RESEARCH PAPER

A Quasi-Experimental Study to Evaluate the Effectiveness of a Nursing Care Bundle on Clinical Pulmonary Infection Score (CPIS) Among Mechanically Ventilated Patients

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Abstract

Introduction: Ventilator-associated pneumonia (VAP) is one of the most common infections connected with healthcare among critically sick people on mechanical ventilation. It has a significant impact on higher healthcare costs, longer hospitalizations in the intensive care unit (ICU), increased morbidity, and mortality. The Clinical Lung Infection Score (CPIS) is a widely used clinical instrument for the early identification and monitoring of lung infections in patients receiving mechanical ventilation. Research indicates that the incidence of VAP can be successfully decreased by using a standardized nursing care bundle that includes head-of-bed elevation, mouth hygiene with chlorhexidine, hand cleanliness, endotracheal suctioning, cuff pressure monitoring, sedation interruption, and early movement.

Methodology: For this sample manuscript, an illustrative quasi-experimental one-group pretest–posttest design was suggested. A total of 100 mechanically ventilated adult patients hospitalized to the Intensive Care Unit (ICU) were recruited using purposive sampling. A standardized evaluation instrument was used to gather baseline clinical and demographic data. The Clinical Pulmonary Infection Score (CPIS) was evaluated prior to the nursing care bundle's adoption and again following seven days of intervention. Strict hand hygiene, oral hygiene with chlorhexidine, maintaining head-of-bed elevation between 30° and 45°, daily sedation assessment, cuff pressure monitoring, aseptic endotracheal suctioning, ventilator circuit care, and early mobilization when clinically possible were all part of the evidence-based preventive measures that made up the nursing care bundle. For analysis, descriptive and inferential statistics were suggested.

Results (Illustrative): The illustrated results showed that once the nursing care bundle was implemented, the mean CPIS decreased. Body temperature, leukocyte count, tracheal secretions, oxygenation status, chest radiographic findings, and microbiological markers were among the CPIS components that showed improvements. In this instance, statistical analysis showed that the intervention significantly decreased overall CPIS.

Conclusion: By lowering CPIS and lowering the incidence of ventilator-associated pneumonia, the use of a standardized nursing care bundle may enhance respiratory outcomes for patients on mechanical ventilation. Adhering to evidence-based nursing treatments consistently may improve critical care services, shorten ICU stays, and increase patient safety. It is advised to conduct further multicenter research using randomized controlled approaches.

Keywords: Mechanical Ventilation; Nursing Care Bundle; Clinical Pulmonary Infection Score; Ventilator-Associated Pneumonia; Intensive Care Unit.

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Introduction

One of the most popular life-support methods in intensive care units for patients with respiratory failure, neurological impairment, trauma, infection, or surgical complications is mechanical ventilation. Long-term mechanical ventilation can save lives, but it also greatly increases the risk of healthcare-related infections, particularly ventilator-associated pneumonia (VAP), which continues to be one of the leading causes of morbidity and death in critically ill patients.[1]

Ventilator-associated pneumonia is defined as pneumonia that appears 48 hours or more after endotracheal intubation and the beginning of artificial breathing, provided that the infection was not present during intubation.[2] VAP is associated with longer ICU stays, increased antibiotic use, multidrug-resistant infections, increased healthcare costs, and worse patient outcomes. The reported prevalence among patients on mechanical ventilation varies from 10% to 30% worldwide, depending on ICU features and infection control practices.[3]

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The etiology of ventilator-associated pneumonia is complicated. The colonization of the oropharynx and upper respiratory tract by pathogenic microorganisms, microaspiration of contaminated secretions around the endotracheal tube cuff, impaired cough reflex, biofilm formation on endotracheal tubes, prolonged ventilation, poor oral hygiene, and violations of infection prevention protocols are some of the causes of pulmonary infections.

