

IMPLEMENTATION OF A PROTOCOL BASED CARE BUNDLE MODEL IN THE PREVENTION OF VENTILATOR ASSOCIATED PNEUMONIA (VAP) IN THE INTENSIVE CARE UNIT

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ABSTRACT

Critically ill patients admitted to the Intensive Care Unit (ICU) often require intubation and mechanical ventilation to maintain an open airway and meet their oxygenation needs. This increases the risk of complications, one of which is Ventilator-Associated Pneumonia (VAP), which can worsen the patient's prognosis. Therefore, optimal preventive measures are required through the implementation of the VAP Bundle. The aim of this study was to determine the effect of implementing the Ventilator-Associated Pneumonia (VAP) Bundle on the incidence of pneumonia in the ICU. A quantitative pre-experimental method was used with 36 respondents selected via purposive sampling. The results of the study showed that there was an effect of the implementation of the Ventilator-Associated Pneumonia (VAP) Bundle on the incidence of pneumonia in the ICU, as evidenced by a P-value of 0.001. It can therefore be concluded that the implementation of the Ventilator-Associated Pneumonia (VAP) Bundle can reduce the incidence of pneumonia in the ICU, and that this Ventilator-Associated Pneumonia (VAP) Bundle can be applied as a measure to prevent the occurrence of pneumonia in the ICU.

Keywords Bundle Care; Ventilator-Associated Pneumonia (VAP); Intensive Care Unit (ICU)

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INTRODUCTION

The Intensive Care Unit (ICU) is a specialised care unit designed for patients in critical or unstable condition who require close monitoring. The ICU is also used to treat patients with acute illnesses, severe injuries, or other life-threatening complications. The majority of patients admitted to the ICU require mechanical ventilation (a ventilator) to support respiratory function^{1,4}. Acute respiratory failure is one of the main reasons patients require intensive care. This condition can place a person in a critical state when respiratory function is impaired. On average, there are around 42 patients with respiratory failure admitted to the ICU each month, with a mortality rate of approximately 10 patients per month².

Mechanical ventilation is used when non-invasive methods are no longer able to adequately meet the patient's oxygenation and ventilation needs. A patient's inability to maintain carbon dioxide (CO₂) levels and acid-base balance due to acute respiratory failure is one of the main indications for the use of this device. The use of mechanical ventilation plays a role in supporting the survival of patients with respiratory failure^{18,23}. Ventilators operate using positive or negative pressure to regulate airflow in the patient's airways, thereby maintaining and improving ventilatory function and oxygen supply over the long term¹⁹. According to research findings, approximately 12% of all inpatients are in a critical condition, and of this number, around 18.7% die during hospitalisation²². Throughout 2021, there were 52,719 critically ill patients, with the average ICU occupancy rate in Indonesia reaching 64.83%²⁹. Based on medical records at Indriati Sukoharjo Hospital over the past three months, 184 patients were on ventilators.

Critically ill patients who are intubated and require long-term mechanical ventilation in the ICU are at high risk of developing a nosocomial infection known as Ventilator-Associated Pneumonia (VAP)²¹. Ventilator-associated pneumonia is one of the most common infections in critically ill patients on mechanical ventilation. This condition is associated with increased mortality, morbidity, and prolonged hospital stays, as well as adding to the economic burden and psychological impact on patients and their families²⁴. ICU patients on mechanical ventilation are at risk of various complications, including venous thromboembolism (VTE), ventilator-associated pneumonia (VAP), and stress-induced gastrointestinal bleeding. To address these issues, the Institute for Healthcare Improvement (IHI) in the United States, the American Thoracic Society, and the Centers for Disease Control and Prevention (CDC) have developed a VAP care bundle guideline with the aim of preventing pneumonia and reducing mortality rates due to VAP²⁵.

