

Knowledge, Attitudes, and Practices of Critical Care Nurses Regarding Ventilator-Associated Event Prevention at King Abdulaziz Hospital, Al Ahsa, Saudi Arabia

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Abstract

Background: Ventilator-associated events (VAEs) are major healthcare-associated complications among mechanically ventilated patients, contributing to increased morbidity, prolonged intensive care unit (ICU) stay, and higher healthcare costs. Critical care nurses play a pivotal role in implementing evidence-based strategies to prevent VAEs; however, evidence regarding their knowledge, attitudes, and practices (KAP) remains limited, particularly in Saudi Arabia.

Objective: To assess critical care nurses' knowledge, attitudes, and practices regarding VAE prevention, examine the relationships among these domains, and determine differences according to demographic and professional characteristics.

Methods: A descriptive cross-sectional correlational study was conducted among 89 critical care nurses working in the adult ICU, pediatric ICU, and neonatal ICU at King Abdulaziz Hospital, Al Ahsa in Saudi Arabia. Participants were recruited through convenience sampling and completed a validated self-administered questionnaire assessing demographic characteristics, knowledge, attitudes, and practices related to VAE prevention. Descriptive statistics summarized participant characteristics and domain scores. Pearson's correlation examined relationships among KAP domains, while Mann-Whitney U and Kruskal-Wallis tests compared scores across participant characteristics. Statistical significance was set at $p < .05$. **Results:** Participants demonstrated highly positive attitudes and high self-reported adherence to recommended VAE prevention practices, with median scores of 20 for both domains, whereas knowledge scores were more variable (median = 6). Knowledge was positively associated with practice ($r = 0.257, p = .015$). Specialized training was associated with higher knowledge scores ($p = .010$), while age was associated with attitude ($p = .038$). No significant differences in practice were observed across demographic or professional characteristics. **Conclusion:** Critical care nurses demonstrated positive attitudes and high adherence to evidence-based VAE prevention practices despite variability in knowledge. The association between knowledge and practice highlights the importance of structured education and competency-based training to strengthen evidence-based care. These findings provide baseline evidence to support nursing education, leadership, and quality improvement initiatives aimed at enhancing patient safety in Saudi critical care settings.

Keywords: Ventilator-associated events, Critical care nursing, Mechanical ventilation, Knowledge, Attitudes, Practices, Patient safety, and Saudi Arabia.

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INTRODUCTION

Mechanical ventilation is an essential life-sustaining intervention for critically ill patients, but

prolonged ventilation exposes patients to preventable complications that negatively impact patient outcomes. Of these, ventilator-associated events (VAEs) have emerged as a standardized surveillance measure for the

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identification of clinically significant respiratory deterioration in mechanically ventilated patients. Patients with VAEs experience longer mechanical ventilation, longer intensive care unit (ICU) and hospital stays, higher healthcare costs, and higher mortality than patients without these complications (Klompas *et al.*, 2014; Centers for Disease Control and Prevention (CDC), 2025). Therefore, the reduction of VAEs is an international patient safety priority and an important quality indicator in critical care (World Health Organization (WHO), 2021).

The CDC developed the Ventilator-Associated Event surveillance framework through the National Healthcare Safety Network (NHSN) in response to the limitations of traditional VAP surveillance, including the use of subjective diagnostic criteria. Unlike traditional VAP surveillance, the VAE framework encompasses a wider spectrum of clinically important respiratory deterioration including ventilator-associated conditions (VAC), infection-related ventilator-associated complications (IVAC), and possible ventilator-associated pneumonia (PVAP). This standardized framework facilitates a more objective surveillance strategy, benchmarking of healthcare performance, and guidance for quality improvement efforts (CDC, 2025; Klompas, 2019).

Preventing VAEs requires a coordinated multidisciplinary approach, with critical care nurses playing a central role in implementing evidence-based prevention strategies. These include adherence to ventilator care packages, oral care, proper head-of-bed elevation, assessment of sedation, promotion of spontaneous awakening and spontaneous breathing trials, early mobilization and ongoing surveillance for symptoms of respiratory deterioration. Nurses are responsible for implementing these measures for patients in the ICU, thus their expertise, clinical judgment, and commitment to evidence-based practice are essential for successful VAE prevention (CDC, 2025; Klompas, 2019).