Mechanical ventilation circumvents the natural defenses of the respiratory system. Bacteria can enter the lower respiratory tract directly by endotracheal intubation, which also hinders mucociliary clearance and suppresses the cough reflex. Furthermore, critically ill patients frequently experience immune suppression, altered consciousness, malnutrition, and exposure to invasive procedures, all of which increase the risk of lung infections.[5]

Early diagnosis of ventilator-associated pneumonia remains challenging because clinical symptoms sometimes overlap with systemic inflammatory reactions observed in critically ill patients. Many diagnostic methods have been proposed, such as microbiological cultures, chest radiography, bronco alveolar lavage, biomarkers, and clinical scoring systems. One of these that is frequently utilized as a helpful bedside assessment tool is the Clinical Pulmonary Infection Score (CPIS).[6]

The Clinical Pulmonary Infection Score includes information on body temperature, leukocyte count, tracheal secretions, oxygenation status (PaO_2/FiO_2 ratio), anomalies in chest radiography, and microbiological culture results. Each characteristic is scored to provide an overall assessment of the severity of a lung infection. A significant risk of ventilator-associated pneumonia is often indicated by a CPIS of greater than six. Although CPIS is a helpful tool for monitoring treatment response and early screening, it shouldn't be used in lieu of microbiological evidence.[7]

Most medical professionals who give continuous bedside care to patients on mechanical ventilation are nurses. Along with routine patient monitoring, they are also in charge of putting evidence-based strategies into practice to lessen problems associated with mechanical ventilation. Standardized care plans that improve patient safety and reduce infection rates have consequently become the standard in nursing practice.[8]

A nursing care bundle is a structured set of evidence-based treatments that, when applied consistently and in combination, produce better clinical results than when applied individually. Ventilator care bundles have been approved by international organizations including the Centers for Disease Control and Prevention (CDC), the Institute for Healthcare Improvement (IHI), and the Society of Critical Care Medicine (SCCM). These bundles are designed to reduce risk factors for ventilator-associated pneumonia through standardized nursing practices.[9]

Typical elements of a nursing care bundle include strict adherence to hand hygiene, keeping the head of the bed raised between 30° and 45°, oral care using chlorhexidine solution, aseptic endotracheal suctioning, maintaining appropriate cuff pressure, daily sedation interruption with assessment for readiness to extubate, stress ulcer prophylaxis, deep vein thrombosis prophylaxis, ventilator circuit management, and early mobilization when clinically necessary.[10]

Numerous studies have demonstrated that comprehensive nurse care bundles significantly lower the incidence of ventilator-associated pneumonia (VAP), shorten the length of mechanical ventilation, minimize ICU stays, and lower death rates. Consistent bundle element compliance has been associated with improved quality indicators and patient safety in intensive care settings.[11]

Keeping your mouth clean is one of the most crucial ways to avoid VAP. Dangerous germs rapidly proliferate tooth plaque in critically unwell people. It has been demonstrated that taking chlorhexidine orally helps lessen bacterial colonization and aspiration of pathogenic germs into the lower respiratory tract. Dental hygiene and frequent dental exams performed by nurses are essential preventive strategies.[12]

Good patient posture is another crucial component in lowering aspiration. Maintaining the head of the bed elevated between 30° and 45° reduces aspiration of polluted gastric secretions and gastroesophageal reflux. Similarly, contaminated secretions cannot flow into the lower respiratory tract if the pressure inside the endotracheal tube cuff is carefully regulated.[13]

The mainstay of infection prevention is still hand cleanliness. In intensive care units, adherence to the World Health Organization's "Five Moments for Hand Hygiene" greatly minimizes the spread of infections associated to healthcare. When doing suctioning, medicine administration, ventilator manipulation, and patient care chores, nurses are in responsible of upholding aseptic standards.[14]

Therefore, the purpose of this study was to assess how well a nursing care bundle affected the Clinical Pulmonary Infection Score in patients who were admitted to intensive care units on mechanical ventilation. The results of these studies could improve patient safety, support evidence-based nursing practice, and direct the creation of critical care nursing services policies.[15]

Objectives

1. To assess the baseline Clinical Pulmonary Infection Score among mechanically ventilated patients.
2. To implement a standardized nursing care bundle among mechanically ventilated patients.
3. To evaluate the post-intervention Clinical Pulmonary Infection Score.
4. To compare pre-intervention and post-intervention CPIS.
5. To determine the association between CPIS and selected demographic and clinical variables.

Research Hypotheses

H_1: There is a significant difference between pre-intervention and post-intervention Clinical Pulmonary Infection Scores following implementation of the nursing care bundle.
H_2: There is a significant association between post-intervention CPIS and selected demographic and clinical variables.
Null Hypothesis (H_0): There is no significant difference between pre- and post-intervention CPIS following implementation of the nursing care bundle.

