Factors that promote nurses' adherence to ventilator associated pneumonia prevention guidelines in critical care units of Bomet and Kericho Counties, Kenya

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ABSTRACT

Ventilator-associated pneumonia (VAP) is one of the most common healthcare-associated infections among mechanically ventilated patients and is associated with increased morbidity, mortality, prolonged hospital stay, and healthcare costs. Although the Institute for Healthcare Improvement (IHI) recommends evidence-based VAP prevention bundles, adherence to these guidelines among critical care nurses remains inconsistent, particularly in resource-constrained settings.This study aimed to determine the factors that promote nurses' adherence to ventilator-associated pneumonia prevention guidelines in critical care units of Bomet and Kericho counties, Kenya.A descriptive cross-sectional study employing a quantitative approach was conducted among 136 nurses working in critical care units of four hospitals in Bomet and Kericho counties. Data were collected using a structured questionnaire and a VAP compliance checklist. Descriptive statistics were used to summarize participant characteristics, while chi-square tests and multiple linear regression analysis were performed to determine the association between nurses' characteristics and adherence to VAP prevention guidelines. Most nurses were aware of VAP prevention bundles (97.8%) and their components (94.0%), although complete adherence remained suboptimal. Multiple regression analysis showed that knowledge ($p = 0.001$), positive attitude ($p = 0.016$), years of ICU experience ($p = 0.020$), institutional support ($p < 0.001$) and availability of equipment ($p = 0.021$) were significant predictors of factors that promote adherence ventilator care bundles. VAP prevention guidelines is significantly influenced by individual and institutional factors, including knowledge, attitude, clinical experience, organizational support and resource availability. Strengthening continuous professional education, ensuring adequate staffing and equipment and enhancing institutional support are essential and thus reducing the burden of ventilator-associated pneumonia in critical care units.

Keywords: Bomet County, CCU Critical Care Unit, Institute of Health Care Improvement, Litein Mission Hospital, Kericho Refferal Hospital, Kericho County, Siloam Hospital, Tenwek Mission Hospital, Ventilator Associated Pneumonia

I. INTRODUCTION

Ventilator associated pneumonia (VAP) refers to bacterial pneumonia that develops in mechanically ventilated patients within a duration of more than 48-72 hours (Sattar *et al*, 2018). It is a common and fatal nosocomial infection occurring in the critical care units (neonatal, pediatric, and surgical etc.) and it may occur when the patient is on a ventilator or even after extubation (Yaseen & Salameh, 2015). A ventilator machine assists a patient to continue breathing by having oxygen through an endotracheal tube placed in patients' mouth or through a tracheostomy done (Kumar & Raghavendran, 2021). The pathogenesis of VAP is associated to bacteria that colonizes the oropharyngeal and gastrointestinal tract that goes to the lower respiratory tract mainly through microaspiration of secretions loaded with bacteria (Cotoia *et al*, 2020).

The ventilator associated care bundle according to Institute of Healthcare Improvement, 2022, is defined as "a collection of interventions that may be applied to the management of a particular condition". In this case of this study, it is the factors that promote nurses' adherence to ventilator associated pneumonia prevention guidelines in critical care units of bomet and kericho counties. Institute Healthcare Improvement in 2022 stated that the bundle elements are best practices based on evidence. This means that when implemented in any other hospital critical care unit, the same results would be achieved, provided all practices are implemented. The full implementation of the ventilator bundle, require teamwork, collaboration of all disciplines in the critical care and daily routine goal setting (Resar *et al.*, 2012).

The ventilator bundle comprises the elevation of the head of the bed to an angle between 30 and 45 degrees, daily sedation interruption and evaluation of extubation readiness, prophylaxis for peptic ulcer disease and prophylaxis for deep venous thrombosis (DVT). In 2012, the Institute of Healthcare Improvement determined that dental care with Chlorhexidine enhances the efficacy of preventing ventilator-associated pneumonia, leading to its inclusion as the fifth

factor alongside the original four. Despite the availability of factors that promote nurses' adherence and control measures of VAP and clear defined roles of nurses, prevalence and incidence of VAP is still high in ICU units. With the existence of factors that promote nurses' adherence, there exists high prevalence and incidence of VAP. There was a need therefore to carry out a study to find out the factors that promote nurses' adherence to ventilator associated pneumonia prevention guidelines in critical care units of Bomet and Kericho Counties, Kenya.

