Implementation of Independent VAP Prevention Bundle to Prevent Ventilator-Associated Pneumonia (VAP) in Mechanically Ventilated ICU Patients

Lia Azizah[1], Akhmad Zainur Ridla[1], Ana Nistiandani[1], Sugito Tri Gunarto[2]
[1]Nursing Department, Universitas Jember, Jember, Indonesia; [2]Emergency Installation, dr. Soebandi Regional Hospital, Jember, Indonesia
Correspondence: **Akhmad Zainur Ridla**: Jl. Kalimantan 37, Jember, Indonesia; akhmadzainur.fkep@unej.ac.id

ABSTRACT
Ventilator-associated pneumonia (VAP) is a nosocomial infection of the lung tissue that most often occurs in patients undergoing mechanical ventilation in intensive care units, with a high morbidity and mortality rate of 1% per day. The incidence of VAP can be prevented through a specific procedure, known as the VAP Bundle. The method in the VAP Bundle includes head-up positioning at 30°-45°, closed suctioning, and oral hygiene using 0.2% chlorhexidine aseptic solution. This study aims to evaluate the effectiveness of the VAP bundle in preventing VAP risk among mechanically ventilated patients at dr. Soebandi Regional Hospital, Jember. This study was a case report involving one patient who met the inclusion and exclusion criteria. The Modified Clinical Pulmonary Infection Score (MCPIS) was measured daily over a six-day intervention period. The results showed that during the six-day intervention, the patient's MCPIS score remained <5 (indicating no VAP). Clinical findings showed no infiltrates, non-purulent secretions, and normalized temperature by intervention end. It can be concluded that the implementation of independent VAP Bundle activities by nurses was successful in preventing VAP among mechanically ventilated ICU patients.
Keywords: ventilator-associated pneumonia; head up; suction; oral hygiene; chlorhexidine

INTRODUCTION
Ventilator-Associated Pneumonia (VAP) is a nosocomial infection of the lung tissue that occurs at least 48 hours after intubation and the use of mechanical ventilation [1]. VAP infections frequently occur in intensive care units, especially in patients undergoing ventilator therapy [2]. Various studies indicate that the use of mechanical ventilation for more than 48 hours significantly increases the risk of VAP, which can be fatal because it raises morbidity and mortality rates in ICU patients by 1% daily [3,4]. This condition results in increased medical costs, longer hospital stays, and mortality rates of 25-50%, potentially rising to 70% [5].

The Intensive Care Unit (ICU) is a hospital facility where 80% of patients require mechanical ventilation support. The World Health Organization reported approximately 1,000 new VAP cases daily worldwide in 2018, with a higher incidence in developing countries (23.9%) compared to developed countries (7.9%) [6]. In China, in 2019, the incidence was 5.03 cases per 1,000 ventilator days; in Ethiopia, it was 31.3%; while in Japan, the incidence ranged around 1.3 cases per 1,000 patients [1,7,8]. In Indonesia, based on the 2018 RISKESDAS data, the prevalence of pneumonia was 2%, with the highest distribution of VAP in DKI Jakarta (37.9%), Central Java (15.9%), DIY Yogyakarta (13.8%), followed by East Java (11.7%), and varying in other provinces [4]. Data from the ICU of RSD dr. Soebandi shows an increase in the incidence of VAP from 8.7% in 2023 to 12.5% in 2024.

VAP is a leading cause of death from healthcare-associated infections (HAIs), accounting for approximately 25% of all infections in the ICU [6]. This infection arises from one ICU treatment procedure, the use of mechanical ventilation via endotracheal tube (ETT) insertion. VAP develops through bacterial colonization of the respiratory and digestive tracts, with the ETT providing a direct pathway for bacteria to reach the lower respiratory tract and the nasogastric tube (NGT) enabling bacterial migration from the digestive tract to the oropharynx and subsequently to the respiratory tract. [5, 9]. Patients with VAP face higher mortality risk and extended lengths of stay both in the ICU and hospital [10]. Therefore, preventing VAP is essential to improve patient outcomes, one strategy being the implementation of the Ventilator-Associated Pneumonia Bundle [3].

