The Impact of Blood Gas Analysis and Pharmacist-Managed Sedation Protocols on Patient Outcomes in Mechanically Ventilated ICU Patients

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Abstract

Background: Managing mechanically ventilated patients in the ICU requires optimizing both ventilation strategies and sedation protocols. This study investigates the impact of interdisciplinary collaboration between respiratory therapists (RTs), laboratory specialists (LS), and pharmacists on patient outcomes in mechanically ventilated ICU patients.

Methods: A retrospective cohort study was conducted on 200 ICU patients at a tertiary hospital. Patients were divided into two groups: those receiving interdisciplinary care, with RTs and LS optimizing ventilation based on blood gas analysis and pharmacists managing sedation, and those receiving traditional care. Primary outcomes included ICU length of stay, duration of mechanical ventilation, mortality, and ventilator-associated pneumonia (VAP) incidence. Secondary outcomes included sedation-related complications, frequency of ventilator adjustments, and patient comfort.

Results: The interdisciplinary care group had significantly shorter ICU stays (10.3 vs. 14.1 days, $p < 0.001$) and mechanical ventilation duration (6.8 vs. 9.4 days, $p < 0.001$). The incidence of VAP was lower in the interdisciplinary group (8% vs. 16%, $p = 0.048$), with fewer sedation-related complications, including over-sedation and delirium. Additionally, ventilator adjustments were more frequent in the interdisciplinary group (5.1 vs. 2.8 per patient, $p < 0.001$).

Conclusion: Interdisciplinary collaboration involving RTs, LS, and pharmacists improves outcomes for mechanically ventilated ICU patients, including reduced ICU stays, lower VAP incidence, and fewer sedation-related complications. This study underscores the importance of a team-based approach in optimizing critical care.

Keywords: Interdisciplinary care, mechanical ventilation, ICU, blood gas analysis, pharmacist-managed sedation, ventilator-associated pneumonia, respiratory therapists

Introduction

Mechanical ventilation is a critical intervention used in intensive care units (ICUs) to support patients with severe respiratory failure. However, the management of these patients is complex and requires careful balancing of ventilation strategies and sedation protocols to prevent complications such as ventilator-associated lung injury, delirium, and prolonged ICU stays (Hess, 2014). Optimizing mechanical ventilation often relies on frequent blood gas analysis, which provides crucial information on pH, partial pressure of

carbon dioxide (pCO_2), and oxygen (pO_2) levels, guiding adjustments to ventilator settings. Respiratory therapists (RTs) and laboratory specialists (LS) play a pivotal role in this process by interpreting blood gas results and implementing appropriate ventilator adjustments (Morris et al., 2008).

Sedation management is equally important for mechanically ventilated patients, as inadequate sedation can lead to agitation, while oversedation increases the risk of delirium, respiratory depression, and prolonged ventilation (Davidson et al., 2013). Pharmacists, who are increasingly recognized as integral members of the ICU care team, can help optimize sedation protocols by ensuring appropriate dosing, preventing drug interactions, and adjusting medications based on a patient's evolving clinical condition (Marshall et al., 2008). This multidisciplinary approach, involving respiratory therapists, laboratory specialists, and pharmacists, is crucial for improving patient outcomes in ICUs.

Despite growing recognition of the importance of blood gas analysis and sedation management in ICU care, there is limited research specifically examining the impact of a collaborative approach between RTs, LS, and pharmacists on patient outcomes. This study aims to investigate how such interdisciplinary collaboration affects key outcomes in mechanically ventilated patients, including ICU length of stay, duration of mechanical ventilation, and sedation-related complications. By exploring the roles of RTs, LS, and pharmacists in managing ventilation and sedation, this research seeks to highlight the potential benefits of a coordinated approach in improving care for critically ill patients.

Literature Review

1. Mechanically Ventilated Patients in the ICU

Mechanical ventilation is a life-saving intervention commonly used in ICUs to support patients with acute respiratory failure, sepsis, or other life-threatening conditions. However, managing patients on mechanical ventilation requires careful attention to ventilation parameters and sedation to minimize complications. Research shows that inappropriate ventilator settings can lead to ventilator-induced lung injury (VILI), which exacerbates existing respiratory failure and prolongs ICU stays (Hess, 2014). Furthermore, mechanically ventilated patients are often sedated to reduce discomfort and facilitate the use of ventilators, but poor sedation management can lead to adverse outcomes such as delirium, prolonged ventilation, and increased mortality (Davidson et al., 2013).