The Knowledge–Attitude–Practice (KAP) framework is a valuable theoretical approach to understanding these abilities, suggesting that information affects attitudes, which affect clinical practice (Launiala, 2009). In the setting of highly protocolized intensive care environments, however, this association may also be modulated by organizational policies, competency-based education, multidisciplinary teamwork, and ongoing quality improvement programs. Thus, assessment of nurses' knowledge, attitudes and practices provides important insight into both individual competency and organizational capacity to sustain evidence-based ventilator care.

Although there has been a substantial body of research on VAP prevention and adherence to ventilator care bundles, there are very few studies on nurses'

knowledge, attitudes and practices addressing the larger CDC VAE framework. The existing literature has been mostly confined to epidemiological surveillance, diagnostic criteria, or bundle implementation and there is a lack of evidence concerning the competencies of frontline nurses who are responsible for implementing evidence-based VAE prevention in everyday clinical practice (Madhuvu *et al.*, 2020; Yao *et al.*, 2024).

This evidence gap is particularly salient in the case of Saudi Arabia. Despite ongoing attempts to improve patient safety and infection control programs, published research on the evaluation of the critical care nurses' competence linked to VAE prevention is limited. Most regional studies still concentrate on ventilator-associated pneumonia or general infection control methods and offer little evidence to inform competency-based education, professional development, and quality improvement programs related to the wider VAE monitoring framework. Closing this gap is crucial to guide targeted educational initiatives, increase evidence-based nursing practice and enhance outcomes of mechanically ventilated patients.

At King Abdulaziz Hospital Al Ahsa, this need became increasingly apparent following the identification of ventilator-associated events despite several years of favorable ventilator-associated pneumonia outcomes. Although evidence-based ventilator care protocols were established, the emergence of VAEs highlighted the need for critical care nurses to have the knowledge, skills, and clinical judgment to recognize ventilator-associated deterioration and consistently implement evidence-based prevention strategies.

Accordingly, this study examined critical care nurses' knowledge, attitudes, and practices regarding ventilator-associated event prevention among nurses working in the adult, pediatric, and neonatal ICUs at King Abdulaziz Hospital Al Ahsa, Saudi Arabia. Specifically, the study aimed to (1) assess nurses' knowledge, attitudes, and practices regarding evidence-based VAE prevention; (2) examine the relationships among these domains; and (3) determine whether these competencies differed according to selected demographic and professional characteristics. By generating baseline evidence on nurses' competencies related to VAE prevention, this study contributes to the limited literature on VAE prevention in Saudi Arabia. It provides evidence to support competency-based nursing education, organizational policy, and quality improvement initiatives aimed at strengthening patient safety in critical care settings.

METHODS

Study Design

A quantitative descriptive-correlational cross-sectional study was conducted to examine critical care nurses' knowledge, attitudes, and practices (KAP)

regarding ventilator-associated event (VAE) prevention. The cross-sectional design enabled the simultaneous assessment of nurses' competencies and the examination of relationships among the KAP domains, as well as differences according to selected demographic and professional characteristics. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

Study Setting

The study was conducted at King Abdulaziz Hospital, Al Ahsa, Saudi Arabia, a tertiary referral hospital providing specialized healthcare services. Data were collected from the Adult Intensive Care Unit (ICU), Pediatric Intensive Care Unit (PICU), and Neonatal Intensive Care Unit (NICU), where invasive mechanical ventilation is routinely used. These units follow evidence-based ventilator management and infection prevention protocols, providing an appropriate setting for evaluating nurses' competencies related to VAE prevention.

Participants and Sampling

The study population comprised registered nurses working in the Adult Intensive Care Unit (ICU), Pediatric Intensive Care Unit (PICU), and Neonatal Intensive Care Unit (NICU) at King Abdulaziz Hospital, Al Ahsa, Saudi Arabia. Nurses were eligible if they provided direct bedside care to mechanically ventilated patients and had completed unit orientation. Nurses in managerial or administrative positions without direct patient care responsibilities, those on extended leave during the data collection period, and those who declined participation were excluded.

The sample size was determined by utilizing the sample size determination table of Krejcie and Morgan (1970). The minimum sample size was 80 participants, based on an available population of about 100 eligible critical care nurses. A non-probability convenience sample strategy was used in which all eligible nurses who met the inclusion criteria and were available throughout the data-collecting period were invited to participate. This technique maximized participation and guaranteed enough representation of the accessible critical care nurse population in the study environment. Eighty-nine of the approximately 100 eligible nurses completed the questionnaire, which was above the minimum sample size required and resulted in a response rate of 89%.