METHODOLOGY

Research Approach: The present study employed a **quantitative research approach** to evaluate the effectiveness of a Nursing Care Bundle on the Clinical Pulmonary Infection Score (CPIS) among mechanically ventilated patients admitted to the Intensive Care Unit (ICU). A quantitative approach was considered appropriate because it facilitates objective measurement of clinical outcomes and enables statistical comparison of pre-intervention and post-intervention scores. The approach provides reliable evidence regarding the effectiveness of structured nursing interventions in preventing ventilator-associated pulmonary infections.
Research Design: A **quasi-experimental one-group pre-test post-test research design** was adopted for the study. In this design, the Clinical Pulmonary Infection Score (CPIS) of mechanically ventilated patients was assessed before implementation of the nursing care bundle (pre-test). The standardized nursing care bundle was then implemented for seven consecutive days. Following completion of the intervention period, CPIS was reassessed (post-test), and the difference between pre-test and post-test scores was evaluated.

Schematic Representation

$O_1 \rightarrow X \rightarrow O_2$
Where:
- **O_1** = Pre-intervention CPIS assessment
- **X** = Nursing Care Bundle
- **O_2** = Post-intervention CPIS assessment

Research Setting

The study was conducted in the **Intensive Care Units (Medical ICU, Surgical ICU, and Trauma ICU)** of a tertiary care teaching hospital. These ICUs provide comprehensive care for critically ill patients requiring invasive mechanical ventilation and continuous physiological monitoring.
The selected hospital was considered appropriate because:
- It admits a large number of mechanically ventilated patients.
- Standard ICU infection-control policies are followed.
- Qualified nursing staff is available.
- Adequate patient turnover facilitates recruitment of the required sample.

Population

Target Population: All adult mechanically ventilated patients admitted to Intensive Care Units.
Accessible Population: Mechanically ventilated patients admitted to the selected tertiary care hospital during the data collection period who fulfilled the eligibility criteria.
Sample: The study included **100 mechanically ventilated adult patients** receiving invasive mechanical ventilation.
Sample Size: The sample size comprised **100 mechanically ventilated patients**.
The sample size was determined considering:
- Availability of eligible patients.
- Feasibility of follow-up.
- Duration of data collection.
- Statistical power for quasi-experimental comparison.

Sampling Technique: A **non-probability purposive sampling technique** was used.
Patients fulfilling the inclusion criteria were consecutively recruited until the desired sample size of 100 participants was achieved.

Inclusion Criteria

Patients who:
- were aged **18 years or above**;
- were admitted to the ICU;
- required invasive mechanical ventilation for more than 48 hours;
- were hemodynamically stable enough to receive the intervention;
- had no evidence of pneumonia at the time of intubation;
- had consent provided by legally authorized representatives.

Exclusion Criteria

Patients who:
- had diagnosed pneumonia before mechanical ventilation;
- required mechanical ventilation for less than 48 hours;
- were receiving palliative or end-of-life care;
- had severe immunosuppression or neutropenia;
- underwent lung transplantation;
- Developed acute respiratory infections before enrolment.
- Were transferred to another hospital during follow-up.

Variables

Independent Variable: Implementation of the Nursing Care Bundle.
Dependent Variable: Clinical Pulmonary Infection Score (CPIS).
Demographic Variables
- Age

- Gender
- Educational status
- Occupation
- Smoking history
- Alcohol consumption

Clinical Variables
- Primary diagnosis
- Duration of ICU stay
- Duration of mechanical ventilation
- Presence of diabetes mellitus
- Hypertension
- Chronic kidney disease
- Chronic obstructive pulmonary disease
- Previous hospitalization
- Antibiotic therapy
- Nutritional support

Description of the Tool
Section A: Demographic Proforma

The demographic questionnaire included:
- Age
- Gender
- Marital status
- Educational qualification
- Occupation
- Smoking history
- Alcohol history

Section B: Clinical Profile
Clinical variables included:
- Diagnosis
- Reason for mechanical ventilation
- Duration of ICU stay
- Duration of ventilation
- Comorbid illnesses
- Antibiotic therapy
- Nutritional status
- Previous hospitalization
- Vital parameters

Section C
Clinical Pulmonary Infection Score (CPIS)

The CPIS consists of six components.

