation with a contingency coefficient value of 0.194 indicates that the higher the sevoflurane concentration, the longer the recovery time, although this relationship is very low.

Sevoflurane is an inhaled anesthetic agent commonly used in general anesthesia. Its mode of action involves inhibiting the transmission of nerve signals in the brain, leading to loss of consciousness and reduction of pain perception. Sevoflurane enhances the inhibitory effects of the neurotransmitter GABA on GABA-A receptors, decreasing neural activity. In addition, sevoflurane affects NMDA receptors reduces synaptic excitation, and decreases the activity of ion channels such as sodium and potassium, all of which contribute to decreased neuronal excitability [17-19]

The results of this study are in line with other studies showing that increasing sevoflurane concentration prolongs the time required for elimination, thus slowing down full recovery, especially in longer procedures. This is also supported by findings showing that neuromuscular effects in patients occur more slowly when they are exposed to sevoflurane at higher concentrations and longer durations [18-20]

The results of this study are also supported by other studies that identified

that of the respondents who were given anesthesia with sevoflurane, as many as 4 respondents (7.8%) showed observation time in the recovery room for 15 minutes, while 47 other respondents (92.2%) took between 30 to 45 minutes. Recovery time ranged from 15 to 45 minutes, with an average of 35 minutes 12 seconds ± 9 minutes 31 seconds (20). The results of this study are consistent with the definition of conscious recovery after general anesthesia, in which neuromuscular conduction, airway protective reflexes, and consciousness are fully restored after cessation of anesthesia, and the operation is completed. (Igede). Approximately 90% of patients achieve full recovery within 15 minutes. If recovery exceeds 15 minutes, it is considered a delayed recovery, but even in more susceptible patients, response to stimulus should occur within 30-45 minutes [21-23]

Researchers assume that in addition to internal patient factors, the use of volatile sevoflurane and additional drugs such as analgesics or sedatives during surgery can prolong the post-anesthesia conscious recovery time. The results showed that patients who received sevoflurane with a concentration of 2%-2.5% tended to experience a longer recovery time than those with a concentration of 1.5%, which was caused by the buildup of anesthetic substances [24]

Limitations and Future Research

During the implementation of this study, the researcher experienced several limitations that need to be considered. First, this study focused on specific objects that fit the characteristics desired by the researcher, so the results may not reflect wider variations in the field. In addition, data related to the use of volatile sevoflurane collected from the field tends to be less varied, which may affect the generalizability of the study results.

The population used in this study was also diverse, which may cause variations in the results and affect the conclusions drawn. In addition, there are differences in the anesthesia techniques used, the experience and skills of the anesthesiologist, and the recovery protocols applied, all of which may impact the results of the study.Another limiting factor is the use of additional medications during the intraoperative procedure, such as analgesics or sedatives, which may affect the study results. The lack of adequate control over the use of these additional drugs is one of the challenges faced in ensuring the accuracy of the study results. Given the limitations of this study, future researchers should be more rigorous in addressing other factors that may affect the results of the study.

Conclusion

Based on research at RSUD Kardinah Kota Tegal regarding the relationship between volatile sevoflurane and recovery time in post-general anesthesia patients, it can be concluded that the majority of respondents had a length of anesthesia of less than 60 minutes, with the most age between 56-65 years (28.9%), Body Mass Index 18.5-22.9 kg/m² (39.8%), and most underwent general surgery (60.2%) with ASA 1 physical status (59.4%). Most respondents received a volatile sevoflurane dose of 2%-2.5% (98.4%), with a mean conscious recovery time of 24.7 minutes, which ranged from 15 minutes to 45 minutes. Spearman correlation analysis showed a significant association between volatile sevoflurane and recovery time with a significance value of 0.028 and a contingency coefficient of 0.194, which falls into the very low category.

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Conflict of Interest Statement
The authors have confirmed that they have no competing interests.

Data Availability
The datasets used or generated in this study are available from the corresponding author upon reasonable request.

Author Contributions
Rahmadiya Hadi Putri: Contributed to research conception and design, database search, methodology, data analysis and interpretation, and writing. **Asmat Burhan**: Contributed to the conception and design of the study, database search, methodology, risk of bias analysis, as well as data analysis, interpretation, writing, reviewing, and editing. **Feti Kumala Dewi**: Contributed to research conception and design, database search, methodology, risk of bias analysis, as well as analysis, interpretation of data, writing, reviewing, and editing.

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