The Institute for Healthcare Improvement (IHI) developed clinical recommendations called the 'VAP Bundles of Care' to reduce VAP-related morbidity and mortality. Consistent and comprehensive implementation of this protocol has been shown to effectively reduce VAP incidence in ventilated patients [6]. In Indonesia, the implementation of bundles for the prevention and control of VAP is regulated by the Ministry of Health Regulation No. 27 of 2017 concerning guidelines for infection prevention and control [11]. The core strategy of the VAP Bundle focuses on two primary aspects: reducing bacterial colonization in the oropharyngeal and tracheobronchial areas and minimizing the risk of aspiration [12]. The protocol includes seven key elements, including elevating the head of the bed, maintaining oral hygiene, and managing secretions. Previous research showed that VAP incidence decreased from 4.75 to 3.42 after bundle interventions in mechanically ventilated patients, with statistically significant differences [3]. While numerous studies have evaluated individual VAP bundle components across various hospitals, this case report uniquely contributes by simultaneously assessing three specific elements, 30°-45° head-up positioning, closed suctioning, and 0.2% chlorhexidine oral hygiene, to demonstrate their feasibility and effectiveness in a resource-limited ICU setting. Unlike prior research offering generalized findings, this study provides detailed and patient-specific MCPIS data from six consecutive intervention days. Therefore, the purpose of this study evaluates independent nurse implementation VAP Bundle procedures as a preventive measure against VAP in the ICU of RSD dr. Soebandi Jember.

METHODS
This study was conducted over a six-day period, from May 11 to 16, 2025, in the ICU of Dr. Soebandi Regional Hospital, Jember. It employed a case report approach with purposive sampling to explore in depth a phenomenon in emergency and critical care nursing practice within an individual patient. The study population consisted of four patients, but only one met the inclusion and exclusion criteria and was selected as the sample for intervention.

This study utilized the Modified Clinical Pulmonary Infection Score (MCPIS) instrument to assess the effectiveness of VAP bundle implementation in reducing VAP risk. The instrument demonstrated high reliability, with a Cronbach's alpha of 0.9. The MCPIS consists of five parameters: body temperature, leukocyte count, pulmonary secretions, PO_2:FiO_2 ratio (mmHg), and chest X-ray findings. Each parameter is scored from 0 to 2, where 0 indicates normal conditions and 1 or 2 indicates worsening conditions. Total scores range from 0 to 10, with scores >5 indicating VAP and scores ≤5 indicating no VAP [13].

The study followed a structured nursing process: assessment, nursing diagnosis, intervention planning, implementation, and evaluation. Interventions were provided daily for six days and included maintaining head-of-bed elevation at 30°–45°, performing closed suctioning as needed

(e.g., for difficult-to-expel secretions or adventitious breath sounds), and providing oral hygiene with 0.2% chlorhexidine solution twice daily for 1 minute per session. Data analysis involved case report to evaluate changes in VAP risk, as measured by the MCPIS instrument, following implementation of the VAP bundle (head-of-bed elevation at 30°–45°, closed suctioning, and oral hygiene with 0.2% chlorhexidine) in a mechanically ventilated patient with decreased consciousness in the ICU of Dr. Soebandi Regional Hospital, Jember.

RESULTS

Overview of the patient and initial condition

On May 10, 2025, at 6:00 p.m, patient Mr. M, aged 74 presented to the Emergency Department of RSD Soebandi Jember was transported by ambulance, referred from the Community Health Center, with the main complaint of decreased consciousness GCS $E_2V_2M_5$ after a motorcycle accident. While at the Community Health Center, the patient vomited once and did not experience a fracture. Still, there was a laceration vulnus in the right temporal region which had been sutured with three stitches and covered with gauze. The patient was then referred to the Emergency Installation RSD dr. Soebandi was transferred to the operating room for a craniotomy. Management of ICH generally includes surgical procedures, such as craniotomy and hematoma removal, to reduce intracranial pressure and prevent further brain damage [14,15].