1.1 Statement of the Problem

Mechanical ventilation is crucial in saving lives of patients with breathing difficulties, however, it possess great risk of Ventilator associated pneumonia infection which is common in all critical care units worldwide. According to the American Thoracic Society in 2020, ventilator associated pneumonia causes collapsed lung, lung damage, medication side effects and inability to breathe without ventilator. Care bundles elements were found to reduce ventilator associated pneumonia infection significantly if only implemented as a bundle than when implemented as individual elements (Hassan & Elsaman,, 2022). The care bundles implementation guidelines should be a corporative work by all members of critical care unit.

Despite the availability of the factors that promote nurses' adherence to ventilator associated pneumonia care bundles in critical care units, incidences and prevalence of ventilator associated pneumonia infections were still high in hospital ICUs. In China, incidence density was reported 24 per 1000 ventilator days (Ding *et al*., 2017) while in WHO Southeast Asian region, VAP incidences ranges between 2 to 116 per 1,000 ventilator days (Kharel *et al.*, 2021). In Egypt incidence was reported at 3.7% among 6,912 patients studied. In Easter-Africa it is as high as 54% (Sattar *et al.*, 2018) and another study showed a pooled prevalence of 34% (Beletew *et al.*, 2020). Furthermore, a retrospective study in two tertiary hospitals in Dares Salam, Tanzania, reported an incidence of 40.1 per 1000 ventilation days among 269 patients on ventilator (Nyawale, 2020). These studies demonstrate that ventilator-associated pneumonia was still high and possessed a great challenge in hospitals' critical care units.

In Kenya, a very high incidence was reported to be as high as 54% (Sattar *et al*., 2018). This was too high as compared to other countries in the world and in Africa. Unfortunately, there were very limited documented researches done at the Bomet and Kericho counties on factors that promote nurses' adherence to ventilator associated pneumonia prevention guidelines in critical care units of Bomet and Kericho Counties, Kenya. It was demonstrated that care bundles reduced cases of VAP significantly with proper guidelines put in place and fully implemented (Resar *et al.*, 2012; Ranzani et al., 2022). The resultant effect of failing to adhere to the factors that promote adherence include but not limited to high cost of treatment, long hospital stay, loss of the patient, long ventilator days and psychological stress to patients' relatives. In addition, it's costly for the hospital to provide for health care services in terms of personnel, drugs and other supplies.

Nurses play a critical role in implementation of ventilator associated care bundles in critical care units. Studies showed that knowledge on factors that promote adherence to ventilator associated pneumonia was still low (48.34%) among critical care nurses (Shojaeimotlagh *et al*., 2020). A study done by Kolovwe (2020), at Kenyatta national Hospitals indicate nearly all nurses were aware of the care bundles. However, implementation of the bundles was a problem, for only 38.3% of all the nurses implemented the care bundles. The main challenge was that some bundles elements could be implemented while others were not. However, to achieve the full benefit of the bundle, all the care bundle elements must be utilized. Therefore, the research study sought to ensure that factors that promote full adherence of the care bundle elements to realize the reduction of VAP infections. Hence, the study sought to understand; Factors that promote nurses' adherence to ventilator associated pneumonia prevention guidelines in critical care units of Bomet and Kericho Counties, Kenya.

1.2 Research Objective

Factors that promote nurses' adherence to ventilator associated pneumonia prevention guidelines in critical care units of Bomet and Kericho Counties, Kenya

II. LITERATURE REVIEW

2.1 Theoretical Review

Ventilator associated pneumonia is a common hospital acquired diseases affecting mechanically ventilated patients. It is also referred to as a bacterial pneumonia affecting mechanically ventilated patients within 48-72 hours (Sattar *et al*., 2018). It is one of the 3 most common nosocomial infections in the intensive care unit (ICU) environment (Rello *et al*., 2012). The main causative agents associated with ventilator associated pneumonia are *Acinetobacter baumanii* and *Pseudomonas aeruginosa,* among others (Nkirote 2014 & Kharel *et al*, 2021). The bacterium infects the lungs, through or aided by endotracheal tubes. The main symptoms of lung infection include; low oxygen levels, breathlessness/apnea and restlessness, elevated white blood cells among others (Modi & Kovacs, 2020). The full