2. Role of Blood Gas Analysis in Optimizing Ventilation

Blood gas analysis is an essential tool for managing patients on mechanical ventilation. By measuring pH, partial pressure of oxygen (pO_2), and carbon dioxide (pCO_2), blood gas results provide critical information on a patient's respiratory status, guiding necessary adjustments to ventilator settings. Respiratory therapists (RTs) and laboratory specialists (LS) are responsible for interpreting blood gas results and making adjustments to optimize ventilation. Studies have demonstrated that regular blood gas monitoring and timely adjustments of ventilation strategies are associated with improved oxygenation and reduced complications in ICU patients (Morris et al., 2008). In particular, protocols involving RTs and LS in continuous monitoring have been shown to improve outcomes, such as reduced ventilator days and lower rates of ventilator-associated pneumonia (VAP) (Hess, 2014).

Optimizing ventilation requires close attention to blood gas values to maintain adequate oxygenation and prevent hypercapnia (excessive CO_2) or hypoxemia (insufficient oxygen). When used correctly, blood gas analysis allows RTs to tailor ventilator settings to individual patient needs, thereby reducing the risk of

complications like VILI. This highlights the critical role of RTs and LS in managing mechanically ventilated patients and optimizing ventilation to improve outcomes (Hess, 2014).

3. Pharmacist-Managed Sedation Protocols

Sedation management in ICU patients is challenging, as both over-sedation and under-sedation can have serious consequences. Over-sedation increases the risk of delirium, prolonged ventilation, and ICU-acquired weakness, while under-sedation can result in agitation and accidental removal of life-support devices (Davidson et al., 2013). Pharmacists, who are increasingly recognized for their role in ICU care, can play a vital role in optimizing sedation protocols. Their expertise in medication management allows them to adjust sedation levels based on patient responses, prevent drug interactions, and titrate sedatives to minimize adverse effects (Marshall et al., 2008).

Pharmacist-driven sedation protocols have been shown to improve patient outcomes by reducing over-sedation and minimizing sedation-related complications. A study by Marshall et al. (2008) found that when pharmacists were involved in sedation management, patients had shorter durations of sedation, fewer episodes of delirium, and reduced ICU lengths of stay. Additionally, pharmacists contribute to the overall medication safety in the ICU by ensuring appropriate dosing and preventing the overuse of sedatives, particularly in patients with comorbidities or compromised organ function (Marshall et al., 2008).

4. The Importance of Multidisciplinary Collaboration in the ICU

The management of mechanically ventilated patients is inherently complex and requires the integration of multiple healthcare professionals, including respiratory therapists, laboratory specialists, and pharmacists. Multidisciplinary collaboration has been shown to improve outcomes in ICU settings by enhancing communication, reducing errors, and optimizing patient care. A study by Diringeret al. (2011) demonstrated that ICUs implementing multidisciplinary rounds and collaborative protocols, which included RTs, pharmacists, and LS, saw significant reductions in ICU mortality, length of stay, and ventilator days.

Effective collaboration between RTs, LS, and pharmacists is particularly crucial in managing ventilation and sedation. RTs and LS provide real-time data on respiratory status, allowing for immediate adjustments to ventilator settings, while pharmacists ensure that sedation is safely and appropriately managed to prevent complications. Studies have shown that patients benefit from this coordinated approach, with fewer incidences of ventilator-associated events, more precise sedation levels, and improved overall outcomes (Morris et al., 2008; Marshall et al., 2008).

5. Gaps in the Literature

While there is substantial evidence supporting the role of RTs, LS, and pharmacists in ICU care, specific research investigating the combined impact of blood gas analysis and pharmacist-managed sedation protocols in mechanically ventilated patients is limited. Most studies tend to focus on either ventilation strategies or sedation management independently. This gap highlights the need for further research into how these critical functions intersect and how interdisciplinary collaboration between RTs, LS, and pharmacists can be optimized to improve patient outcomes.

The literature demonstrates the critical importance of both blood gas analysis for ventilation management and pharmacist-managed sedation protocols in the care of mechanically ventilated ICU patients. However, while the individual roles of RTs, LS, and pharmacists in ICU care are well-documented, there is a need for further research into how their collaborative efforts can be enhanced to optimize patient outcomes. This

study aims to address that gap by investigating the combined impact of these professionals in improving care for mechanically ventilated patients.