Researchers conducted an assessment in the ICU on May 11, 2025, at 3:00 a.m, and found that the patient had been transferred from the operating room and entered the Intensive Care Unit with a non-spontaneous breathing condition, requiring assisted breathing via ETT, with an SPO2 of 100%. Due to this condition, the patient was provided with respiratory support on a BIPAP ventilator, with an FiO_2 of 40%, an ASB of 10, and a PEEP of 5. The patient's consciousness was sedated. The TTV results showed a blood pressure of 158/76 mmHg, a pulse of 83 bpm, a respiratory rate of 16 breaths per minute, an SPO_2 of 100% on a BIPAP ventilator mode, and a temperature of 36.7°C. The patient's previous medical history, the patient's family said that the patient had no history of infectious or chronic diseases, but he was an active smoker. Based on the results of the physical examination, additional breath sounds were found in the form of rhonchi in the right lung field. The patient was placed on an NGT for nutritional fulfillment because the patient's consciousness was sedated and a dantrolene catheter was installed. A surgical wound dressing covered with gauze was also found in the right temporal region vertically ±10 cm. The results of the chest X-ray at the Emergency Installation showed no abnormalities in the COR and lungs and no visible infiltrates. The CT-Scan results showed bleeding in the right and left temporal lobes, left cerebellum, subdural hematoma in the left temporal region, and subarachnoid hemorrhage. Laboratory results showed leukocytosis (12.2 × 10^3/µL), thrombocytopenia (114 × 10^3/µL), and anemia (8.9 g/dL). Blood gas analysis results showed pH 7.53, PCO_2 26.4 mmHg, and HCO_3 22 mmol/L, indicating respiratory alkalosis. The patient's therapy during treatment was midazolam 2mcg/hour, fentanyl 25 mcg/hour, Tutosol 500 ml/24 hours, Clanexi 2x1 gram, levofloxacin 1x750 mg, ranitidine 2x50 mg, omeparzole 2x40 mg, antrain 3x1000 mg, kutoin 3x100 mg, and tranexamic acid 3x500 mg.

Nursing interventions and evaluation

The researchers then identified five nursing diagnoses: spontaneous ventilation impairment, ineffective airway clearance, decreased intracranial adaptive capacity, ineffective peripheral perfusion, and self-care deficit. The researchers identified these priority diagnoses, and interventions were implemented based on Evidence-Based Nursing (EBN) findings related to the 30°-45° head-up position, close suction, and oral hygiene with 0.2% chlorhexidine aseptic as part of the VAP (Ventilator-Associated Pneumonia) prevention bundle. The 30°-45° head-up position was implemented daily, with close suction performed as indicated, and oral hygiene was performed twice daily at 9:00 a.m. and 4:00 p.m. These practices were then evaluated using the Modified Clinical Pulmonary Infection Score (MCPIS) at the end of the implementation, after oral hygiene, at 5:00 p.m. MCPIS has a score of 0-2 for each indicator, with a maximum score of 10. If the score is > 5, it can be indicated that VAP is present; a score of ≤5 indicates that VAP is not present. The results of the MCPIS assessment are shown in Table 1.

Table 1. Results of the MCPIS (Modified Clinical Pulmonary Infection Score)

Assessment date	Temperature	Leukocytes	Pulmonary secretions	PO_2-FiO_2 ratio	Chest X-ray	Total score	Conclusion
May 11, 2025	0	1	1	0	0	2	Undiagnosed VAP
May 12, 2025	0	0	1	0	0	1	Undiagnosed VAP
May 13, 2025	0	0	1	0	0	1	Undiagnosed VAP
May 14, 2025	1	-	1	0	0	2	Undiagnosed VAP
May 15, 2025	1	1	1	0	0	3	Undiagnosed VAP
May 16, 2025	0	1	1	0	0	2	Undiagnosed VAP