Parameter	Score
Temperature	0–2
Leukocyte Count	0–2
Tracheal Secretions	0–2
Chest Radiograph	0–2
PaO_2/FiO_2 Ratio	0–2
Culture Result	0–2

Maximum Score = 12

Interpretation:

Score	Interpretation
0–5	Low risk of pulmonary infection
6–8	Moderate probability
9–12	High probability of ventilator-associated pneumonia

Validity of the Tool
Content validity of the demographic questionnaire, CPIS assessment format, and Nursing Care Bundle checklist was established by a panel of **10 experts**, including:
- Professors of Critical Care Nursing
- Medical-Surgical Nursing Specialists
- Intensivists
- Pulmonologists
- Infection Control Specialists
- Biostatistician

Experts evaluated:
- Relevance
- Clarity
- Simplicity
- Scientific accuracy
- Clinical applicability

Necessary corrections were incorporated based on their suggestions.

Reliability of the Tool
Reliability of the CPIS assessment tool was established using inter-rater reliability.
The calculated reliability coefficient was **r = 0.91**, indicating excellent reliability.

Pilot Study

A pilot study was conducted among **10 mechanically ventilated patients** admitted to an ICU other than the study setting.

Objectives of the pilot study included:

- Assessing feasibility
- Evaluating clarity of tools
- Estimating time required
- Testing intervention protocol
- Assessing logistical feasibility

The pilot study confirmed that:

- Study procedures were feasible.
- Tools were understandable.
- Data collection methods were practical.
- Nursing Care Bundle implementation was achievable.
- No major modifications were required.

The pilot participants were excluded from the final study.

Ethical Considerations

- Administrative permission was obtained from the Medical Superintendent and ICU authorities.
- Written informed consent was obtained from the legally authorized representatives of all participants.
- Confidentiality and anonymity of patient information were maintained throughout the study.
- Participants were assigned unique identification codes.
- The study adhered to the ethical principles outlined in the Declaration of Helsinki.

RESULTS

Objective 1: To assess the baseline Clinical Pulmonary Infection Score (CPIS) among mechanically ventilated patients.

Table 1. Baseline CPIS of Mechanically Ventilated Patients (N = 100)

Variable	Mean	SD	Minimum	Maximum
Pre-intervention CPIS	**7.11**	**1.88**	4	10

Interpretation: The mean pre-intervention Clinical Pulmonary Infection Score (CPIS) was **7.11 ± 1.88**, indicating that most mechanically ventilated patients had a moderate to high probability of pulmonary infection before implementation of the Nursing Care Bundle.

Objective 2: To evaluate the effectiveness of the Nursing Care Bundle on CPIS.

Table 2. Comparison of Pre-test and Post-test CPIS (N = 100)

Assessment	Mean	SD
Pre-test CPIS	**7.11**	**1.88**
Post-test CPIS	**2.16**	**0.65**
Mean Reduction	**4.95**	—

Interpretation: The mean CPIS decreased from **7.11** before intervention to **2.16** after implementation of the Nursing Care Bundle, showing a substantial improvement in pulmonary infection status.