Methodology

Study Design

This was a retrospective cohort study conducted in the intensive care unit (ICU) of a tertiary hospital. The study aimed to evaluate the impact of blood gas analysis and pharmacist-managed sedation protocols on patient outcomes in mechanically ventilated ICU patients. Patient records were reviewed to analyze how respiratory therapists (RTs), laboratory specialists (LS), and pharmacists contributed to the management of ventilation and sedation, with comparisons drawn between patients receiving interdisciplinary care and those receiving traditional care.

Study Setting and Population

The study was conducted in a 30-bed ICU at a tertiary hospital. The study included adult patients (aged ≥18 years) who were mechanically ventilated for at least 48 hours during their ICU stay and had continuous blood gas monitoring and sedation protocols managed by pharmacists. Exclusion criteria included patients with incomplete medical records, those transferred from other hospitals during the course of mechanical ventilation, or those with pre-existing conditions that significantly confounded sedation outcomes (e.g., advanced neurological disorders, terminal illness).

A total of 200 patients were included in the analysis, divided into two groups:

- Interdisciplinary Care Group (n = 100): Patients who received ventilation adjustments based on blood gas analysis conducted by LS and RTs, with sedation protocols managed by pharmacists.
- Traditional Care Group (n = 100): Patients who received standard care with ventilation adjustments made by ICU physicians and sedation managed without pharmacist involvement.

Intervention

The core intervention was the interdisciplinary collaboration between RTs, LS, and pharmacists:

- Respiratory Therapists (RTs): Responsible for adjusting ventilator settings based on blood gas results. RTs monitored oxygenation (pO_2), ventilation (pCO_2), and acid-base status (pH) to ensure optimal ventilation strategies were implemented.
- Laboratory Specialists (LS): Conducted arterial blood gas (ABG) analyses and provided real-time feedback to the RTs and ICU team, ensuring timely and accurate ventilation adjustments.
- Pharmacists: Managed sedation protocols, including the selection, dosing, and titration of sedatives (e.g., propofol, midazolam, dexmedetomidine). Pharmacists also monitored for drug interactions and adverse effects, adjusting therapy based on patient response and clinical condition.

Data Collection

Patient data were retrospectively collected from the hospital's electronic medical records (EMR) system. Data points included:

- Demographics: Age, gender, comorbidities (e.g., diabetes, hypertension, chronic obstructive pulmonary disease).
- Ventilator Settings: Initial and adjusted settings for tidal volume, respiratory rate, FiO_2 (fraction of inspired oxygen), and PEEP (positive end-expiratory pressure).
- Blood Gas Analysis: pO_2, pCO_2, pH, bicarbonate (HCO_3^-) values, and oxygen saturation (SpO_2) before and after ventilator adjustments.

- Sedation Protocols: Type of sedative used, dosage, sedation level (measured using RASS - Richmond Agitation Sedation Scale), and complications related to sedation (e.g., delirium, agitation, respiratory depression).
- Primary Outcomes: ICU length of stay, duration of mechanical ventilation, mortality, and the incidence of ventilator-associated pneumonia (VAP).
- Secondary Outcomes: Sedation-related complications (e.g., over-sedation, under-sedation), frequency of ventilator adjustments based on blood gas results, and patient comfort levels.

Outcome Measures

- Primary Outcomes:
  1. ICU Length of Stay (LOS): The total number of days from ICU admission to discharge or death.
  2. Duration of Mechanical Ventilation: The total number of days the patient was on mechanical ventilation.
  3. Mortality Rate: Defined as in-hospital mortality during the ICU stay.
  4. Incidence of Ventilator-Associated Pneumonia (VAP): Diagnosis confirmed based on clinical criteria (fever, purulent secretions, and new or progressive infiltrates on chest X-ray).

- Secondary Outcomes:
  1. Sedation-Related Complications: Incidences of over-sedation (measured by prolonged time in deep sedation, RASS $\leq$ -4) or under-sedation (agitation, RASS $\geq$ +2), as well as the development of delirium (measured using the Confusion Assessment Method for the ICU, CAM-ICU).
  2. Frequency of Ventilator Adjustments: Number of adjustments made to ventilator settings following blood gas analysis.
  3. Patient Comfort: Measured by the frequency of episodes of agitation and the need for additional sedative boluses.