An endotracheal tube (ETT) inserted for mechanical ventilation has the potential to act as a direct entry route for bacteria into the lower respiratory tract. This condition results in the loss of the natural barrier between the upper airways and the trachea, thereby reducing the body's ability to filter and warm the air. The insertion of an ETT also frequently suppresses or reduces the cough reflex. Furthermore, the function of the cilia on the respiratory tract mucosa may be disrupted due to mucosal injury during the intubation process, making the trachea a site susceptible to bacterial colonisation²⁶.

The incidence of VAP in hospitals, particularly in ICUs, can be reduced through the implementation of a set of interventions known as the VAP bundle. This care strategy aims to prevent VAP by focusing on efforts to reduce bacterial colonisation in the oropharynx and tracheobronchial tree, as well as minimising the risk of aspiration. The VAP bundle comprises both collaborative and independent interventions. The success of its implementation in intensive care units is influenced by standard operating procedures, nurses' knowledge of the VAP bundle, and adherence to nursing care practices^{30,31}. There are a number of concepts or principles that can be applied in VAP prevention efforts, namely raising the head of the bed (HOB) by 30–40°, the use of thromboembolism prophylaxis, the administration of prophylaxis to prevent peptic ulcers, the temporary suspension of daily

sedative use accompanied by continuous evaluation of readiness for extubation, and the implementation of oral hygiene care²⁷. In line with the research conducted by Kartini (2023), entitled “The Effect of the VAP Bundle on the Incidence of VAP in Patients on Mechanical Ventilation in the ICU at the Surabaya Military Hospital”, which shows that the implementation of the VAP Bundle has an impact on VAP prevention efforts, particularly in patients on long-term mechanical ventilation.

METHODS

This study is a quantitative study with a pre-experimental design in the form of a one-group pre-test and post-test without a control group. The aim of this study is to determine the effect of implementing the Ventilator-Associated Pneumonia (VAP) Bundle on the prevention of pneumonia in the ICU among patients on mechanical ventilation. A non-probability sampling method using convenience sampling was employed to recruit adult patients (aged 18 years or older) admitted to medical and surgical ICUs who had been on mechanical ventilation for more than 48 hours.

The data collection form was adapted from a study that had been reviewed and approved by two experts: an intensivist and two doctoral experts in critical care and nursing administration. The form included seven elements of VAP care, namely:

1. Head elevation of 30–45 degrees
2. Administration of peptic ulcer disease (PUD) prophylaxis
3. Daily sedation vacation
4. Daily spontaneous breathing trials if the patient is ready for ventilator weaning
5. Daily assessment of readiness for weaning (ventilator weaning)
6. Oral care with chlorhexidine
7. Prophylaxis for DVT (deep vein thrombosis)

RESULTS

The study sample comprised 36 patients admitted to the ICU and on mechanical ventilation.

Table 1. Distribution of Respondents by Characteristics

No	Respondent Characteristics	Classification (year)	Frequency (n)	Percentage (%)
1.	Age	26 – 35	4	11.11
		36 – 45	1	2.78
		46 – 55	7	19.44
		56 – 65	11	30.6
		>65	13	36.11
			36	100
2.	Gender	Laki-laki	21	58,33
		Perempuan	15	41,67
			36	100

The table above shows that the majority of respondents were aged over 65, namely 13 people, representing 36.11%. As for the respondents' characteristics by gender, the majority were male, accounting for 58.33% (21 people).

Table 2. Incidence of Pneumonia Infections prior to the implementation of the VAP Bundle in the ICU

No	Incidence of Pneumonia	Mean	Frequency (n)	Percentage (%)
1.	VAP infection	1.36	23	63.89
2.	No infection occurs	2.77	13	36.11

	36	100
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Table 2 shows that, prior to the implementation of the VAP bundle, the majority of respondents—23 patients (63.89%)—had developed VAP, whilst 13 patients (36.11%) had not

Table 3. Incidence of Pneumonia Following the Implementation of the VAP Bundle in the ICU

No	Incidence of Pneumonia	Mean	Frequency (n)	Percentage (%)
1.	VAP infection	9	4	11.11
2.	No infection occurs	1.12	32	88.89
			36	100

