

Evaluating the Effectiveness of Nurse-Led Weaning Protocols for Mechanical Ventilation: A Comparative Study with Traditional Methods in ICU Settings

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Abstract

Background: Mechanical ventilation weaning is a critical process in the ICU, traditionally managed by physicians. This study evaluates the effectiveness of nurse-led weaning protocols compared to traditional physician-led methods.

Objective: To compare the success rates, timing, and outcomes of nurse-led versus physician-led weaning protocols for mechanical ventilation in adult ICU patients.

Methods: A quantitative study was conducted at a single hospital, analyzing data from patients who underwent mechanical ventilation. We compared the weaning success rates, time to initiation, duration of weaning, and complications between nurse-led and physician-led protocols.

Results: The nurse-led protocol achieved a success rate of 85%, compared to 78% for the physician-led protocol, though the difference was not statistically significant ($p=0.289$). Time to initiation and total duration of weaning were similar between groups. Complication rates and in-hospital mortality were comparable.

Conclusions: Nurse-led weaning protocols are as effective as physician-led methods, with similar success rates and patient outcomes. These findings support the integration of nurse-led protocols into ICU practices, potentially improving efficiency and collaboration.

Keywords: Nurse-led weaning, mechanical ventilation, ICU, patient safety, protocol effectiveness, respiratory care

Introduction

Mechanical ventilation is a critical intervention used in intensive care units (ICUs) to support patients with acute respiratory failure. Timely and effective weaning from mechanical ventilation is essential to reduce the risk of complications, such as ventilator-associated pneumonia (VAP), prolonged ICU stays, and increased mortality rates (Esteban et al., 2004). Traditionally, physicians have managed the weaning process, guided by standardized protocols. However, nurse-led weaning protocols have emerged as an alternative approach, leveraging the continuous bedside presence and clinical expertise of nurses to optimize patient outcomes (Blackwood et al., 2014).

Nurse-led weaning protocols involve empowering ICU nurses to initiate, adjust, and manage the weaning process in collaboration with physicians. These protocols are designed to enhance the efficiency of weaning by allowing nurses to make timely adjustments based on patient-specific parameters, such as oxygenation status, respiratory rate, and hemodynamic stability (Boles et al., 2007). The involvement of nurses in weaning has shown promise in reducing the duration of mechanical ventilation, decreasing ICU length of stay, and minimizing complications (Larsen et al., 2017).

The effectiveness of nurse-led protocols compared to traditional physician-led weaning has been the subject of ongoing research. Studies have suggested that nurse-led protocols may result in similar or better outcomes in terms of successful extubation and reduced ventilation duration (Price, 2001). Despite these findings, the adoption of nurse-led weaning protocols varies across institutions, with some healthcare providers remaining cautious due to concerns over protocol adherence and the perceived complexity of the weaning process (Rose et al., 2011).

This study aims to evaluate the effectiveness of nurse-led weaning protocols in comparison to traditional physician-led methods. By analyzing patient outcomes in ICUs that utilize nurse-led protocols, this research will contribute to the ongoing debate regarding the best practices for ventilator weaning, and provide evidence to support or challenge the widespread adoption of nurse-led protocols in clinical practice.

Literature Review

The process of weaning patients from mechanical ventilation in the intensive care unit (ICU) is a complex and critical aspect of patient management, requiring close monitoring and timely decision-making. Over the years, various strategies for ventilator weaning have been developed, with the goal of reducing complications, decreasing ICU length of stay, and improving patient outcomes. This literature review explores the research on nurse-led weaning protocols, comparing their effectiveness to traditional physician-led methods, and examining the factors influencing their implementation.

Traditional Weaning Methods: Traditionally, the weaning process has been managed by physicians, who assess the patient's readiness for weaning based on clinical criteria, such as oxygenation, respiratory rate, and hemodynamic stability (Esteban et al., 2004). Several studies have shown that structured, protocol-driven approaches can standardize the weaning process, reducing variability in care and improving outcomes (Blackwood et al., 2014). Physician-led weaning protocols are often based on specific guidelines that determine the steps to reduce ventilator support gradually until the patient can breathe independently (Boles et al., 2007). However, physician-led protocols may encounter delays due to the availability of physicians and the need for ongoing assessments, potentially prolonging mechanical ventilation unnecessarily.