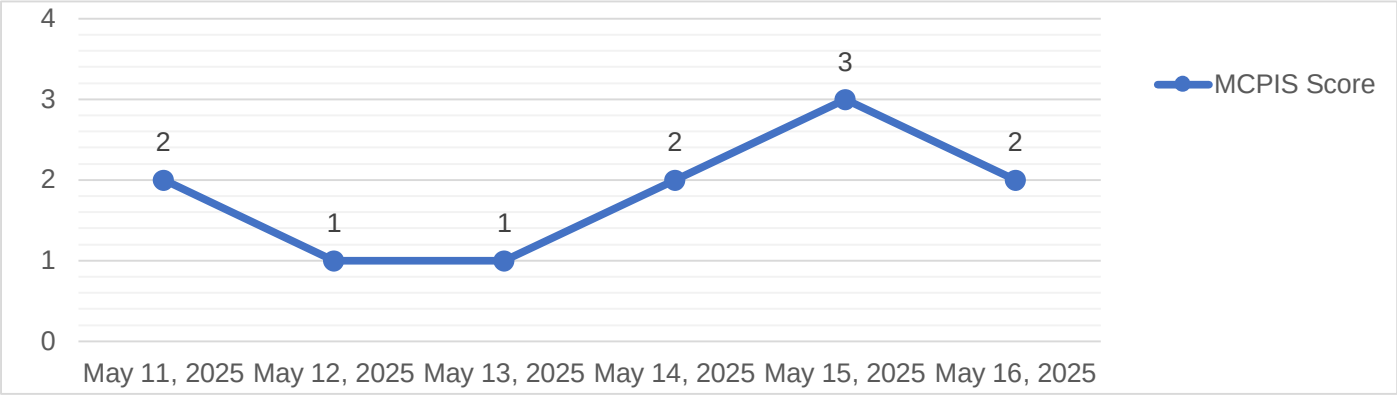

Figure 1. MCPIS score graph

The results of the intervention for Mr. M, which was carried out over 6 days in the Intensive Care Unit of Dr. Soebandi Jember Hospital, were evaluated using the MCPIS instrument to identify the presence of VAP. This assessment measures five indicators, including body temperature, leukocytes, pulmonary secretions, FiO_2:PO_2 ratio, and chest X-ray results. This implementation was carried out directly by the researcher while on duty, with the assistance of colleagues and Intensive Care Unit nurses, using Standard Operating Procedures (SOP) that had been determined and implemented by the hospital where the study took place. The results of Mr. M's MCPIS score graph is shown in Figure 1.

Based on the results of observations using the MCPIS instrument on Mr. M from day 1 to day 6 of ventilator use and after the VAP bundle intervention, Mr. M's MCPIS score was <5, indicating that Mr. M was undiagnosed or did not experience VAP during ventilator use and the VAP bundle intervention.

DISCUSSION

Based on the results of the research that has been conducted, it shows that the MCPIS value of Mr. M during the 6 days of intervention is not indicative of VAP during the use of a mechanical ventilator. The respondent in this study was Mr. M, a 74-year-old individual with COS and ICH following craniotomy surgery. Increasing age also increases susceptibility to disease, including the occurrence of VAP (Ventilator-Associated Pneumonia) due to decreased immune function [16]. Moreover, the patient experienced decreased consciousness and non-spontaneous breathing when entering the ICU room, requiring intubation using a mechanical ventilator for a long time (> 48 hours), and the installation of an NGT which is a risk of nosocomial infection [10]. The patient also underwent an evacuation craniotomy procedure due to bleeding in the right temporal lobe to remove the bleeding that occurred in the brain cavity. Traumatic and pathological conditions experienced by patients due to injury or critical conditions can impact the function of the immune system [17].

Patients also experience decreased consciousness and sedation, which is a factor influencing the occurrence of VAP. Decreased levels of consciousness, the installation of an ETT, NGT, and a ventilator in patients, have a high risk of VAP (Ventilator-Associated Pneumonia) incidents. Reviewing the patient's condition results in a decrease or even disappearance of the cough and gag reflexes, increasing the risk of aspiration, disrupting mucociliary function, and damaging the tracheal epithelium, which is the body's natural defense against various infections [16]. Because patients require several interventions related to the VAP bundle to prevent the risk of VAP, researchers identified three intervention steps to prevent pneumonia associated with the use of mechanical ventilators in patients. These will be explained as follows.

Head-up position 30°-45°

Mr. M was placed in a 30°-45° head-up position as part of the VAP bundle intervention to reduce the risk of VAP. Researchers provided Mr. M with a 30°-45° head-up position from intubation until mechanical ventilation was installed on day 1, extending through day 6 of his intensive care stay. This intervention involved elevating the head of the bed at an angle of 30°-45° on the first day, and researchers maintained this position throughout the patient's stay. Mr. M was then measured daily with the Modified Cardiac Assessment System (MCPIS) instrument, where the MCPIS score never exceeded 5, and the initial and final PaO2:FiO2 ratio remained within normal limits (>240 mmHg).

