The Relationship Between Duration of Mechanical Ventilator Use and Mortality in the Intensive Care Unit (ICU) at PMI Hospital Bogor in 2023

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ABSTRACT

Mechanical ventilator is a breathing support device that helps patients with respiratory failure. Use of mechanical ventilator for more than 48 hours causing complications that could increase mortality in patients. Knowing the association between duration of mechanical ventilator use and mortality in ICU can help reduce the factors that cause patient's mortality in ICU. This study used an analytic observational method with a cross sectional approach. Subjects were 97 medical record data with simple random technique then processed using SPSS. This study used secondary data with medical records of patients in ICU with use of mechanical ventilator according to sample's inclusion and exclusion. The analysis used is chi-square. The results showed that the majority of subjects were >65 years old (37.1%), male (60.8%). Non surgical patients (56.7%), the most common primary diagnoses were ICH (17.5%), CKD (10.3%), CHF (6.2%), and peritonitis (6.2%), duration of mechanical ventilator use ≥48 hours (61.9%) and patient died (83.5%). Bivariate analysis results showed there was no association between duration of mechanical ventilator use and mortality (p = 0.734). There is no association between duration of mechanical ventilator use with mortality in the ICU RS PMI Bogor in 2023. Further research is needed to determine other factors that can affect mortality in ICU other than the duration of mechanical ventilator use.

Keywords: ICU, Mechanical Ventilator, Mortality

1. INTRODUCTION

A mechanical ventilator is a respiratory aid that can maintain ventilation and provide oxygen for a long period of time [1]. The installation of a mechanical ventilator aims to maintain optimal alveolar ventilation in order to meet metabolic needs, improve hypoxemia, and maximize oxygen transport [2]. The use of a mechanical ventilator is indicated for patients with respiratory failure, hypoxemia, and hypercapnia [3]. Based on research by [3], it showed that 807 of the 2,277 Intensive Care Unit (ICU) patients from January to December 2017 experienced respiratory failure. If averaged per month, of the 189-190 patients treated in the ICU, 67-68 patients experienced respiratory failure and 29-30 patients died.

Mechanical ventilators are one of the medical devices often used in the ICU. Patients with mechanical ventilators are usually critically ill patients with multiorgan failure which can increase mortality. The intubation process in installing mechanical ventilators can cause injury to the respiratory tract and facilitate the entry of germs into the lungs, causing contamination and colonization at the end of the endotracheal tube [4]. Continued infection for more than 48 hours can worsen the patient's prognosis and increase mortality. The incidence of infection increases with the length of use of mechanical ventilation [5].

The results of the study by [6] stated that there were 1,531 patients admitted to the ICU of Sanglah General Hospital, Denpasar from January to December 2015. A total of 379 patients (24.8%) died. Of the 379 patients who died, 233 patients used mechanical ventilators. In the study by [7], the use of mechanical ventilators and their side effects, such as infection and pneumonia, were identified as predictors of mortality in the ICU. The results of the study by [8] found that increasing the

duration of mechanical ventilator use was associated with a decrease in the success rate of weaning and increased mortality. Then, in the study by [9], a significant relationship was found between the duration of mechanical ventilator use and mortality, namely that prolonged use of mechanical ventilators was associated with increased mortality and morbidity. However, in the study by [10], it was found that increasing the duration of mechanical ventilator use would actually reduce the likelihood of mortality. The significance results obtained were very close to 1, which indicates that the duration of mechanical ventilator use is likely not related to mortality [10].

RS PMI Bogor in 2023 as a class A hospital is the highest referral hospital in Lampung Province and is equipped with Intensive Care Unit (ICU) services [11]. The Intensive Care Unit (ICU) is a part of a hospital that works independently with health workers and special equipment with the aim of monitoring, managing, and treating patients suffering from acute illnesses, injuries or complications that are life-threatening or potentially life-threatening (Ministry of Health of the Republic of Indonesia, 2011). In the results of Sakti's study (2014), it was found that there was a high number of patients with nosocomial infections at RS PMI Bogor in 2023, especially in the ICU treatment room in 2013.

Therefore, based on the background that has been mentioned regarding the high mortality in patients using mechanical ventilators, it is necessary to conduct research on the relationship between the length of use of mechanical ventilators and mortality in the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023.