The table above shows that following the implementation of the VAP Bundle in patients on mechanical ventilation, the majority of patients did not develop VAP—namely 32 patients (88.89%) with an average VAP score of 9—whilst the number of patients who developed VAP following the implementation of the VAP Bundle was 4 (11.11%) with an average VAP score of 1.12

Table 4. The Effect of Implementing the Ventilator-Associated Pneumonia (VAP) Bundle on the Incidence of Pneumonia in the ICU

Group	n	Mean	SD		P (z)
Pretest	36	7.76	1.222		
Posttest	36	5.20	0.830	-2.81	0.001

Based on the table above, the results of the statistical test show that there is an influence of the implementation of the Ventilator Associated Pneumonia (VAP) Bundle on the incidence of pneumonia infections in the ICU with a P value of 0.001.

DISCUSSION

Ventilator-Associated Pneumonia (VAP) is pneumonia in patients receiving mechanical ventilation with an endotracheal tube (ETT) for a minimum duration of 48 hours³⁴. Eighty-six percent of all nosocomial pneumonia infections are ventilator-associated, known as VAP. The VAP bundle strategy aims to prevent the development of VAP by focusing on reducing bacterial colonization of the oropharynx. Steps to prevent VAP include elevating the head of the bed, discontinuing daily sedation, assessing readiness for extubation, preventing peptic ulcer disease, intravenous prophylaxis, thromboembolism, and oral therapy³⁵.

Respondents in this study were 36 patients treated in the ICU and on mechanical ventilators. The distribution of respondent characteristics by age is shown in Table 1, with the majority of respondents aged 13 or over 65 years, representing 36.11%. Meanwhile, the characteristics of respondents based on gender, the majority of respondents were male with 58.33% or 21 people. Patients on mechanical ventilation are generally in a critical condition and experience a reduced level of consciousness. This condition leads to the accumulation of secretions in the endotracheal tube. These secretions may be contaminated with bacteria from the oropharynx and have the potential to migrate to the lower respiratory tract³. In the table detailing patient age characteristics, the majority of patients on mechanical ventilation were over 65 years of age. Elderly patients have a higher likelihood of developing ventilator-associated pneumonia (VAP) in the ICU. According to a study by Susanti et al. (2015), of the total 30 patients studied, 11 were aged over 60 years. This occurs because in older adults (>60 years), there is a decline in immune system function, making the body more vulnerable and at risk of various diseases⁵.

In general, men tend to be at a higher risk of developing VAP than women. This difference is attributed to the influence of hormones on the body's immune response to bacterial infections, whereby testosterone is known to suppress the immune response, whilst oestrogen plays a role in enhancing it. However, the incidence of VAP is not only influenced by gender but also by other factors such as the duration of ventilator use, oral hygiene, and the patient's comorbidities⁶.

Table 2 shows that, prior to the implementation of the VAP bundle, the majority of respondents—23 patients (63.89%)—had developed VAP, whilst 13 patients (36.11%) had not. Endotracheal intubation is a major risk factor for ventilator-associated pneumonia. This procedure disrupts the airway's defence mechanisms, impairs the cough reflex and mucociliary clearance, and facilitates the micro aspiration of secretions containing bacteria that accumulate on the inflated cuff of the endotracheal tube. Furthermore, bacteria can form biofilms on and within the endotracheal tube, which protect them from antibiotics and the body's defence system. The highest risk of ventilator-associated pneumonia occurs within the first 10 days following intubation. Ventilator-associated pneumonia occurs in approximately 9 to 27% of patients on mechanical ventilation^{32,33}.

The majority of patients on mechanical ventilation showed signs of VAP. Assessment was carried out using the Critical Pulmonary Infection Score (CPIS), characterised by an increase in the patient's body temperature, an elevated white blood cell count, an increase in the volume and viscosity of secretions in the trachea, a decrease in oxygen saturation, and, in some patients, chest X-rays revealed excessive secretion build-up.