Head of bed elevation improves respiratory circulation, prevents the risk of aspiration of gastric fluid and oropharyngeal secretions that can enter the lower respiratory tract, thereby reducing the colonization of pathogenic bacteria, which are the main cause of VAP [18]. Other studies have shown that the supine position is at a higher risk of VAP because it increases the risk of pulmonary aspiration in patients compared to the semi-recumbent position [17]. Another study also showed that providing a 45° HOB position can prevent VAP [18]. This finding is also supported by previous research involving 60 patients. Their results showed that head-of-bed elevation at 30° (VAP incidence: 25%) and 45° (20%) significantly reduced VAP risk compared to <30° (55%) ($p = 0.022$) [19]. Thus, the researcher assumes that providing a head-up position of 30°-45° is effective in preventing aspiration and maintaining respiratory function, thereby reducing the risk of VAP.

Close suction

During the intervention, Mr. M had colorless secretions on days 1-3, followed by increased pulmonary secretions, that became slightly yellowish-white on days 4-6. Researchers assumed that Mr. M experienced decreased immunity on days 4-6, as evidenced by the leukocyte count and body temperature exceeding usual limits, suggesting an infection. Overall, the MCPIS score during the six days of treatment showed no significant change (score <5), indicating that the patient did not have an infectious disease. Even during the periodic suctioning, Mr. M did not develop purulent secretions.

Other studies have also shown that suctioning improves oxygen saturation, maintains airway patency, prevents accumulation of secretions in the lower respiratory tract, and supports hemodynamic stability during intensive care [3]. In addition, suctioning also plays a role in preventing serious complications, such as Ventilator-Associated Pneumonia (VAP), by reducing the accumulation of secretions that can serve as a growth medium for pathogenic bacteria [6]. The entry of microorganisms into the lower respiratory tract through secretions from the oropharynx, stomach, and trachea around the usually sterile endotracheal tube balloon is the most common bacterial accumulation that causes VAP [20,21]. This is reinforced by other research showing that suctioning significantly reduces VAP incidence, with 70% of 21 patients ($n = 21$) remaining not having VAP [22]. Additionally, other studies have shown that closed suctioning is more effective in preventing VAP (OR: 1.57, 95% CI; 1.06-2.32, $P = 0.02$) [23]. Thus, the researcher assumes that suctioning contributes to preventing the risk of VAP in patients using mechanical ventilators.

Oral hygiene using 0.2% chlorhexidine aseptic

The results of the implementation showed improvement in the patient's oral condition, as assessed by moist lips, clean teeth, and the absence of plaque, as well as a clean tongue. According to the MCPIS score, baseline results during the first three days of the intervention were relatively stable, with normal leukocyte counts, body temperature, and secretion characteristics, indicating the effectiveness of this intervention in preventing the risk of VAP. However, on days 4 to 6, researchers assumed that Mr. M experienced decreased immunity, as evidenced by an increase in the number of leukocytes, fever, and a yellowish-white color of the secretions, indicating a possible infection or inflammation. This finding is consistent with research showing that body temperature and leukocyte counts increase due to the body's inflammatory response to infection [3]. Overall, the MCPIS score change from days 4 to 6 remained within the range of 3, indicating that this score is not a reliable indicator for VAP.

Oral hygiene aims to prevent infection, maintain oral hygiene, prevent plaque buildup, and reduce bacterial adhesion to tooth surfaces [17]. The reason for choosing 0.2% chlorhexidine aseptic solution is that studies have shown it to be the most used and effective mouthwash in oral care, due to its bactericidal and bacteriostatic properties, which effectively combat various gram-positive and gram-negative bacteria that are the primary cause of VAP [24]. The results of the intervention in this study indicate that oral hygiene using 0.2% chlorhexidine aseptic solution is considered

effective in preventing VAP. After 6 days of treatment, the MCPIS score remained <5, indicating no VAP. This finding is consistent with research showing a significant difference in CPIS scores between pre- and post-oral hygiene periods using 0.2% chlorhexidine [25]. Therefore, the researchers' assumption that oral hygiene intervention using 0.2% chlorhexidine is effective in preventing microbial colonies that are the source of VAP.