Data Analysis

Data were analyzed using SPSS. Descriptive statistics (means, medians, standard deviations, and interquartile ranges) were used to summarize patient demographics, clinical characteristics, and outcomes. For comparisons between the interdisciplinary care group and the traditional care group, independent t-tests were used for continuous variables (e.g., ICU LOS, ventilator days), and chi-square tests were used for categorical variables (e.g., mortality, VAP incidence).

- Multivariate Regression Analysis: A multivariate regression model was used to adjust for potential confounders such as age, comorbidities, and severity of illness (measured by APACHE II scores). This analysis assessed the independent effect of interdisciplinary care on the primary outcomes.

- Kaplan-Meier Survival Analysis: Kaplan-Meier curves were generated to compare survival rates between the interdisciplinary and traditional care groups, and the log-rank test was used to assess the statistical significance of differences in survival.

Ethical Considerations

The study was approved by the ethics committee. Given the retrospective nature of the study, informed consent was waived. Patient confidentiality was strictly maintained by anonymizing all data during collection and analysis.

Limitations

This study is limited by its retrospective design, which may introduce bias in data collection and limit the ability to infer causality. Additionally, the study was conducted in a single tertiary hospital, which may limit the generalizability of the findings to other healthcare settings with different ICU protocols or staffing models. Further prospective and multicenter studies are recommended to validate the results and assess the impact of interdisciplinary collaboration in various ICU environments.

Findings

1. Demographic Characteristics

A total of 200 patients were included in the study, with 100 patients in the interdisciplinary care group and 100 in the traditional care group. The mean age of the patients was 61.2 years (SD = 14.8), with 57% of the population being male. The most common comorbidities were chronic obstructive pulmonary disease (COPD) and diabetes. There were no significant differences in baseline demographic characteristics between the two groups.

Table 1: Demographic and Baseline Characteristics

Characteristic	Total (n = 200)	Interdisciplinary Care (n = 100)	Traditional Care (n = 100)	p-value
Mean Age (years)	61.2 ±14.8	60.8 ±14.7	61.6 ±14.9	0.764
Male (%)	57%	56%	58%	0.732
COPD (%)	32%	31%	33%	0.821
Diabetes (%)	28%	29%	27%	0.804
Hypertension (%)	25%	24%	26%	0.882

2. Primary Outcomes

2.1 Length of ICU Stay

The mean length of ICU stay was significantly shorter in the interdisciplinary care group (mean = 10.3 days, SD = 3.6) compared to the traditional care group (mean = 14.1 days, SD = 4.2) ($p < 0.001$). This demonstrates that interdisciplinary care involving blood gas analysis and pharmacist-managed sedation protocols contributed to more efficient patient management.

Table 2: Comparison of ICU Length of Stay

Group	Mean Length of ICU Stay (days)	SD	p-value
Interdisciplinary Care	10.3	3.6	< 0.001
Traditional Care	14.1	4.2	

2.2 Duration of Mechanical Ventilation

Patients in the interdisciplinary care group had a significantly shorter duration of mechanical ventilation (mean = 6.8 days, SD = 2.4) compared to those in the traditional care group (mean = 9.4 days, SD = 3.1) ($p < 0.001$).

Table 3: Comparison of Duration of Mechanical Ventilation

Group	Mean Duration of Ventilation (days)	SD	p-value
Interdisciplinary Care	6.8	2.4	< 0.001
Traditional Care	9.4	3.1	

2.3 Mortality Rate

The ICU mortality rate was lower in the interdisciplinary care group (14%) compared to the traditional care group (23%), although this difference was not statistically significant ($p = 0.092$).

Table 4: Comparison of ICU Mortality Rate

Group	Mortality Rate (%)	p-value
Interdisciplinary Care	14%	0.092
Traditional Care	23%	

2.4 Incidence of Ventilator-Associated Pneumonia (VAP)

The incidence of ventilator-associated pneumonia (VAP) was significantly lower in the interdisciplinary care group (8%) compared to the traditional care group (16%) ($p = 0.048$). This indicates that the regular blood gas monitoring and ventilator adjustments made by RTs and LS, along with optimized sedation management by pharmacists, helped reduce VAP incidence.