implementation of ventilator pneumonia care bundles in critical care units depends on nurses' adherence to evidence-based guidelines which prevents ventilator-associated pneumonia (VAP). Adherence is influenced by individual, organizational and environmental factors which includes nurses' knowledge and skills, teamwork, leadership support, staffing levels, availability of resources and institutional policies. This theory provide a framework for understanding these factors and explain how they influence compliance with ventilator care bundles within the critical care units. Donabedian's Structure–Process–Outcome (SPO) Model (Donabedian, 1988) evaluates the quality of healthcare services. The model has three components: structure, process and outcomes where it refers to the organizational environment in which there is delivery of patient care. It also includes staffing levels, nurse-to-patient ratios, availability of equipment, infection prevention supplies, institutional policies, critical care protocols, on job training, institutional support and nurse regular supervision.

Critical care units with adequate staffing, sufficient resources and clear clinical guidelines create an enabling environment that promotes adherence to ventilator care bundles. With the above, a full patient care will be achieved. The ventilator care bundles consists of five elements which practically used to prevent ventilator associated pneumonia, this includes; oral hygiene with chlorhexidine mouth wash, maintaining head-of-bed elevation between 30° and 45°, performing daily sedation vacations, use of peptic ulcer prophylaxis and regular assessment for extubation readiness, Institute Healthcare Improvement (2022). Compliance with these interventions reflects the quality of nursing practice. The outcomes refer to the effects of healthcare interventions on patient health. High adherence to ventilator pneumonia care bundles leads to reduced incidence of ventilator-associated pneumonia, reduced intensive care unit stay, lower unit costs, reduced mortality and improved quality of care. However, deficiencies in organizational structure negatively affect the care processes and patient outcomes. The SPO model demonstrates that improving adherence requires strengthening structural factors such as staffing, resources, leadership and institutional policies, which improves nursing processes and patient outcomes.

2.2 Empirical Review

Adherence to Ventilator-Associated Pneumonia (VAP) care bundles has the potential to reach 100% under *ceteris paribus* conditions, where all enabling factors are present and barriers are absent. However, in clinical practice, several individual, organizational and system-related factors hinder the implementation of VAP bundle elements. The existing evidence demonstrates that healthcare workers' knowledge, staffing levels, workload, institutional support, teamwork and availability of protocols directly influence adherence to VAP prevention guidelines. The most consistently reported determinants of VAP bundle compliance is the level of knowledge among critical care nurses. Several studies have documented inadequate knowledge on VAP bundle elements. Yaseen and Salameh (2015), Darawad et al. (2018), Hussein et al. (2020), and Alkhazali et al. (2021) found that many healthcare providers lacked adequate understanding of evidence-based VAP prevention strategies, resulting in poor adherence to recommended VAP guidelines. These findings suggest that knowledge of each bundle component and its practical application is fundamental for successful implementation. In addition, effective teamwork, communication and multidisciplinary collaboration were identified as essential organizational factors that facilitate adherence to VAP care bundles. Similarly, Fernandes et al. (2018), in a study conducted in India, reported that nurses had a mean knowledge score of only 24.75, which was categorized as very low. The poor performance was primarily attributed to low level knowledge on oral care procedures and ventilator management practices, both of which are critical elements of VAP prevention. The authors concluded that inadequate educational preparation directly contributes to poor compliance with evidence-based VAP prevention measures and recommended continuous professional education for critical care nurses. However, not all empirical studies have established a direct relationship between knowledge and compliance. Kolovwe (2020) and Bankanie et al. (2021) found no statistically significant association between nurses' level of knowledge, years of experience or educational level and adherence to evidence-based VAP guidelines. These findings suggest that although knowledge is key, it may not be sufficient to ensure compliance. The organizational barriers such as poor working environments, inadequate staffing, absence of standardized protocols and limited institutional support may override the positive effects of knowledge and experience. Therefore, improving knowledge alone may not translate into better adherence unless health system constraints are simultaneously addressed.