This study has several limitations, particularly regarding patient therapy factors. The patient received antibiotic therapy during treatment, specifically Clanexi and Levofloxacin, both broad-spectrum antibiotics effective against pathogenic bacteria including pneumonia-causing pathogens such as Streptococcus pneumoniae and Pseudomonas aeruginosa. These pharmacological interventions likely contributed synergistically to the final MCPIS scores obtained by researchers, making it difficult to isolate the independent effect of the nurse-led VAP bundle. Suggestions for future researchers include considering comparator factors in the implementation of the intervention, such as the level of head elevation and the type and frequency of oral hygiene interventions. Furthermore, to optimize research results and avoid confounding factors such as antibiotic use, future researchers can use a control and intervention group study design, which is expected to enable a more comprehensive and accurate evaluation of VAP.

CONCLUSION

Based on the intervention results, it can be concluded that the VAP bundle implementation consisting of 30°-45° head-up positioning, closed suctioning, and 0.2% chlorhexidine oral hygiene was effective in preventing VAP in the mechanically ventilated patient during the six-day ICU treatment period. The clinical outcomes confirmed no VAP diagnosis, demonstrating the success of independent nurse-led VAP bundle procedures as a practical preventive strategy in resource-limited settings.

Ethical consideration, competing interest and source of funding

-This study adhered to the ethical principles of nursing research, including autonomy, beneficence, non-maleficence, and confidentiality of patient data. Ethical approval was obtained from the institutional review board, along with informed consent from the patient (or their legal representative) and formal permission from Dr. Soebandi Regional Hospital prior to data collection.
-There is no conflict of interest related to this publication.
-Source of funding is authors.