Table 5: Comparison of VAP Incidence

Group	VAP Incidence (%)	p-value
Interdisciplinary Care	8%	0.048
Traditional Care	16%	

3. Secondary Outcomes

3.1 Sedation-Related Complications

Sedation-related complications were significantly reduced in the interdisciplinary care group. Patients in this group experienced fewer incidences of over-sedation (measured as prolonged deep sedation, RASS ≤ -4) and under-sedation (RASS $\geq +2$) compared to those in the traditional care group. Additionally, the incidence of delirium was lower in the interdisciplinary care group (12%) compared to the traditional care group (21%) ($p = 0.034$).

Table 6: Comparison of Sedation-Related Complications

Complication	Interdisciplinary Care (%)	Traditional Care (%)	p-value
Over-sedation (RASS ≤ -4)	7%	15%	0.046
Under-sedation (RASS $\geq +2$)	5%	12%	0.038
Delirium (CAM-ICU Positive)	12%	21%	0.034

3.2 Frequency of Ventilator Adjustments

The interdisciplinary care group had significantly more frequent ventilator adjustments based on blood gas analysis (mean = 5.1 adjustments per patient) compared to the traditional care group (mean = 2.8 adjustments per patient) ($p < 0.001$).

Table 7: Comparison of Ventilator Adjustments

Group	Mean Ventilator Adjustments (per patient)	SD	p-value
Interdisciplinary Care	5.1	1.3	< 0.001
Traditional Care	2.8	1.0	

3.3 Patient Comfort

Patient comfort, measured by episodes of agitation requiring additional sedative boluses, was significantly improved in the interdisciplinary care group. Fewer patients in the interdisciplinary care group required additional sedatives due to agitation (9%) compared to the traditional care group (17%) ($p = 0.045$).

Table 8: Comparison of Patient Comfort (Agitation Episodes)

Group	Agitation Episodes (%)	p-value
Interdisciplinary Care	9%	0.045
Traditional Care	17%	

Summary of Findings

The results indicate that interdisciplinary collaboration between respiratory therapists, laboratory specialists, and pharmacists led to improved outcomes for mechanically ventilated ICU patients. This group experienced shorter ICU stays, shorter durations of mechanical ventilation, fewer cases of ventilator-associated pneumonia, and reduced sedation-related complications. Moreover, the study highlights the critical role of frequent blood gas analysis and optimized sedation protocols in enhancing patient comfort and reducing agitation.

Discussion

This study aimed to evaluate the impact of interdisciplinary collaboration between respiratory therapists (RTs), laboratory specialists (LS), and pharmacists on the outcomes of mechanically ventilated ICU patients. The findings demonstrate that the integration of blood gas analysis and pharmacist-managed sedation protocols significantly improves patient outcomes, particularly by reducing the length of ICU stay, the duration of mechanical ventilation, and the incidence of ventilator-associated pneumonia (VAP). These results are consistent with existing literature that highlights the benefits of a multidisciplinary approach in ICU settings (Morris et al., 2008).

Impact on ICU Length of Stay and Mechanical Ventilation

Patients in the interdisciplinary care group experienced a significantly shorter ICU length of stay (10.3 days vs. 14.1 days) and duration of mechanical ventilation (6.8 days vs. 9.4 days) compared to those receiving traditional care. These findings suggest that real-time adjustments to ventilator settings based on blood gas analysis by RTs and LS, combined with pharmacist-driven sedation management, contribute to more efficient patient care. Studies have shown that timely and appropriate ventilator adjustments are crucial in preventing ventilator-associated complications such as lung injury, which can prolong ICU stays (Hess,

2014). By ensuring that ventilation strategies were optimized, RTs and LS helped reduce the duration of mechanical ventilation, thereby shortening ICU stays.

Moreover, the role of pharmacists in managing sedation protocols cannot be overstated. Proper sedation is essential in preventing agitation and promoting patient comfort, yet oversedation can lead to prolonged ventilation, ICU-acquired weakness, and other complications (Davidson et al., 2013). The interdisciplinary care group, where pharmacists managed sedation, experienced fewer complications related to sedation, which likely contributed to the reduced ICU length of stay. Pharmacists' involvement in titrating sedatives and preventing adverse drug interactions allowed for more precise control of sedation, further enhancing recovery.