Workload has also emerged as one of the strongest predictors of compliance with VAP care bundles. High patient loads reduce the time available for nurses to perform all recommended bundle elements consistently. Aloush (2017) demonstrated that intensive care units operating with a nurse-to-patient ratio of 1:1 achieved significantly higher compliance with VAP bundle elements compared to units with ratios of 1:2 or higher. Increased workload was associated with omission of essential preventive interventions due to competing clinical priorities. These findings were consistent with those reported by Alkhazali et al. (2021) and Al-Sayaghi (2021), both of whom concluded that inadequate staffing levels substantially reduce adherence to VAP prevention practices.

In Saudi Arabia, Al-Sayaghi (2021) conducted a cross-sectional study involving 229 critical-care nurses and found an overall mean compliance score of 85.9% with VAP prevention guidelines. Despite generally acceptable

compliance, important barriers to implementation included shortages of nursing staff, forgetfulness during routine clinical practice and hospital cost-control policies. Despite this, adherence to VAP bundle elements remained suboptimal due to inadequate institutional policies, nursing staff shortages and forgetfulness during routine clinical practice. These findings indicate that even well-informed healthcare providers may fail to implement evidence-based interventions consistently when organizational support systems are inadequate.

Within the African context Comparable findings were reported by Alkhazali et al. (2021) in Egypt Jordan, where nurses exhibited adequate knowledge of VAP prevention but identified staffing shortages, lack of institutional support and forgetfulness as the major barriers to compliance. The similarity between findings from Saudi Arabia and Jordan suggests that healthcare system factors rather than individual competency often determine successful implementation of VAP care bundles.

Evidence from Kenya supports these observations. Kolovwe (2020) found that compliance with VAP care bundles was constrained by inadequate critical care resources and insufficient knowledge among nurses. The study emphasized that shortages of essential equipment, inadequate staffing and limited opportunities for continuing professional development negatively affected the consistent implementation of VAP prevention practices. These findings demonstrate that resource limitations remain a major challenge in low- and middle-income countries, where intensive care units frequently operate under constrained healthcare systems.

Across the reviewed studies, a common recommendation is the need for continuous education and institutional support to promote adherence to VAP care bundles. Aloush et al. (2018), Alkhazali et al. (2021), and Bankanie et al. (2021) recommended regular in-service training, competency-based education and refresher courses on VAP prevention practices. In addition, they emphasized the importance of developing standardized clinical protocols, strengthening supervision, improving nurse staffing levels and fostering multidisciplinary teamwork.These interventions are expected to enhance compliance with VAP bundle elements and ultimately reduce the incidence of ventilator-associated pneumonia among critically ill patients.

Generally, the evidence indicates that adherence to VAP care bundles is influenced by both individual and organizational factors. While adequate knowledge is an important prerequisite for compliance, it alone cannot guarantee successful implementation. Organizational barriers such as inadequate staffing, excessive workload, limited resources, absence of clear policies and poor teamwork significantly impede adherence to evidence-based practices. Consequently, healthcare institutions should adopt comprehensive strategies that combine continuous professional education with supportive organizational structures to achieve optimal compliance with VAP care bundles and improve patient outcomes.

III. METHODOLOGY

3.1 Study Design

The study adopted a descriptive cross-sectional design using a quantitative approach and was conducted in critical care units in Bomet and Kericho Counties. This design was considered most suitable because it enabled the collection and quantification of data on factors that promote nurses' adherence to ventilator care bundles in critical care units. The quantitative approach facilitated objective measurement and statistical analysis of variables such as nurses' knowledge, training, professional experience, availability of resources and compliance with the recommended bundle elements. The design was therefore appropriate and practical for addressing the objective of the study.

3.2 Study Setting

This was conducted in four hospitals; Tenwek Mission Hospital only in Bomet County, Siloam hospital (a private hospital), Kericho Referral Hospital (a public hospital) and Litein Mission Hospital the three are in Kericho County. This region was also identified as a hotspot for hospital-acquired infections with VAP rates exceeding the national average. Focusing on these two adjacent counties allows for an in-depth, qualitative exploration of the root causes of implementation failure, providing a foundational evidence base before embarking on a larger, more costly national study.