Nurse-Led Weaning Protocols: In recent years, nurse-led weaning protocols have gained attention as an alternative strategy to enhance the efficiency of ventilator weaning. These protocols allow nurses, who are continuously present at the bedside, to initiate and adjust weaning based on patient-specific criteria without waiting for physician orders (Larsen et al., 2017). The continuous monitoring by nurses enables real-time decisions, which can potentially shorten the duration of mechanical ventilation and reduce ICU length of stay (Price, 2001).

Nurse-led protocols have been associated with improved weaning outcomes in several studies. A systematic review conducted by Blackwood et al. (2014) found that nurse-led weaning protocols were equally effective as physician-led protocols in reducing the duration of mechanical ventilation and the incidence of ventilator-associated complications. Similarly, a study by Larsen et al. (2017) demonstrated that nurse-led weaning resulted in a shorter ICU stay and lower rates of reintubation compared to traditional methods. These findings suggest that nurse-led weaning protocols can achieve comparable, if not superior, outcomes.

Benefits of Nurse-Led Weaning: Nurse-led weaning protocols capitalize on the unique position of nurses in the ICU. As frontline caregivers, nurses have a deep understanding of the patient's condition and can make timely decisions regarding weaning progress. This empowerment can lead to faster identification of weaning readiness and more efficient adjustments to ventilator settings (Rose et al., 2011). Additionally, nurse-led protocols can reduce the workload on physicians by delegating routine weaning tasks to nurses, allowing physicians to focus on more complex cases (Ely et al., 1996).

Furthermore, nurse-led weaning protocols can foster a more collaborative approach to patient care. By involving nurses in the decision-making process, multidisciplinary teamwork is enhanced, leading to better communication and coordination among healthcare providers (Blackwood et al., 2014). This collaborative approach can contribute to a more holistic view of patient care, where the expertise of nurses complements the clinical judgment of physicians.

Barriers to Implementation

Despite the potential benefits, the implementation of nurse-led weaning protocols has been met with challenges. One significant barrier is resistance from physicians who may be hesitant to relinquish control over the weaning process (Rose et al., 2011). Concerns about protocol adherence, lack of training, and the perceived complexity of managing ventilator weaning are additional obstacles to widespread adoption (Price, 2001).

Institutional factors also play a role in the successful implementation of nurse-led protocols. Hospitals with a strong culture of interdisciplinary collaboration and continuous education may be more likely to adopt and

sustain nurse-led weaning initiatives. Conversely, facilities with rigid hierarchical structures or insufficient support for nursing autonomy may struggle to implement such protocols effectively (Price, 2001).

The literature suggests that nurse-led weaning protocols have the potential to enhance the weaning process from mechanical ventilation, offering benefits such as reduced ICU stays, lower complication rates, and improved multidisciplinary collaboration. However, challenges remain in the widespread adoption of these protocols, including resistance from physicians and institutional barriers. Further research is needed to explore strategies for overcoming these challenges and to establish the long-term effects of nurse-led weaning on patient outcomes.

Methodology

Study Design: This study employed a retrospective quantitative research design to assess the effectiveness of nurse-led weaning protocols compared to traditional physician-led weaning methods for mechanically ventilated patients in an adult ICU. The research was conducted at a single tertiary care hospital, utilizing a combination of medical record reviews and data extraction from the hospital's electronic health records (EHR) system. The study covered a period of 12 months.

Setting and Population: The study was conducted in the adult intensive care unit (ICU) of a tertiary care hospital. The ICU is a 30-bed unit that provides care for critically ill patients requiring mechanical ventilation for various conditions, including respiratory failure, sepsis, and post-surgical care. The study population included all adult patients (≥ 18 years old) who were admitted to the ICU and required mechanical ventilation for at least 48 hours during the study period.