Reduction in Ventilator-Associated Pneumonia (VAP) Incidence

The interdisciplinary care group also showed a significantly lower incidence of VAP (8% vs. 16%) compared to the traditional care group. VAP is a common and serious complication in mechanically ventilated patients, often resulting in increased morbidity and extended ICU stays. The reduced incidence of VAP in the interdisciplinary group highlights the importance of regular blood gas monitoring and timely ventilator adjustments. Frequent ventilator adjustments based on real-time blood gas analysis ensure that optimal ventilation settings are maintained, reducing the likelihood of atelectasis and other factors that contribute to VAP development (Morris et al., 2008). This finding aligns with previous research showing that interventions aimed at preventing VAP, such as the use of lung-protective ventilation strategies, can significantly reduce the risk of infection (Hess, 2014).

Sedation-Related Complications

Sedation-related complications, such as oversedation and undersedation, were significantly lower in the interdisciplinary care group. Patients in this group experienced fewer incidences of over-sedation (7% vs. 15%) and under-sedation (5% vs. 12%), as well as fewer episodes of delirium (12% vs. 21%). These results highlight the critical role pharmacists play in managing sedation levels, ensuring that patients receive the appropriate amount of sedatives based on their clinical needs. Over-sedation can lead to prolonged mechanical ventilation, while under-sedation can result in agitation, which may lead to unintentional extubation or other adverse events (Marshall et al., 2008).

Pharmacists in the interdisciplinary care group were able to tailor sedation protocols based on individual patient responses, which contributed to fewer complications. This aligns with existing evidence that pharmacist involvement in sedation management reduces the risk of delirium and improves overall patient outcomes (Davidson et al., 2013). Additionally, pharmacist-managed sedation protocols were associated with improved patient comfort, as evidenced by fewer episodes of agitation requiring additional sedative boluses in the interdisciplinary care group.

Frequency of Ventilator Adjustments

The frequency of ventilator adjustments was significantly higher in the interdisciplinary care group (mean = 5.1 adjustments per patient) compared to the traditional care group (mean = 2.8 adjustments per patient). This finding underscores the importance of frequent blood gas analysis in guiding ventilator management. RTs and LS in the interdisciplinary care group were able to make timely adjustments to ventilator settings based on up-to-date blood gas results, ensuring that oxygenation and ventilation were optimized throughout the course of mechanical ventilation. This proactive approach likely contributed to the overall improvement

in patient outcomes, as studies have shown that frequent ventilator adjustments reduce the risk of ventilator-induced lung injury and other complications (Hess, 2014).

Clinical Implications

The findings of this study have important implications for ICU practice. First, they highlight the value of an interdisciplinary approach in managing mechanically ventilated patients. The collaboration between RTs, LS, and pharmacists resulted in better patient outcomes, including shorter ICU stays, reduced VAP incidence, and fewer sedation-related complications. This underscores the need for ICUs to adopt a team-based approach where each healthcare professional's expertise is leveraged to optimize patient care.

Second, the results suggest that incorporating pharmacists into sedation management protocols can lead to improved patient outcomes. Given the complexity of managing sedation in critically ill patients, the involvement of pharmacists in titrating sedative doses and monitoring for drug interactions can help reduce the risk of both over-sedation and under-sedation. Hospitals should consider implementing pharmacist-driven sedation protocols to improve sedation safety and overall patient recovery.

Limitations

Despite the promising findings, this study has several limitations. First, as a retrospective cohort study, it is subject to inherent biases, including the possibility of unmeasured confounding variables. Additionally, the study was conducted in a single tertiary hospital, which may limit the generalizability of the findings to other healthcare settings with different staffing models or ICU protocols. Furthermore, the study focused on a relatively small sample size, and larger prospective studies are needed to confirm the benefits of interdisciplinary collaboration in ICU care.

Conclusion

In conclusion, this study demonstrates that interdisciplinary collaboration between respiratory therapists, laboratory specialists, and pharmacists significantly improves outcomes for mechanically ventilated ICU patients. By integrating blood gas analysis and pharmacist-managed sedation protocols, the interdisciplinary care group achieved better patient outcomes, including shorter ICU stays, reduced duration of mechanical ventilation, lower incidence of VAP, and fewer sedation-related complications. These findings highlight the importance of a team-based approach in ICU care and suggest that further efforts to promote interdisciplinary collaboration could enhance patient outcomes across a variety of critical care settings.

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