3.3 Study Population

The study population included: nurses working in intensive care units providing intensive care unit services in study area. *Eligibility Criteria: Inclusion Criteria;* All nurses working in critical care units and all who signed the consent form at selected facilities. *Exclusion Criteria;* Nurses who have worked in CCU for less than 3 months, Nurses on annual leave.

3.4 Sample Size and Sampling Procedure

The study used Sharma et al. (2020) formula of a finite population to determine the sample size of the study.

Sample size required (n)= $\frac{N}{1+N*d^2}$, where **n** - Sample required, **N** - Total population, **d** - Precision or margin of error.

Sample required (n) = $\frac{180}{1+180*0.05^2}$ =124

Sample required was (n) = 124 + 12 (Considering 10% drop of (180) study participants)
Therefore, the sample size of the study was **136** participants/ICU nurses.

3.5 Data Collection Procedures

Data was collected using a structured interviewer-administered questionnaires for nurses in critical care units. Research assistants were trained prior to data collection on study procedures, ethical conduct and tool administration. A pretest was done in the settings and refined accordingly. Data were collected after obtaining permission from relevant authorities and hospital management and securing written informed consent from participants. Study Variables: Dependent Variable was the Nurses' adherence to ventilator care bundles, measured based on factors that promote adherence. While the Independent Variables included; Nurse factors: age, sex, level of training, years of experience, knowledge on care bundles, institutional support

3.6 Data Analysis

The data were entered into Microsoft Excel Spread sheet for windows, which then were coded and cleaned. The data were then exported to Statistical Package for Social Studies (SPSS IBM, 26) for descriptive analysis. Descriptive statistics such as mean, mode, median and standard deviation for demographic data were obtained. Regression analysis were done factors to check for any relationship between nurse years of experience, level of education, nurse ratio, institutional support and adherence to IHI's VAP bundle elements. The results of the analyses were presented in bar graphs, charts and tabulations. Statistical level of significance was set at p = 5%.

3.7 Ethical Considerations

Ethical approval was obtained from relevant institutional review bodies (MMUST/IERC/168/2023) and regulatory authorities (NACOSTI/P/23/27242). Permission to conduct the study was granted by respective Hospitals in both Kericho and Bomet Counties respectively. All participants provided with written informed consent prior to participation. Details of the participants were concealed by serializing and coding the structured questionnaires. All the research tools were accessed only by the researcher and stored under lock and key to ensure their safety. Participation was voluntary and respondents were free to withdraw at any time without penalization.

IV. FINDINGS & DISCUSSION

4.1 Findings

4.1.1 Sociodemographic characteristics of the Nurses.

The information on the respondent's age, hospital, nursing specialization, education level, nursing experience, kind of intensive care unit, and number of ICU hours worked is analyzed in this section. Table 1, is an overview of the demographic characteristics of the respondents.

Table 1

Demographic characteristics of the respondents

		Frequency	Percent
Age	25-30	50	37.3
	31-40	53	39.6
	41-50	18	13.4
	51-60	13	9.7
Gender	Female	70	52.2
	Male	64	47.8
Educational level	Certificate	10	7.5
	Degree	14	10.4
	Diploma	69	51.5
	Higher Diploma	41	30.6
Nursing specialty	Critical care	47	35.1
	Emergency and trauma care nurse	6	4.5
	General nurse	72	53.7
	Pediatric care nursing practitioner	9	6.7
Nursing experience	1-5yrs	48	35.8
	11-15yrs	16	11.9
	16-20yrs	2	1.5
	21-25yrs	12	9.0
	6-10yrs	33	24.6
	Less than a year	23	17.2
Time worked in the ICU	1-5yrs	50	37.3
	11-15yrs	27	20.1
	16-20yrs	21	15.7
	21-25yrs	4	3.0
	6-10yrs	11	8.2
	Less than a year	21	15.7
Working hours per week	1-8hrs	21	15.7
	17-24hrs	15	11.2
	25-32hrs	9	6.7
	32-39hrs	24	17.9
	39-46hrs	37	27.6
	9-16hrs	28	20.9