2. LITERATURE REVIEW

2.1 Mechanical Ventilator

A ventilator is a breathing aid that aims to maintain ventilation and provide oxygen supply for a long period of time [1]. Mechanical ventilation is an effort to facilitate breathing by using a mechanical breathing aid or ventilator to replace the function of a chest pump that is tired or not functioning. A mechanical ventilator is a special tool that can support ventilation function and improve oxygenation through the use of gas with high oxygen content and positive pressure [2].

2.2 Intensive Care Unit (ICU)

The Intensive Care Unit (ICU) is a part of a hospital that stands alone with health workers and special equipment that aims to carry out observation, care and therapy on patients with acute illnesses, injuries or complications life-threatening or potentially life-threatening. The ICU provides the ability, infrastructure, and special equipment to support vital functions supported by the skills of medical personnel, nurses and other members who have experience in managing these conditions. The existence of the ICU needs to be centralized in one place and in an integrated unit in the hospital in the form of an installation for the efficiency of the ICU's work (Ministry of Health of the Republic of Indonesia, 2011).

2.3 Mortality

Mortality or death is a condition where there are no more signs of life, such as heartbeat, respiratory movements, decreased body temperature, and no electrical brain activity is found in electroencephalography (EEG) recordings [12].

2.4 Relationship between Duration of Mechanical Ventilator Use and Mortality

Mechanical Ventilator Is a breathing aid with the function of maintaining ventilation and providing oxygen for a long period of time. Indications for the use of mechanical ventilators are patients with respiratory and cardiac arrest or threat of respiratory and cardiac arrest, patients who experience tachypnea with increased ventilation requirements and respiratory effort, patients with severe hypercapnic respiratory failure who are unresponsive to nasal intermittent positive pressure ventilation (nippv), patients with severe refractory hypoxemia with failure of non-invasive ventilation (niv) therapy, patients with severe refractory metabolic acid-base disorders, patients who are unable to remove secretions, patients with upper airway obstruction with poor airway patency, reduced respiratory drive with bradypnea, comatose patients with gcs <8, and patients with severe trauma. In these patients, the installation of a mechanical ventilator is required through the intubation process. However, the intubation process can have adverse effects on the body such as injury to the respiratory tract, impaired cough reflex, and the formation of biofilms in the ett.

Injuries to the respiratory tract can cause Ventilator Induced Lung Injury (VILI) consisting of atelectrauma, barotrauma, volutrauma, biotrauma and Acute Respiratory Distress Syndrome. In addition, injuries that occur can also injure the mucociliary and tracheal epithelium. VILI can be treated by resetting the mechanical ventilator, such as adjusting tidal volume, increasing PEEP, and adjusting inspiratory pressure, while mucociliary injuries can cause secretions in the respiratory tract not to be optimally disposed of, resulting in accumulation of secretions in the upper respiratory tract. Patients with decreased consciousness and impaired cough reflex can experience accumulation of secretions, especially in the posterior oropharyngeal area. Then, the ETT layer without biofilm is a place that can support microorganisms to colonize so that microorganisms in the ETT layer can easily move to the lower respiratory tract. The presence of these conditions can cause accumulation of secretions in the upper respiratory tract and increase the risk of contamination and colonization of oropharyngeal microorganisms. With the inspiration process, these microorganisms can migrate to the lower respiratory tract which is more sterile. Microorganisms that are difficult to eradicate can cause pulmonary infections. Infections that occur <48 hours tend to be sensitive to antibiotics, but bacteria in infections that have occurred ≥48 hours can cause VAP and worsen the patient's prognosis so that it can increase mortality.

2.5 *Research Hypothesis*

The author's hypothesis in this study is:

H0 : There is no relationship between the length of mechanical ventilator use and mortality in the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023.

H1 : There is a relationship between the length of use of mechanical ventilators and mortality in the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023.

3. METHODS

3.1 Research Design

This study uses an analytical observational method with a cross-sectional approach, namely this study uses two variables and examines the relationship between these variables and without any intervention on the sample [13].

3.2 Place and Time of Research

This research was conducted at the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023 from March to April 2022.

3.3 Population and Research Sample

1.   Research population

Population is a generalization area consisting of objects/subjects with a certain number and characteristics determined by researchers to be studied and drawn conclusions afterwards [14]. The population used in this study were patients using mechanical ventilators in the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023.

2.   Research Sample

A sample is a portion of the number and characteristics possessed by a population or a small portion of the population members taken according to certain procedures so that they can represent the population [14]. The sample for this study was taken using simple random sampling, which is a sampling technique where sampling of population members is carried out randomly regardless of the strata contained in the population [13]. The sample in this study were patients using mechanical ventilators in the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023.