Inclusion and Exclusion Criteria

Inclusion criteria:

- Adult patients (≥ 18 years old) admitted to the ICU and requiring mechanical ventilation for at least 48 hours.
- Patients who were weaned from mechanical ventilation using either nurse-led protocols or physician-led protocols.

Exclusion criteria:

- Patients with a do-not-resuscitate (DNR) order or palliative care designation.
- Patients transferred from another hospital with ongoing mechanical ventilation.
- Patients who died before the weaning process could be initiated.

Sampling and Data Collection: A total of 200 patient records were reviewed, with 100 patients managed using nurse-led weaning protocols and 100 patients managed using traditional physician-led weaning methods. Data collection was conducted using a structured data extraction form designed to capture relevant clinical variables from the EHR system. The following data were collected for each patient:

Demographic data: Age, gender, BMI, comorbidities.

Clinical data: Primary diagnosis, duration of mechanical ventilation, ICU length of stay, complications (e.g., ventilator-associated pneumonia), and mortality.

Weaning process data: Type of weaning protocol used (nurse-led or physician-led), time to initiation of weaning, total duration of weaning, and weaning success (defined as extubation without the need for reintubation within 48 hours).

Ethical Considerations: The study protocol was reviewed and approved by the ethics committee. Informed consent was waived due to the retrospective nature of the study. Patient confidentiality and data protection were ensured by de-identifying all patient records and limiting access to the data to authorized research personnel only.

Data Analysis: Data analysis was performed using SPSS version 26.0. Descriptive statistics, including means, standard deviations, and frequencies, were used to summarize demographic and clinical characteristics of the

study population. Independent t-tests were used to compare continuous variables (e.g., duration of mechanical ventilation, ICU length of stay) between the nurse-led and physician-led groups. Chi-square tests were used to compare categorical variables (e.g., weaning success rates, complications).

A multivariate logistic regression analysis was conducted to identify factors independently associated with weaning success, controlling for potential confounders such as age, comorbidities, and severity of illness. The level of statistical significance was set at $p < 0.05$.

Outcome Measures: The primary outcome of interest was the duration of mechanical ventilation. Secondary outcomes included ICU length of stay, weaning success rate, incidence of complications (e.g., ventilator-associated pneumonia), and in-hospital mortality. Additionally, the study aimed to assess the impact of nurse-led weaning protocols on reducing the time to initiation of weaning compared to physician-led protocols.

Findings

The study analyzed data from 200 patients, equally divided between those managed with nurse-led weaning protocols and those managed with physician-led weaning methods. The results are summarized in the following tables and described in the text below.

1. Demographic and Clinical Characteristics: The patient demographics and clinical characteristics were similar between the nurse-led and physician-led groups. There were no significant differences in age, gender, BMI, or primary diagnosis between the groups.

Table 1: Demographic and Clinical Characteristics of Patients

| Characteristic | Nurse-Led Group (n=100) | Physician-Led Group (n=100) | p-value |
|--------------------------------|-------------------------|-----------------------------|---------|
| Age (years) | 63.2 ±12.5 | 62.8 ±13.1 | 0.785 |
| Gender (Male) | 56 (56%) | 60 (60%) | 0.604 |
| BMI (kg/m ²) | 27.4 ±5.8 | 27.2 ±6.1 | 0.835 |
| Primary Diagnosis | | | |
| - Respiratory Failure | 65 (65%) | 68 (68%) | 0.672 |
| - Sepsis | 25 (25%) | 22 (22%) | 0.575 |
| - Post-Surgical | 10 (10%) | 10 (10%) | 1.000 |
| Duration of Ventilation (days) | 5.3 ±2.1 | 5.6 ±2.4 | 0.351 |
| ICU Length of Stay (days) | 7.5 ±3.2 | 8.1 ±3.5 | 0.431 |

2. Weaning Process Data: The time to initiation of weaning and the total duration of weaning were not significantly different between the nurse-led and physician-led groups. The nurse-led group initiated weaning slightly earlier, but the difference was not statistically significant.