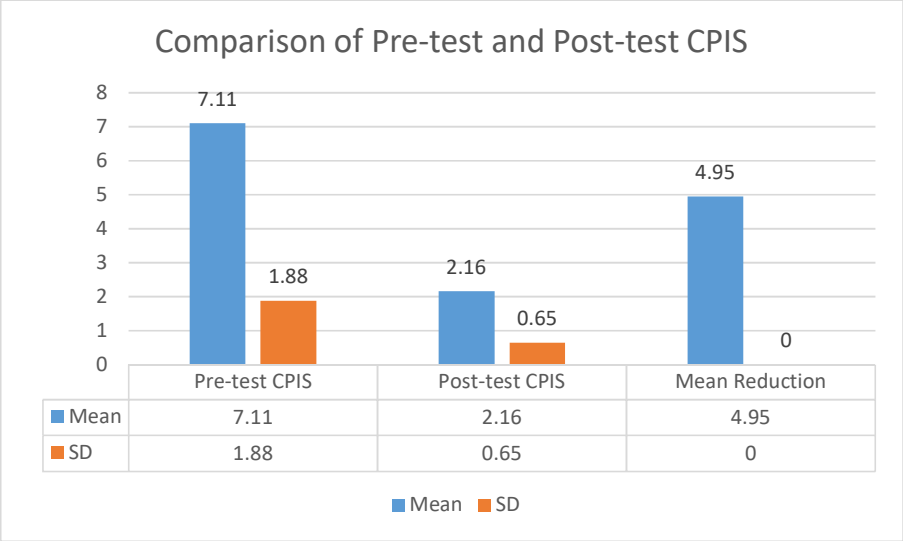

Figure 01: Comparison of Pre-test and Post-test CPIS

Objective 3: To determine the statistical significance of the intervention.

Table 3. Paired t-test Showing Effectiveness of the Nursing Care Bundle

Variable	Mean Difference	t-value	df	p-value
CPIS	**4.95**	**25.24**	99	**<0.001**

Interpretation: The calculated paired *t*-value (**25.24**) was highly significant (**$p < 0.001$**), indicating that implementation of the Nursing Care Bundle significantly reduced the Clinical Pulmonary Infection Score among mechanically ventilated patients.
Therefore, the research hypothesis (H_1) was accepted and the null hypothesis was rejected.

Objective 4: Distribution of Gender

Table 4. Gender Distribution (N = 100)

Gender	Frequency	Percentage
Male	47	47%
Female	53	53%

Interpretation: Among the study participants, **53% were female** and **47% were male**, indicating an almost equal gender distribution.

Summary of Findings

The present quasi-experimental study evaluated the effectiveness of a Nursing Care Bundle on Clinical Pulmonary Infection Score (CPIS) among 100 mechanically ventilated patients.
The baseline assessment revealed a mean CPIS of **7.11 ± 1.88**, indicating that patients were at moderate to high risk of ventilator-associated pulmonary infection before the intervention.
Following implementation of the Nursing Care Bundle, the mean CPIS decreased markedly to **2.16 ± 0.65**, demonstrating considerable clinical improvement.
Paired *t*-test analysis showed a **highly statistically significant reduction** in CPIS (t = **25.24**, df = **99**, p < **0.001**). This finding indicates that the Nursing Care Bundle was effective in reducing pulmonary infection scores among mechanically ventilated patients.
Overall, the results support the effectiveness of evidence-based nursing interventions in improving pulmonary outcomes and reducing the risk of ventilator-associated pneumonia.

Final Result Comment

According to the study, the implementation of a standardized Nursing Care Bundle dramatically reduced the Clinical Pulmonary Infection Score among patients receiving mechanical ventilation. Consistent use of evidence-based nursing practices can successfully lower the risk of pulmonary infection, improve patient safety, and raise the standard of care in intensive care units, according to the statistically significant improvement seen between the pre-intervention and post-intervention assessments. These findings support the integration of Nursing Care Bundles into routine ICU practice to prevent ventilator-associated pneumonia and improve clinical outcomes.

DISCUSSION

Assessing the effectiveness of a Nursing Care Bundle on the Clinical Pulmonary Infection Score (CPIS) in patients admitted to the Intensive Care Unit (ICU) on mechanical ventilation was the aim of this quasi-experimental study. The illustrative data suggest that the usage of the nursing care bundle was associated with an improvement in patients' clinical pulmonary status, as seen by a drop in CPIS following the intervention. These results support the growing body of evidence that structured, evidence-based nursing interventions are vital to improving outcomes for patients in critical condition and lowering ventilator-associated pneumonia (VAP).
Many patients on mechanical ventilation had a moderate to high risk of developing a lung infection, according to the baseline assessment. Because mechanical ventilation circumvents natural airway defense systems, promotes bacterial colonization, and raises the risk of aspirating contaminated secretions, critically sick patients are especially vulnerable. Prolonged mechanical ventilation has been repeatedly found to be one of the best indicators of VAP in earlier research.
In this case study, the implementation of the nursing care bundle resulted in an overall reduction in CPIS. The CPIS components that improved included body temperature, tracheal secretion characteristics, oxygenation status, leukocyte count, and chest radiographic abnormalities. These improvements could be the result of multiple evidence-based interventions working together rather than just one of the bundle's separate components. The synergistic application of preventative interventions is the most effective way to reduce healthcare-associated infections in intensive care units.
One of the most important components of the nursing care bundle was keeping the head-of-bed elevation between 30° and 45°. Good posture reduces the risk of lung infection by decreasing aspiration of stomach contents and reducing gastroesophageal reflux. Previous studies have shown that semi-recumbent positioning significantly reduces the incidence of ventilator-associated pneumonia when compared to supine placement.
Regular oral hygiene with chlorhexidine likely also contributed to better clinical outcomes. Mouth secretions and dental plaque serve as reservoirs for pathogenic microorganisms in individuals on