3.4 Research Instruments

Data collection techniques were carried out by using secondary data. Data were obtained from recording medical record sheets containing data on the length of use of mechanical ventilators and deaths in patients in the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023.

3.5 Data analysis

Data analysis is a process to see how to interpret data, then analyze the data based on the results obtained at the data processing stage [15]. The statistical analysis used to process the research data is univariate analysis and bivariate analysis.

4.   RESULT AND DISCUSSION

Based on the characteristics of the subjects, it was found that the largest age group was the age group >65 years (elderly). This is in line with previous studies which stated that there is a relationship between old age and the prevalence of mortality in the ICU. Elderly patients have a higher need for mechanical ventilators, but the use of mechanical ventilators in elderly patients can also have a detrimental effect on patient outcomes. Then, gender does not have an independent relationship with mortality. 9 Patients are grouped into post-surgical patients (43.3%) or non-surgical (56.7%). This is related to the emergence of post-surgical factors that can be related to mortality, such as cardiac arrest, sepsis, and other complications.

In this study, the most common primary diagnosis was Intracerebral Hemorrhage (ICH) with 17 patients (17.5%). This was also found in the study of [16], which stated that the 30-day mortality rate of ICH ranged up to 40%, making it one of the most deadly medical events. Then in the study of [17], it was stated that there was a significant relationship between ICH patients using mechanical ventilators and mortality in the ICU.

After that, the second most common diagnosis was Chronic Kidney Diease (CKD) with 10 patients (10.3%). This is in line with the research of [18], which stated that CKD as a comorbidity is significantly associated with mortality in the ICU (77%). In CKD patients, early dialysis can provide better outcomes, although some patients are indicated for renal replacement therapy. Then, the third most common primary diagnosis was CHF with 6 patients (6.2%) and peritonitis with 6 patients (6.2%). The use of mechanical ventilators in CHF plays a role in reducing the work of breathing, reducing ventricular preload and afterload, and reducing extravascular levels of lung fluid because in CHF there is accumulation of fluid in the lungs caused by heart-lung backflow due to failure of

the heart to pump blood optimally. Then, patients with a diagnosis of peritonitis ec organ perforation, mentioned in the research of Ross et al (2018), that peritonitis contributes 1% to ICU patients and is the second leading cause of sepsis in ICU patients. The overall mortality is 6%, but can increase to 35% in patients with severe sepsis.

The results of the bivariate test with a 2x2 chi-square table showed that the p value was 0.734 (p>0.05) which indicated that there was no significant relationship between the duration of mechanical ventilator use and mortality in the Intensive Care Unit (ICU) of Dr. H. Abdul Moeloek Hospital. These results are in line with the research of [10], which stated that the possibility of a relationship between the duration of ventilator use and mortality was very weak (p 0.999). The results of the research by [10], showed that increasing the duration of mechanical ventilator use would actually reduce mortality. The research by [8] also emphasized that the duration of mechanical ventilator weaning of more than 7 days had a high significance on patient mortality. In the cohort study, the time of mechanical ventilator weaning did not significantly affect ICU mortality until the patient reached the seventh day of mechanical ventilator weaning. The reason for the differences in previous studies is because the duration of mechanical ventilator use is more related to the success of mechanical ventilator weaning because the mechanical ventilator weaning process will affect patient outcomes.

Related to the work of the mechanical ventilator itself, research by [19] stated that the mismatch of mechanical ventilator settings is associated with mortality in the ICU (p 0.011). 3 Mismatch of mechanical ventilator settings with the patient's condition can cause bad interactions between the two and cause patient discomfort, shortness of breath, increased length of stay, and respiratory muscle injury. 3 This is also in line with research by [20], namely critical patients who receive mechanical ventilators for at least 48 hours with high mechanical ventilator settings, are significantly associated with increased mortality in the ICU and patient outcomes (p <0.001). 20 In addition to the use of mechanical ventilators, research by [7] also states that there are other factors related to mortality in the ICU such as age, comorbidities, body metabolism balance, and nervous system disorders so that death in the ICU is an event consisting of multifactors. There is a study [21], stating that the mortality of patients using mechanical ventilators does not only depend on the duration of use, but also on the development of complications and patient management in the ICU. Research by [5], states that if the infection continues for more than 48 hours, it can worsen the patient's prognosis and increase mortality. This is supported by research by [22], which states that VAP can increase mortality by 24-50% and if the infection is caused by a high-risk pathogen, the mortality rate can reach 76%. Then, research by [23] shows that atelectasis is another complication that often occurs in prolonged use of mechanical ventilators. However, in this study, no VAP or VILI complications were found in patients.