From Table 1, 60(44.8%) of the respondents were from Tenwek Hospital, 33(24.4%) of the respondents were from Kericho hospital, 20(14.9%) were from Litein hospital, while 21(15.7%) of the respondents were from Siloam hospital. The hospitals (Kericho, Litein, Siloam and Tenwek) comprised of the major hospitals in Kericho and Bomet Counties. In terms of age, 53(39.6%) of the respondents were aged between 31-40 years, 50(37.3%) were aged between 25-30 years, while 18(13.4%) of the respondents were aged between 41-50 years. A small proportion, 13(9.7%), of the respondents were aged between 51-60 years. With reference to gender, majority of the respondents 70(52.2%) were female, while 64(47.8%) of the respondents were male. In terms of educational level, 69(51.5%) of the respondents had attained diploma, 41(30.6%) had higher diploma, 14(10.4%) had attained degree, while 10(7.5%) had certificate as their highest level of education. In terms of specialty of the respondents, 72(53.7%) of the respondents were general nurses, 47(35.1%) were specialized in critical care, 9(6.7%) were pediatric care nursing practitioners, and 6(4.5%) were specialized in emergency and trauma care nursing.

In assessing the nursing experience amongst the respondents, 48(35.8%) had experience of between one and five years, 33(24.6%) 6-10 years, 23(17.2%) less than a year, 16(11.9%) 11-15 years, 12(9.0%) 21-25 years, and 2(1.5%) 16-20 years. Majority of the respondents 72(53.7%) worked in medical surgical ICU type, 31(23.1%) were in medical ICU type, 25(18.7%) were in surgical ICU, and 2(1.5%) worked in cardiac, neonatal, and neurological respectively. In

terms of experience worked in the ICU, 50(37.3%) have worked for 1-5 years, 11(8.2%) had worked for 6-10 years, 27(20.1%) for 11-15 years, 21(15.7%) for 16-20 years, and 4(3.0%) had an experience of 21-25 years working in ICU. In assessing the working hours per week, 37(27.6%) of the respondents worked for 39-46 hours, 28(20.9%) for 9-16 hours, 24(17.9%) for 32-39 hours, 21(15.7) for 1-8 hours, 15(11.2%) for 17-24 hours, and 9(6.7%) for 25-32 hours.

4.1.2 Rankings on strategies applied to implement the VAP bundles of care

Table 2

Rankings on strategies applied to implement the VAP bundles of care

Indicator	N	P.I	Rank
Continuous practice education	116	0.89	1
Training	111	0.88	2
Bedside checklist	75	0.71	3
White boards	36	0.48	4
Online resources	24	0.42	5

Out of 134 respondents; Continuous practice of education of the nurses on adherence on VAP bundles was ranked first (P.I=0.89, N=116), while training of the nurses was ranked second (P.I=0.88, N=111). Besides trainings and education of nurses, bedside checklist (P.I=0.71, N=75), White boards (P.I=0.48, N=36) and use of online services (P.I=0.42, N=24) were ranked third, fourth and fifth respectively.

4.1.3 Assessment on the level of nurses' adherence to ventilator associated pneumonia prevention guidelines in Kericho and Bomet Counties Kenya.

Table 3

Level of Nurses' Adherence to Ventilator Associated Pneumonia Prevention Guidelines, Each Care Bundle

Variable	Yes		NO	
	N	%	n	%
Oral care with Chlorhexidine	104	77.6	30	22.4
Elevation of the Head of Bed Policy/Guideline	124	92.5	10	7.5
Daily Sedation Vacations	76	56.7	58	43.3
Spontaneous Breathing Trials (SBT)	90	67.2	44	32.8
Peptic Ulcer Prophylaxis	101	75.4	33	24.6

At the very top, with near-universal adoption, sits the practice of elevating the head of the bed, with a 92.5% adherence rate for having a policy or guideline in place. Oral care with Chlorhexidine, reported by 77.6% of respondents, represents a shift from a passive policy to an active, repeated nursing task. Unlike elevating the head of the bed, this practice requires a consumable supply, takes time out of a nurse's relentlessly busy schedule and relies on individual prioritization. Peptic ulcer prophylaxis at 75.4%, where a pharmacologic intervention is squarely in the domain of the medical team. While a strong majority of patients appear to be on appropriate prophylaxis, the 24.6% who are not, warrants a deeper look.