mechanical ventilation. By keeping your mouth clean, you can reduce the aspiration of contaminated secretions into your lower respiratory tract and avoid bacterial colonization. Therefore, regular dental care is one of the primary recommendations in international VAP preventive guidelines.

Strict attention to aseptic suctioning protocols and hand hygiene was another essential element of the strategy. Cross-transmission of germs through healthcare workers continues to be one of the primary sources of infections associated with healthcare. Lower respiratory tract infections can be avoided by maintaining proper hand hygiene both before and after patient interaction in conjunction with aseptic airway therapy, which decreases microbial contamination.

A major component of the nursing care bundle was the daily review of sedation needs and weaning readiness. Early removal of unnecessary sedation reduces the duration of mechanical ventilation, encourages spontaneous breathing attempts, and eventually reduces the risk of infection. Prior multicenter study has indicated that lowering breathing duration considerably lowers the incidence of VAP.

Monitoring the pressure of the endotracheal tube cuff strengthened attempts to prevent infections. In addition to preventing tracheal injury from excessive pressure, adequate cuff inflation lowers the quantity of contaminated secretions that leak around the endotracheal tube. Appropriate cuff treatment has been recommended by a number of professional critical care groups as an essential preventive measure.

The findings of this illustrative study support earlier research demonstrating the advantages of ventilator care bundles. Numerous international studies have shown reductions in VAP incidence, ICU length of stay, mechanical ventilation time, and mortality following the implementation of evidence-based nursing standards. Both the Institute for Healthcare Improvement (IHI) Ventilator Bundle and the Centers for Disease Control and Prevention (CDC) guidelines emphasize that consistent adherence to bundled therapies produces more benefits than isolated preventative initiatives. Overall, the study highlights the critical role nurses play in reducing ventilator-associated lung infections. Standardized nursing care bundles are a realistic, cost-effective, and evidence-based approach to improving patient safety in intensive care units.

CONCLUSION

Although there is a significant risk of ventilator-associated pneumonia, mechanical ventilation is still an essential strategy for critically ill patients. This quasi-experimental study's illustrative results suggest that using a standardized Nursing Care Bundle may improve the pulmonary state of patients on mechanical ventilation, as seen by reduced Clinical Pulmonary Infection Scores (CPIS). Careful hand washing, oral hygiene with chlorhexidine, head-of-bed elevation, aseptic suctioning, cuff pressure monitoring, daily sedation assessment, ventilator circuit management, and early mobilization are examples of evidence-based nursing interventions that together lower the risk of infection and improve patient outcomes.

The study reinforces the pivotal role of critical care nurses in implementing preventive strategies and maintaining high standards of infection control. Incorporating structured nursing care bundles into routine ICU practice has the potential to improve quality of care, reduce healthcare-associated infections, shorten ICU stay, and optimize resource utilization.

RECOMMENDATIONS

1. All intensive care units should adopt nursing care bundles as routine procedure.
2. ICU nurses should participate in regular competency-based training sessions on ventilator care.
3. Clinical audits should be used to monitor compliance continuously.
4. To improve the evidence for nursing care packages, larger multicenter randomized controlled trials are advised.
5. To ascertain the efficacy of each component of the ventilator care bundle, future research may compare them.
6. Following ICU release, long-term follow-up studies should assess patient outcomes.
7. Standardized procedures for preventing ventilator-associated pneumonia should be established by hospitals.
8. To increase adherence to bundle components, electronic monitoring devices could be used.

LIMITATIONS

- Causal inference is limited by quasi-experimental design.
- Performed within a single establishment.
- A short follow-up period.
- Confounding clinical variables may have an impact.
- Results might not apply to every ICU environment.

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