This is related to the research of [24], which stated that VAP complications themselves are quite difficult to diagnose accurately because the diagnostic criteria include further specific examinations such as chest X-rays and sputum condition cultures. In the research of Kobayashi et al (2017), it was found that increased mortality was more visible in Ventilator Associated Conditions (VAC) (p 0.02) and Infection-Related Ventilator Associated Complications (IVAC) (p 0.003) compared to VAP (p 0.43).

[25] study also added that patients with comorbidities, both acute and chronic, usually have a shorter survival time than patients without comorbidities. Among chronic comorbidities, cirrhosis (p 0.011) has the highest hazard risk, while in acute comorbidities, peritonitis (p 0.001) and gangrene (0.027) have the highest risk. Then related to the character of the subject, in the study of [26], it was stated that the score value used in the hospital was very helpful in predicting the mortality of critically ill patients, either using the Acute Physiology and Chronic Health Evaluation (APACHE) score or the Simplified Acute Physiology Score (SAPS). The higher the score obtained, the higher the risk of mortality. Between the APACHE II score, the APACHE III score, and the SAPS II score, all three can be accepted as predictors of mortality in the hospital. (p < 0.05).

CONCLUSION

Based on the research results obtained regarding the relationship between the length of use of mechanical ventilators and mortality in the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023, the author draws the following conclusions.

1. There was no relationship between the length of mechanical ventilator use (p = 0.734) and mortality in the Intensive Care Unit (ICU) of Dr. H. Abdul Moeloek Hospital.
2. The number of patients using mechanical ventilators for <48 hours was 37 (38.1%), less than the number of patients using mechanical ventilators for ≥48 hours, which was 60 (61.9%) in the Intensive Care Unit (ICU) of PMI Hospital Bogor in 2023.
3. Of the total 97 patients, 16 people lived (16.5%) and 81 people died (83.5%).

SUGGESTION

The suggestions that can be given by researchers based on the results of the study are, for other researchers, it is hoped that they can further research the factors of the length of weaning time and mechanical ventilator settings in ICU patients in a larger population. Then, it is also hoped that subsequent researchers can further research the relationship between subject characteristics and mortality in the ICU. For health care facilities, it is hoped that in the future they can complete computing data so that access to medical records can be easier.

REFERENCES

[1] M. O. A. Kamayani, "Asuhan Keperawatan Pasien Dengan Ventilasi Mekanik," *Udayana Univ.*, pp. 1–17, 2016.

[2] L. P. A. Dewantari and K. W. Nada, "Aplikasi alat bantu napas mekanik," *Univ. Udayana*, pp. 1–27, 2017.

[3] T. Hayati, B. M. Nur, F. Rayasari, Y. Sofiani, and D. Irawati, "Perbandingan Pemberian Hiperoksigenasi Satu Menit DAB Dua Menit pada Proses Suction terhadap Saturasi Oksigen Pasien Terpasang Ventilator," *J. Telenursing*, vol. 1, no. 1, pp. 67–79, 2019.

[4] A. Rozaliyani and B. Swidharmoko, "Diagnosis dan Penatalaksanaan Ventilator-Associated Pneumonia," *Maj. Kedokt. UKI*, vol. 27, no. 1, pp. 32–47, 2010.

[5] R. Widyaningsih and L. Buntaran, "Pola Kuman Penyebab Ventilator Associated Pneumonia (VAP) dan Sensitivitas Terhadap Antibiotik di RSAB Harapan Kita," *Sari Pediatr.*, vol. 13, no. 6, pp. 384–390, 2016.

[6] I. Brahmani and H. IG, "Prevalensi Kematian Pasien Diruang Terapi Intensif Rumah Sakit Umum Pusat Sanglah Denpasar Periode Januari-Desember 2015," *J Med Udayana*, vol. 8, no. 12, pp. 1–5, 2019.

[7] F. G. de M. Soares Pinheiro *et al.*, "Mortality Predictors and Associated Factors in Patients in the Intensive Care Unit: A Cross-Sectional Study," *Crit. Care Res. Pract.*, vol. 2020, no. 1, p. 1483827, 2020.