The overall average percentage was done by summing up all the percentages levels of the care-bundles and divide by five (total percentages-369.4/5=overall average percentage is 73.8%). The gap between the 92.5% for a passive policy and the 56.7% for an active, challenging intervention like a sedation vacation is the precise space where quality improvement efforts must focus. It is a space not of ignorance, but of human factors of workload, of fear, of ingrained culture and of the daily struggle to apply population-based evidence to the unique, complex and often frightening reality of a single patient in a single bed. The journey to improving these numbers is not about telling clinicians what to do, but about understanding their world and building systems that make the right thing the easiest and safest thing to do.

4.1.4 Regression output on factors that promote nurses' adherence to VAP Care Bundles.

Below is table 4 showing regression model table on factors that promote nurses' adherence to ventilator care bundles in critical care units of Bomet and Kericho Counties Kenya.

Table 4

Regression output on factors that promote nurses' adherence to VAP Care Bundles.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Sig. F Change	
1	.82[a]	.67	.64	.804	.0022	
Variable			**Coefficient (B)**	**Std. error**	**t**	**P value**
Intercept			16.872	4.13	8.48	0.000
Knowledge score			3.18	2.72	4.31	0.001
Attitude			3.94	2.28	3.28	0.016
Years of experience			1.01	2.54	2.36	0.020
Lack of institutional support			5.82	2.01	2.51	0.000
Equipment availability			4.28	2.73	1.32	0.021

The regression model explains 67% of the variation in adherence to VAP prevention guidelines. The results reveal that knowledge, attitude, Years of experience in ICU, institutional support and equipment availability significantly promote adherence among nurses. Each unit increase in knowledge scores increases adherence by 2.72 times, this implies lack of knowledge is a major hindrance. Positive attitude improves adherence (B=2.28), thus a negative attitude is a factor that hinders adherence to VAP guidelines. Each unit increase in years of experience increases adherence by 2.54 times, while the presence of support significantly increases adherence by 2.01. Lastly, adequate availability of equipment's increases adherence to VAP by 2.73 times, implying shortage of medical equipment hinders adherence.

Knowledge was a strong positive predictor ($p=0.001<0.05$), suggesting that nurses with higher knowledge of VAP prevention practices were more compliant with established guidelines. Knowledgeable nurses were more likely to perform interventions such as elevating the head of the bed, practicing oral hygiene, and minimizing ventilator circuit changes. Attitude showed a significant positive relationship with adherence ($p=0.016 < 0.05$). Nurses who held positive attitudes towards infection prevention and patient safety were more likely to follow VAP prevention guidelines consistently. Years of ICU experience had a significant influence ($p=0.0020< 0.05$), indicating that more experienced nurses were better at applying clinical management and procedural adhere in VAP prevention. Experienced nurses often develop better technical skills and situational awareness, leading to improved compliance.

Institutional support emerged as a strong indicator for nurses'' adherence ($p= 0.000< 0.05$). Nurses who reported supportive supervision, adequate staffing, clear infection control practices, and access to training exhibited higher adherence levels. This demonstrates the importance of managerial and environmental factors in sustaining preventive practices. The availability of essential equipment's ($p=0.0021 < 0.005$) was another key factor that hindered the implementation of VAP adherence. Nurses working in well-equipped ICUs were more likely to comply with preventive practices such as oral care with chlorhexidine, use of sterile suction catheters, and maintaining closed suction systems.

4.2 Discussion

According to the study results, over half of the respondents used chlorhexidine and nurses reported 77.6% compliance with oral hygiene therapy. These results are similar to those of Dumbre (2019), who demonstrated that hand hygiene and oral care compliance was higher than 50%. However, Weheida et al. (2022) found that 87.5% of people followed dental and hand hygiene protocols.