REFERENCES

1. Tegegne EM, Chekol Gete B, Demissie DB. Prevalence of ventilator-associated pneumonia and associated factors among intubated adult patients admitted in public hospitals in Addis Ababa, Ethiopia: A facility-based retrospective study design. Front Med. 2025;1500901(12):1–10.
2. Havaldar AA, Rajgopalan N, Gupta V, PH M. Clinical usefulness of ventilator associated events in predicting ventilator associated pneumonia. Int J Infect Control. 2020;16(3):1.
3. Damasnyah H, Yunus P, Monoarfa S, Taliki V. Pengaruh VAP bundle intervention dalam pencegahan VAP pada pasien terpasang ventilator mekanik di ruangan ICU RSUD Prof. Dr. H. Aloei Saboe Kota Gorontalo. J Keperawatan Muhammadiyah. 2024;9(3):173–80.
4. Fatmawati R, Kusumajaya H, Ardiyansyah. Faktor-faktor yang berhubungan dengan pengetahuan perawat dalam pencegahan ventilator associated pneumonia. J Penelitian Perawat Profesional. 2023;4(5):2175–6855.
5. Amalia Shidiq NR, Awaludin S, Kurniawan A. Implementasi oral care hygiene untuk mengurangi risiko ventilator associated pneumonia (VAP) di ruang Intensive Care Unit (ICU) Rumah Sakit Prof. Dr. Margono Soekarjo: Case study. J Bionursing. 2021;3(2):113–21.
6. Trifianingsih D, Ivana T, Hawini Z. Knowledge of the nursing team on ventilator-associated pneumonia (VAP) prevention strategies in the intensive care unit Ulin Hospital Banjarmasin. J Keperawatan Suaka Insan. 2024;9(1):61–9.
7. Ding X, Ma X, Gao S, Su L, Shan G, Hu Y, et al. Effect of ICU quality control indicators on VAP incidence rate and mortality: A retrospective study of 1267 hospitals in China. Crit Care. 2022;26(26):1-8.
8. Nanao T, Nishizawa H, Fujimoto J, Ogawa T. Additional medical costs associated with ventilator-associated pneumonia in an intensive care unit in Japan. Am J Infect Control. 2021;49(3):340–4.
9. Gesa Mulya S, Sarjana M, Universitas K, Sukabumi M. Hubungan tingkat pengetahuan tentang bundle ventilator associated pneumonia terhadap perilaku perawat dalam pencegahan ventilator associated pneumonia (VAP) di ICU RSUD Jampangkulon. J Lentera. 2023;6(2):26–32.
10. Usman R, Afriani L, Ariyasra U, Rahma Sari S. Ventilator associated pneumonia dengan faktor determinan terkait pemasangan ventilator mekanik. J Keperawatan. 2025;17(2):365–74.
11. Kemenkes RI. Peraturan Menteri Kesehatan Republik Indonesia nomor 27 tahun 2017 tentang pedoman pencegahan dan pengendalian infeksi di fasilitas pelayanan kesehatan. Jakarta: Kementerian Kesehatan Republik Indonesia; 2017.
12. Al Fatih H, Iklima N, Kurniasih R. Hubungan pengetahuan dengan kepatuhan perawat terhadap bundle VAP di ruang ICU. J Keperawatan BSI. 2024;12(2):143–52.
13. Mohamed MM, Ali ZH, Hassan SN. The relationship between endotracheal tube different cuff pressure measurements and the incidence of ventilator-associated pneumonia. Int J Chem Biochem Sci. 2023;8:83-8.
14. Aulia Dewi A, Fikriyanti, Jufrizal. Asuhan keperawatan post craniotomy evakuasi intracerebral hemorrhage (ICH) di intensive care unit: Studi kasus. J Gawat Darurat. 2024;6(1):9–20.
15. Melinda R, Wirakhmi IN. Asuhan keperawatan posisi semi fowler pasca craniotomy evakuasi ICH. J Penelitian Perawat Profesional. 2024;6(5):2559–66.
16. Salsabilah N, Wahyuni A, Sidharti L. Faktor-faktor yang berpengaruh terhadap kejadian ventilator associated pneumonia. Medula. 2023;13(3):259–64.
17. Tri Pramesuari NK, Haristiani R, Adi Yunanto R, Handoko YT. Pengaruh pemberian oral hygiene dengan povidone iodine 1% terhadap pencegahan kejadian ventilator associated pneumonia (VAP) di ruang ICU RSUD dr. Haryoto Lumajang. J Ilmiah Keperawatan Altruistik. 2024;7(2):45–56.
18. Agustilano Salim V, Zainur Ridla A, Setioputro B, Tri Gunarto S. Penerapan elevasi head of bed 45 derajat pada pasien cerebrovascular accident untuk pencegahan ventilator associated pneumonia di ruang ICU RSD dr. Soebandi Jember. J Ilmiah Keperawatan. 2023;9(3):554–61.
19. Güner CK, Kutlutürkan S. Role of head-of-bed elevation in preventing ventilator-associated pneumonia: Bed elevation and pneumonia. Nurs Crit Care. 2022;27(5):635–45.

20. Hess D, MacIntyre N, Galvin W, Mishoe S. Respiratory care: Principles and practice. 4th ed. Jones & Bartlett Publishers; 2020.
21. Jindal S, Guleria R. World clinics pulmonary & critical care medicine: Pneumonia. 1st ed. Vol. 6. Jaypee Brothers Medical Publisher; 2019.
22. Atrie UY, Widiastuti L, Kurniawan D, Rahardiantini I, Putri E. Hubungan frekuensi open suction terhadap kejadian ventilator associated pneumonia (VAP) di ruang ICU Rumkital dr. Midiyato Suratani Tanjungpinang. J Vokasi Keperawatan. 2025;8(1):86–98.
23. Sanaie S, Rahnemayan S, Javan S, Shadvar K, Saghaleini SH, Mahmoodpoor A. Comparison of closed vs open suction in prevention of ventilator-associated pneumonia: A systematic review and meta-analysis. Indian J Crit Care Med. 2022;26(7):839–45.
24. Pongoh S, Makiyah SNN. Effectiveness of oral hygiene with chlorhexidine in the prevention of VAP: Literature review. Jurnal Aisyah J Ilmu Kesehatan. 2022;7(S2):253–62.
25. Dilla NS. Pengaruh tindakan oral hygiene menggunakan chlorhexidine 0,20% terhadap kejadian VAP pada pasien dengan ventilator mekanik di ruang observasi intensif (ROI). J Anesthesiol Tiara Bunda. 2021;1(1):8–18.