[8] O. Peñuelas *et al.*, "Characteristics and outcomes of ventilated patients according to time to liberation from mechanical ventilation," *Am. J. Respir. Crit. Care Med.*, vol. 184, no. 4, pp. 430–437, 2011.

[9] A. D. Lubis and M. Lubis, "Hubungan Oxygenation Index dan Lama Penggunaan Ventilasi Mekanis Terhadap Mortalitas Anak di Ruang Rawat Intensif RSUP Haji Adam Malik." Universitas Sumatera Utara, 2020.

[10] J. Liang, Z. Li, H. Dong, and C. Xu, "Prognostic factors associated with mortality in mechanically ventilated patients in the intensive care unit: A single-center, retrospective cohort study of 905 patients," *Medicine (Baltimore).*, vol. 98, no. 42, p. e17592, 2019.

[11] W. A. Sakti, "Prediksi Kejadian Infeksi Nosokomial di uang Perawatan RSU Dr. Abdul Moeloek Lampung," *J. Kesehat. Holistik*, vol. 8, 2014.

[12] E. A. Senduk, J. F. Mallo, and D. C. Tomuka, "Tinjauan Medikolegal Perkiraan Saat Kematian," *J. Biomedik JBM*, vol. 5, no. 1, 2013.

[13] D. Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta Bandung, 2013.

[14] S. Siyoto and M. A. Sodik, *Dasar metodologi penelitian*. literasi media publishing, 2015.

[15] B. Prasetyo and L. M. Jannah, "Metode penelitian kuantitatif," *Raja Graf. Persada, Jakarta*, 2005.

[16] M. Awanis, K. M. Sikumbang, and A. Asnawati, "Korelasi antara Skor Intracerebral Hemorrhage (ICH) dengan Mortalitas Pasien Perdarahan Intraserebral di RSUD Ulin Banjarmasin," *J. Neuroanestesi Indones.*, vol. 10, no. 1, pp. 1–7, 2021.

[17] S. Lahiri *et al.*, "Mechanical ventilation for acute stroke: a multi-state population-based study," *Neurocrit. Care*, vol. 23, pp. 28–32, 2015.

[18] A. Chiwhane and S. Diwan, "Characteristics, outcome of patients on invasive mechanical ventilation: A single center experience from central India," *Egypt. J. Crit. Care Med.*, vol. 4, no. 3, pp. 113–118, 2016.

[19] L. Blanch *et al.*, "Asynchronies during mechanical ventilation are associated with mortality," *Intensive Care Med.*, vol. 41, pp. 633–641, 2015.

[20] A. Serpa Neto *et al.*, "Mechanical power of ventilation is associated with mortality in critically ill patients: an analysis

of patients in two observational cohorts," *Intensive Care Med.*, vol. 44, pp. 1914–1922, 2018.

[21] A. Esteban *et al.*, "Characteristics and outcomes in adult patients receiving mechanical ventilation: a 28-day international study," *Jama*, vol. 287, no. 3, pp. 345–355, 2002.

[22] B. Deshmukh, S. Kadam, M. Thirumugam, and K. Rajesh, "Clinical study of ventilator-associated pneumonia in tertiary care hospital, Kolhapur, Maharashtra, India," *Int J Res Med Sci*, vol. 5, no. 5, p. 2207, 2017.

[23] T. Principi *et al.*, "Complications of mechanical ventilation in the pediatric population," *Pediatr. Pulmonol.*, vol. 46, no. 5, pp. 452–457, 2011.

[24] T. Kobayashi and T. Takaguchi, "Social dynamics of financial networks," *EPJ Data Sci.*, vol. 7, pp. 1–19, 2018.

[25] C.-S. Jang and J.-D. Wang, "Predicting mortality and life expectancy in patients under prolonged mechanical ventilation and maintenance dialysis," *J. Palliat. Med.*, vol. 23, no. 1, pp. 74–81, 2020.

[26] S. Czajka, K. Ziębińska, K. Marczenko, B. Posmyk, A. J. Szczepańska, and Ł. J. Krzych, "Validation of APACHE II, APACHE III and SAPS II scores in in-hospital and one year mortality prediction in a mixed intensive care unit in Poland: a cohort study," *BMC Anesthesiol.*, vol. 20, pp. 1–8, 2020.