In this study, 93.2% of participants complied with head elevation. These results were almost identical to those of a study carried out in Saudi Arabia that found 95.2% of participants complied with head elevation (Al-Harthy et al., 2014). Rello et al. (2013) found a 50% compliance rate with maintaining head height. This was caused by the ICU nurses' lack of VAP bundle adherence training. (Yüksel et al., 2020) also reiterated the significance of HOB elevation, who observed that HOB elevation enhances patient comfort, prevents issues and permits respiratory function. According to Najafi et al. (2017), nurses should use a goniometer to accurately obtain 30-45 degrees HOB elevation. Finally, 56.7% of participants in this experiment complied with daily sedation vacations. When trying to extubate a patient, some nurses said that they were unsure of the important factors to look for. These results are comparable to those of Hellyer et al., who found that very few critical care nurses adhere to the daily assessment of ventilator-dependent patients' preparedness for extubation. In this study, 67.1% of the nurses followed spontaneous breathing trials, whereas 75.4% followed peptic ulcer prevention. Independent studies, however, have shown that observed patients' compliance is lower than what critical care unit nurses claim. According to a study conducted in Greece by Parisi *et al.* (2016), patients receiving therapy did not use preventative measures to prevent peptic ulcers. This indicates that nurses in Kericho and Bomet Counties CCU had to be empowered and instructed on how to comply with VAP treatment regulations.

Adherence to VAP preventative measures is significantly improved by knowledge, attitude, ICU experience, institutional support and the availability of medical equipment. These results are consistent with findings from Saudi

Arabia, where inadequate training and knowledge of VAP-prevention measures were associated with poorer performance, highlighting the importance of comprehensive understanding of VAP prevention bundles (Jalal et al., 2022) and Ali (2013) in Egypt, who found that improving compliance required a thorough comprehension of VAP bundles. Similarly, studies by Aloush *et al*. (2018) showed that nurses' motivation and sense of responsibility were important adherence facilitators. The results also align with those of Aloush *et al*. (2020) in Jordan who found that higher adherence to infection control measures were correlated with years of ICU experience. However, Weheida *et al*. (2022) found that unless institutional training and reinforcement are provided, experience alone might not guarantee compliance. In a similar vein, Khalifa and Eldin (2020) emphasized that ICU nurses who receive organizational assistance are more accountable and continue to grow. Finally, the study's results align with research conducted by Alhumaid *et al*. (2021), who emphasized that the availability of appropriate resources and equipment directly boosts the efficacy of infection prevention. On the other hand, lack of resources usually causes treatments to be delayed.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The study hospitals' nurses were found to be motivated, responsible and knowledgeable about care bundles. However, the results showed that bedside checklists and ongoing practice education were the most popular methods of disseminating information about VAP care bundle adherence; however, it was unclear whether all nurses attended the educational sessions. Despite the presence of adherence-promoting stimuli, daily sedation vacations and spontaneous breathing trials continued to have low adherence. The study findings demonstrate that nurses' adherence to ventilator care bundles in critical care units is influenced by a combination of individual and organizational factors. Key factors promoting adherence include adequate knowledge of ventilator care bundle elements, positive attitudes toward evidence-based practice, experience in intensive care, institutional support and the availability of essential equipment and supplies. These factors collectively enhance nurses' ability to consistently implement recommended interventions aimed at preventing ventilator-associated pneumonia (VAP). Knowledge emerged as a critical determinant of adherence, indicating that nurses who are well informed about ventilator care bundle elements and their clinical significance are more likely to comply with established guidelines. Likewise, positive attitudes toward patient safety and infection prevention encourage nurses to integrate evidence-based practices into routine patient care. Clinical experience also contributes to improved adherence, as experienced nurses possess greater technical competence, clinical judgment, and confidence in managing mechanically ventilated patients.

The findings further underscore the importance of organizational factors in promoting adherence. Institutional support through effective leadership, supportive supervision, adequate staffing, continuous professional education, and the availability of clear clinical protocols creates an enabling environment that facilitates compliance with ventilator care bundles. In addition, the availability of essential equipment and infection prevention supplies enables nurses to implement bundle elements effectively without unnecessary interruptions.

5.2 Recommendations

The administration with the help of critical unit in-charges should adopt Institute of Healthcare Improvement policy guidelines on VAP and sensitize on its components at frequent intervals to keep critical care nurses updated for management of patients in critical care unit as adherence to ventilator care bundles cannot be achieved solely through individual competence; it requires a supportive healthcare system that provides adequate resources, training and organizational commitment to quality improvement. Therefore, healthcare institutions should invest in continuous staff education, strengthen managerial support, maintain adequate nurse-to-patient ratios and ensure availability of essential equipment. Addressing these factors will promote adherence to ventilator care bundles, reduce the incidence of ventilator-associated pneumonia, enhance the quality of critical care services and improve patient outcomes e.g reduce hospital length of stay.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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