Table 2: Weaning Process Data

| Variable | Nurse-Led Group (n=100) | Physician-Led Group (n=100) | p-value |
|---------------------------------------|-------------------------|-----------------------------|---------|
| Time to Initiation of Weaning (hours) | 24.1 ±8.3 | 26.5 ±9.1 | 0.209 |
| Total Duration of Weaning (hours) | 36.7 ±12.4 | 39.2 ±14.1 | 0.326 |
| Weaning Success Rate | 85 (85%) | 78 (78%) | 0.289 |

3. Weaning Success Rate: The weaning success rate was higher in the nurse-led group (85%) compared to the physician-led group (78%), but this difference was not statistically significant.

Table 3: Complications and Mortality

| Outcome | Nurse-Led Group (n=100) | Physician-Led Group (n=100) | p-value |
|---------------------------------|----------------------------|--------------------------------|---------|
| Ventilator-Associated Pneumonia | 8 (8%) | 10 (10%) | 0.635 |
| In-Hospital Mortality | 12 (12%) | 15 (15%) | 0.497 |

Complications and Mortality: The incidence of ventilator-associated pneumonia and in-hospital mortality rates were comparable between the two groups. There were no significant differences in these outcomes. Overall, the study suggests that nurse-led weaning protocols have comparable outcomes to traditional physician-led methods in terms of weaning success, duration of mechanical ventilation, and incidence of complications. However, further research may be needed to confirm these findings and explore potential benefits of nurse-led protocols in different clinical settings.

Discussion

This study aimed to evaluate the effectiveness of nurse-led weaning protocols for mechanical ventilation compared to traditional physician-led methods. Our findings reveal several key insights into the comparative effectiveness of these approaches.

Effectiveness of Nurse-Led vs. Physician-Led Protocols: The analysis indicated that nurse-led protocols had a comparable success rate and duration of weaning when compared to physician-led protocols. While the weaning success rate was slightly higher in the nurse-led group (85%) compared to the physician-led group (78%), this difference was not statistically significant ($p=0.289$). This suggests that nurse-led protocols can be as effective as traditional methods in achieving successful weaning from mechanical ventilation.

Weaning Process Timing: The time to initiation of weaning and the total duration of the weaning process did not differ significantly between the two groups. The nurse-led group initiated weaning slightly earlier, which could suggest a proactive approach in managing ventilated patients. However, this difference in timing was not statistically significant, indicating that both approaches have similar efficiencies in terms of weaning initiation and duration.

Complications and Mortality: Complications such as ventilator-associated pneumonia and in-hospital mortality rates were similar between the two groups. The nurse-led and physician-led groups both showed comparable rates of these adverse outcomes. This result underscores that nurse-led weaning protocols do not adversely impact patient safety or outcome quality, which is crucial in an intensive care setting.

Implications for Practice: The results of this study highlight the potential for nurse-led weaning protocols to be an effective alternative to traditional physician-led methods. Implementing nurse-led protocols could provide a more collaborative and integrated approach to patient care in the ICU, potentially leading to improved patient management and utilization of healthcare resources. This is especially relevant in settings where physician time is limited, and maximizing the role of nursing staff could enhance overall efficiency.

Limitations and Future Research: Several limitations should be considered when interpreting these findings. The study was conducted in a single hospital, which may limit the generalizability of the results to other settings. Additionally, the sample size was relatively small, which could affect the power of the statistical analyses. Future research should include larger, multicenter studies to confirm these findings and explore the nuances of nurse-led weaning protocols in various clinical environments.

Further studies could also investigate specific elements of nurse-led protocols that contribute to their effectiveness. For instance, understanding the training and experience of nurses involved in weaning could provide insights into optimizing these protocols. Additionally, exploring patient outcomes beyond weaning success, such as long-term respiratory function and quality of life, could provide a more comprehensive evaluation of nurse-led weaning strategies.

Conclusion

In summary, this study suggests that nurse-led weaning protocols are as effective as physician-led methods in managing mechanical ventilation in ICU patients. The comparable success rates, timing of weaning, and complication rates support the potential for expanding nurse-led protocols in clinical practice. However, further research is needed to fully understand their impact and optimize their implementation across diverse healthcare settings.

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