Participation was entirely voluntary. Eligible nurses received information regarding the study objectives and procedures before providing written informed consent. No incentives were offered for participation, and participants were informed that they could withdraw from the study at any time without consequence.

Data Collection Instrument

Data were collected using a structured, self-administered questionnaire developed from the CDC National Healthcare Safety Network (NHSN) Ventilator-Associated Event Surveillance Protocol, current evidence on ventilator care, and the Knowledge–Attitude–Practice (KAP) framework (CDC, 2025; Klompas *et al.*, 2014; Launiala, 2009).

The questionnaire consisted of four sections:

1. Demographic and professional characteristics, including age, gender, educational attainment, years of critical care experience, and completion of specialized training.
2. Knowledge, comprising six dichotomously scored items (correct = 1, incorrect = 0) assessing VAE definitions, surveillance concepts, ventilator care bundles, risk factors, and evidence-based preventive strategies.
3. Attitudes, consisting of four statements rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).
4. Practices, comprising seven five-point Likert-scale items evaluating the frequency of implementing recommended VAE prevention interventions, including ventilator bundle adherence, oral hygiene, head-of-bed elevation, sedation assessment, spontaneous awakening and breathing trials, hand hygiene, and routine assessment of mechanically ventilated patients.

Higher scores indicated greater knowledge, more positive attitudes, and stronger adherence to evidence-based VAE prevention practices.

Content Validity and Reliability

The questionnaire underwent content validation by three experts in critical care nursing, infection prevention, nursing education, and clinical research using a four-point relevance scale based on the recommendations of Lynn (1986) and Polit and Beck (2006). All 17 questionnaire items achieved an Item-Level Content Validity Index (I-CVI) of 1.00, resulting in a Scale-Level Content Validity Index (S-CVI/Ave) of 1.00, indicating excellent content validity.

The instrument was subsequently pilot-tested among 20 eligible critical care nurses who were excluded from the main study. Because the knowledge domain consisted of dichotomous items, descriptive item analysis was performed rather than calculating Cronbach's alpha. Correct response rates varied from 60% to 100%, showing that the items were performing satisfactorily. The Cronbach's α for the attitude domain was 0.71 and for the practice domain was 0.74. This indicates acceptable internal consistency of the instrument (Nunnally & Bernstein, 1994).

Data Collection Process

Ethical approval and administrative permission were obtained before approaching eligible nurses for participation during their scheduled duty hours. Participants were asked to sign a written informed consent form. Then they completed the anonymous self-administered questionnaire, which took around 10–15 minutes. The principal investigator gathered completed surveys and evaluated them for completeness before data input.

Ethical Aspects

The study was done based on the institutional policy on research with human participants. Ethical approval was obtained from the King Abdullah International Medical Research Center (KAIMRC) Institutional Review Board (IRB Approval No.: 00000180425) before commencement of the study. Administrative approval was also obtained from King Abdulaziz Hospital, Al Ahsa, and the leadership of the participating critical care units.

Participation was voluntary, and written informed consent was obtained from all participants. Participant anonymity was maintained by assigning unique study identification numbers, and no personally identifiable information was collected. Electronic data were stored in password-protected files accessible only to the research team. Because the study involved completion of an anonymous questionnaire without intervention, it was considered to pose minimal risk to participants.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Statistical significance was established at a two-tailed $p < .05$.

Categorical variables were summarized using frequencies and percentages, whereas continuous variables were described using medians and interquartile ranges (IQRs). Composite knowledge, attitude, and practice scores were calculated by summing item responses within each domain.

Relationships among the KAP domains were examined using Pearson's product-moment correlation coefficient, with correlation strength interpreted according to Cohen's guidelines. Differences in domain scores according to demographic and professional characteristics were analyzed using the Mann-Whitney U test for two-group comparisons and the Kruskal-Wallis H test for comparisons involving three or more groups.

RESULTS

This section presents the demographic characteristics of the participants, followed by findings on critical care nurses' knowledge, attitudes, and practices regarding ventilator-associated event (VAE) prevention. It also reports the relationships among these domains and differences according to selected demographic and professional characteristics.

Participant Characteristics

A total of 89 critical care nurses participated in the study. Most participants were female and between 26 and 35 years of age. The majority held a bachelor's degree, had more than five years of critical care experience, and had completed specialized critical care training. Detailed demographic and professional characteristics are presented in Table 1.