Based on observations using the Clinical Pulmonary Infection Score (CPIS) on the third day of ventilator use and after the VAP Bundle intervention, changes were observed after the implementation of the VAP Bundle. Although some patients still experienced VAP infections, there was a significant decrease in the incidence of infection. In Indonesia, the implementation of the VAP bundle is stipulated in the Indonesian Minister of Health Regulation Number 27 of 2017 concerning guidelines for infection prevention and control. The VAP bundle strategy aims to prevent the development of VAP by focusing on efforts to reduce bacterial colonization in the oropharynx³⁵.

The statistical test in Table 4 shows that the implementation of the Ventilator Associated Pneumonia (VAP) Bundle has an effect on the incidence of pneumonia infections in the ICU with a P value of 0.001. VAP is a frequent and serious complication in ICU patients, with a complex and multifactorial mechanism. This condition generally refers to significant lung inflammation due to the use of a mechanical ventilator for ≥ 48 hours, which is associated with high mortality and has a significant impact on patient prognosis⁴.

Ventilator-associated pneumonia (VAP) is pneumonia that develops within 48–72 hours or more following endotracheal intubation. This condition is characterised by the appearance of new or worsening infiltrates, the presence of systemic signs of infection such as fever and changes in white blood cell count, changes in sputum characteristics, and the identification of causative microorganisms¹². VAP accounts for approximately half of all hospital-acquired pneumonia cases^{12,13}. Its incidence is estimated to range from 9–27% in patients on mechanical ventilation, with the highest risk occurring in the early phase of care. Furthermore, VAP is the second most common nosocomial infection in intensive care units (ICUs) and the most common in patients on mechanical ventilation^{12,14}.

A diagnosis of Ventilator-Associated Pneumonia (VAP) can be made if characteristic clinical signs are present, such as fever, tachycardia, leukocytosis, purulent sputum, and consolidation on chest X-ray. However, diagnosing VAP tends to be difficult if one relies solely on the patient's clinical presentation. As an adjunct, the Critical Pulmonary Infection Score (CPIS) is used, with a score range of 0–12. The CPIS assessment is based on six parameters: body temperature, white blood cell count, volume and viscosity of tracheal

secretions, oxygenation status, chest X-ray findings, and semi-quantitative analysis of endotracheal fluid via Gram staining^{10,11}.

In line with the long-standing theory that mechanical ventilation is the primary trigger for VAP, the incidence of VAP increases with the duration of ventilation, typically after at least 48 hours¹⁵. The study was conducted over a period of 3 days. Patients exhibited an elevated body temperature, increased white blood cell count, increased tracheal secretions, and the presence of infiltrates on chest X-rays. The researchers performed hand hygiene before each procedure on patients by applying the five steps of correct handwashing. Furthermore, a daily assessment was carried out regarding the patient's readiness for extubation or weaning from ventilation. The bed position was set at an angle of 30–45 degrees provided there were no contraindications, such as head trauma or spinal injury. Oral hygiene care was carried out routinely every 2–4 hours using a 0.02% chlorhexidine-based antiseptic, along with tooth cleaning every 12 hours to prevent plaque formation. This is important because plaque can serve as a breeding ground for pathogenic bacteria that may potentially enter the patient's lungs¹⁵.

The incidence of VAP tends to increase with the duration of ventilator use, which can have long-term consequences. The management of patients on prolonged ventilator support has the potential to increase the risk of VAP. This condition also leads to increased antibiotic use, which can trigger resistance, prolonged ICU stays, higher hospital costs, reduced quality of life for patients, and ultimately death¹⁷.

CONCLUSION

The results of the study indicate that the implementation of the Ventilator-Associated Pneumonia (VAP) bundle has an impact on the incidence of pneumonia in the ward. Based on these findings, the implementation of the VAP bundle by nurses requires gradual evaluation to optimise the provision of professional nursing care, thereby improving patients' health outcomes.

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Conflicts of Interest

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