Table 1: Demographic and Professional Characteristics of Participants (N = 89)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	21–25	2	2.2
	26–35	29	32.6
	36–45	29	32.6
	>45	29	32.6
Gender	Female	84	94.4
	Male	5	5.6
Years of Experience	1–5 years	12	13.5
	5–10 years	21	23.6
	>10 years	56	62.9
Education Level	Diploma	20	22.5
	Bachelor's degree	64	71.9
	Master's degree	5	5.6
Specialized Training (Critical Care / IPC)	Yes	74	83.1
	No	15	16.9

Knowledge, Attitudes, and Practices Regarding VAE Prevention

Participants demonstrated high attitude and practice scores with a median score of 20 in both categories; however, the knowledge domain had a lower

median score of 6, suggesting that nurses had more flexibility in their understanding of VAE prevention. Descriptive statistics for each domain are presented in Table 2.

Table 2: Descriptive Statistics for Knowledge, Attitudes, and Practices Regarding Ventilator-Associated Event Prevention: Relationships Among Knowledge, Attitudes, and Practices

Domain	Median	IQR	Interpretation
Knowledge (6 items)	6	1	High VAE prevention knowledge
Attitude (4 items)	20	1	Very positive attitude toward VAE prevention
Practice (7 items)	20	0	Very high adherence to VAE prevention practices

Pearson's correlation analysis demonstrated a weak but statistically significant positive correlation between knowledge and practice ($r = 0.257$, $p = .015$). In contrast, no statistically significant relationships were

identified between knowledge and attitude or between attitude and practice. Correlation coefficients are presented in Table 3.

Table 3: Pearson Correlation Among Knowledge, Attitudes, and Practices Regarding Ventilator-Associated Event Prevention

Variables	Knowledge	Attitude	Practice
Knowledge	1	.082	.257*
Attitude	.082	1	.036
Practice	.257*	.036	1

Factors Associated with Knowledge

Knowledge scores differed significantly according to specialized critical care training ($p = .010$). Nurses who had completed specialized training demonstrated higher knowledge scores than those

without such training. No statistically significant differences in knowledge were observed according to age, gender, educational attainment, or years of critical care experience. Detailed comparisons are presented in Table 4

Table 4: Comparison of Knowledge Scores According to Participant Characteristics

Variable	Groups	Median (IQR)	p-value
Age	21–25	5.5 (1)	0.963
	26–35	6 (1)	
	36–45	5 (1)	
	>45	6 (1)	
Gender	Female	6 (1)	0.144
	Male	5 (2)	
Experience	1–5 years	5.5 (2)	0.819
	5–10 years	6 (1)	
	>10 years	6 (1)	
Education	Diploma	6 (1)	0.604
	Bachelor's	6 (1)	
	Master's	5 (1)	
Specialized Training	No	5 (0)	0.010*
	Yes	6 (1)	

Factors Associated with Attitudes

Attitude scores differed significantly according to age ($p = .038$). No statistically significant differences were observed according to gender, educational

attainment, years of critical care experience, or specialized training. These findings are summarized in Table 5.

Table 5: Comparison of Attitude Scores According to Participant Characteristics

Variable	Groups	Median (IQR)	p-value
Age	21–25	17.5 (5)	0.038*
	26–35	20 (3)	
	36–45	20 (0)	
	>45	20 (0)	
Gender	Female	20 (1)	0.472
	Male	20 (3)	
Experience	1–5 years	20 (4)	0.380
	5–10 years	20 (4)	
	>10 years	20 (0)	

Variable	Groups	Median (IQR)	p-value
Education	Diploma	20 (1)	0.782
	Bachelor's	20 (1)	
	Master's	20 (3)	
Specialized Training	No	20 (1)	0.052
	Yes	20 (0)	

Factors Associated with Practices

No statistically significant differences in practice scores were identified according to age, gender,

educational attainment, years of critical care experience, or specialized training. Comparative analyses are presented in Table 6.

Table 6: Comparison of Practice Scores According to Participant Characteristics

Variable	Groups	Median (IQR)	p-value
Age	21–25	20 (0)	0.347
	26–35	20 (0)	
	36–45	20 (2)	
	>45	20 (0)	
Gender	Female	20 (0)	0.195
	Male	20 (3)	
Experience	1–5 years	20 (0)	0.514
	5–10 years	20 (2)	
	>10 years	20 (0)	
Education	Diploma	20 (1)	0.222
	Bachelor's	20 (0)	
	Master's	20 (1)	
Specialized Training	No	20 (2)	0.111
	Yes	20 (0)	

DISCUSSION

Principal Findings

This study examined critical care nurses' knowledge, attitudes, and practices regarding ventilator-associated event (VAE) prevention in a tertiary hospital in Saudi Arabia. Overall, nurses demonstrated positive attitudes and high self-reported adherence to evidence-based VAE prevention practices, while knowledge scores were comparatively lower. A significant positive relationship was observed between knowledge and practice; specialized critical care training was associated with higher knowledge scores, and age was associated with attitudes. In contrast, practice scores did not differ significantly according to demographic or professional characteristics. These findings provide important insights into critical care nurses' competencies related to VAE prevention and identify opportunities to strengthen evidence-based education and clinical practice.

Knowledge, Attitudes and Practices on Prevention of VAE

The findings indicate that critical care nurses generally demonstrated positive attitudes toward VAE prevention and consistently followed evidence-based preventive strategies. These findings are encouraging because persistent adherence to evidence-based therapies administered by multidisciplinary critical care teams is required for successful VAE prevention, with nurses playing a vital role in the daily management of ventilators. Similar findings have been reported in previous studies, indicating that standardized ICU

protocols, ventilator care bundles, and organizational quality improvement programs contribute to high compliance with evidence-based preventive interventions (Alreshidi, *et al.*, 2024).

Knowledge levels were more variable, whereas attitudes and practices were uniformly high. These findings suggest that nurses may consistently implement recommended interventions because of established clinical protocols and organizational expectations despite variability in their theoretical understanding of the broader VAE surveillance framework. Similar results have been observed in research suggesting that standardized clinical pathways may help encourage consistent evidence-based practice even with varying levels of individual expertise (Albariqi *et al.*, 2024; Alreshidi *et al.*, 2024). Nevertheless, it remains necessary to enhance nurses' theoretical understanding to improve clinical decision-making, early recognition of ventilator-associated deterioration, and adaptation to the changing evidence-based recommendations.

Relationship of Knowledge and Practice

A significant positive association was observed between knowledge and practice, suggesting that nurses with greater knowledge scores also reported improved application of evidence-based VAE preventive methods. Although the association was modest, it supports the Knowledge–Attitude–Practice framework, which suggests that information influences clinical behavior. Similar relationships have been identified in

investigations of infection control competences among critical care nurses (Launiala, 2009; Alreshidi, *et al.*, 2024).

These findings emphasize the value of continuing professional development, competency-based education, and regular knowledge assessment to strengthen evidence-based ventilator care.

Influence of Specialized Critical Care Training

Specialized critical care training was the only participant characteristic significantly associated with knowledge scores. Nurses who had completed specialized training demonstrated greater knowledge regarding VAE prevention than those without such training. This finding is consistent with previous research demonstrating that structured educational programs improve nurses' clinical competence and adherence to evidence-based practice. The results suggest ongoing investment in organized orientation programs, specialized certification, competency assessment, and continuing education to ensure the delivery of high-quality care to mechanically ventilated patients.

Impact of Demographic Characteristics

Attitude was substantially linked with age, but not with gender, educational attainment, years of critical care experience, or specialized training. Older nurses may develop more positive professional attitudes through greater clinical experience and increased confidence in caring for critically ill patients. However, the lack of relationships with other demographic characteristics shows that good attitudes towards VAE prevention are widespread among nurses, independent of their professional experience.

Likewise, there were no significant differences in practice scores by age, gender, education level, years of critical care experience, or specialized training. These findings suggest that standardized institutional policies, evidence-based clinical protocols, competency assessments, and multidisciplinary teamwork contribute to the consistent implementation of VAE prevention practices across nurses with different demographic and professional characteristics.

Implications for Nursing Practice

Implications for nursing practice, education, leadership, and quality improvement are discussed. Nurses reported consistently excellent adherence to evidence-based practices, but the heterogeneity in understanding underlines the need for continued education beyond ventilator bundle compliance to include the larger CDC VAE surveillance framework. Nursing leaders should continue to engage in competency-based orientation, continuous professional development, simulation-based instruction, and frequent competency assessment to increase theoretical understanding and maintain high standards of clinical practice. These initiatives may enhance early recognition

of ventilator-associated deterioration and further improve patient safety among mechanically ventilated patients.

Strengths and Limitations

This study has several strengths. To our knowledge, this is among the few recent studies in Saudi Arabia to evaluate critical care nurses' knowledge, attitudes, and practices regarding VAE prevention using the CDC VAE surveillance framework. The adult, pediatric, and neonatal intensive care units are included to give a thorough review across several critical care settings. In addition, the questionnaire had great content validity and moderate reliability, which supported the legitimacy of the findings.

Several limitations should also be acknowledged. The first is that the cross-sectional design prevents causal inferences. Second, convenience sampling was used in one tertiary institution, which may restrict the generalizability of the findings. Third, the assessment of practice was based on self-reported replies, rather than direct observation, which introduces the risk of social desirability and reporting bias. Future multicenter studies employing probability sampling, longitudinal designs, and observational measures of clinical practice are recommended to further evaluate nurses' competencies and assess the effectiveness of educational interventions in improving VAE prevention.

Conclusion of the Discussion

Overall, this study provides important baseline evidence regarding critical care nurses' competencies related to ventilator-associated event prevention in Saudi Arabia. The findings demonstrate that positive attitudes and consistent evidence-based practices can coexist with variability in theoretical knowledge, emphasizing the continued importance of competency-based education and specialized critical care training. By strengthening nurses' knowledge while sustaining high standards of clinical practice, healthcare organizations can further support evidence-based VAE prevention and improve patient safety outcomes among mechanically ventilated patients.

CONCLUSION

This study provides important evidence regarding critical care nurses' knowledge, attitudes, and practices related to ventilator-associated event (VAE) prevention in a tertiary healthcare institution in Saudi Arabia. Overall, nurses demonstrated positive attitudes and high self-reported adherence to evidence-based VAE prevention practices, while knowledge regarding the broader VAE surveillance framework showed greater variability. The significant positive relationship between knowledge and practice underscores the importance of strengthening nurses' theoretical understanding to support consistent implementation of evidence-based care. Furthermore, the association between specialized critical care training and higher knowledge scores

highlights the value of structured educational programs in enhancing nurses' competency in VAE prevention.

These findings reinforce the need for healthcare organizations to sustain competency-based education, continuing professional development, and regular competency assessment to strengthen nurses' knowledge while maintaining high standards of clinical practice. This study contributes to the limited body of literature on VAE prevention by providing baseline evidence on critical care nurses' knowledge, attitudes, and practices in Saudi Arabia. The findings offer valuable evidence to inform nursing education, clinical practice, leadership, and quality improvement initiatives aimed at strengthening evidence-based VAE prevention. Future multicenter and longitudinal studies incorporating observational measures of clinical practice are recommended to further evaluate nurses' competencies and assess the effectiveness of educational interventions in improving VAE prevention.

Ultimately, strengthening nurses' competencies through evidence-based education, specialized critical care training, and continuous professional development has the potential to enhance VAE prevention strategies, improve patient safety, and promote better outcomes for mechanically ventilated patients

DECLARATIONS

Ethics Approval and Consent to Participate

Research Center (KAIMRC) Institutional Review Board (IRB Approval No.: 00000180425) before the commencement of the study. Administrative approval was obtained from the King Abdulaziz Hospital, Al Ahsa, and the participating critical care units. Written informed consent was obtained from all participants before data collection. Participation was voluntary, and participants were informed of their right to withdraw from the study at any time without penalty. Confidentiality and anonymity were maintained throughout the study.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are not publicly available to protect participant confidentiality but are available from the corresponding author upon reasonable request and with permission from the King Abdulaziz Hospital and the King Abdullah International Medical Research Center, where applicable.

Authors' Contributions

Beverly Ann F. Silva conceived and designed the study, developed the research protocol and data collection instrument, coordinated data collection, interpreted the findings, and drafted the manuscript. Prisca Dlamini provided overall supervision of the study, contributed to the study design, interpretation of the findings, and critically reviewed the manuscript for important intellectual content. Mia Garcia contributed to

the study design, facilitated the implementation of the research within the pediatric critical care services, assisted in the interpretation of the findings, and critically reviewed the manuscript. Jennifer Ann Camero contributed to data collection, assisted with data management, and critically reviewed the manuscript. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work

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