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EFFECT OF SENSITIZING PROGRAM ON COMPLIANCE TO MODIFIED EVIDENCE-BASED VAP BUNDLE PRACTICES ON VENTILATOR ASSOCIATED PNEUMONIA AMONG THE PATIENTS ON MECHANICAL VENTILATORS

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Abstract

Background: Ventilator-associated pneumonia (VAP) is one of the leading concerns of intensivists.
Aim: It is critical that healthcare professionals follow the best evidence-based interventions that are both cost-effective and preventive in order to deliver high-quality care and decrease costs, morbidity, and mortality among ICU patients. The purpose of this study was to assess the efficacy of compliance with a modified evidence-based VAP bundle in reducing the incidence of ventilator-associated pneumonia.
Methods: For a period of 6 months (3 months before and 3 months after the implementation of the intervention), a prospective cohort interventional trial on modified evidence-based VAP bundle care) with 390 patients (180 patients in the pre-implementation group and 210 patients in the post-implementation group for 3 months) was undertaken in adult critical care units. Ventilator-associated pneumonia infection rates were expressed as incidence rates. The data on compliance with the modified evidence-based VAP bundle was collected using a structured checklist.
Results: The study results revealed a significant improvement mean rank of compliance of nurses to the modified bundle components. The VAP rate significantly decreased from 6.7 to 0.8/1000 at p0.01 in the post-implementation period, with the 'Z' value of 16.14 ($p<0.001$) in the post-implementation group (280.8) compared to the pre-implementation group (95.99).
Conclusion: VAP rates were significantly reduced when all the elements of the modified VAP bundle of care were strictly followed. Auditing adherence to the care bundle is a useful strategy for improving the outcome. The Hospital infection control committees (HICC) should not only adopt cost-effective care packages but also audit the adherence to each element as standard operating practice.

Key Words: Ventilator-Associated Pneumonia, VAP bundle care, Mechanical ventilator, Sensitizing program, Critical care unit, Compliance

Introduction:

The employment of cutting-edge methods and medical equipment for life support is a distinctive feature of critical care units. When the oropharynx and trachea are compromised by endotracheal intubation, oral and stomach secretions can enter the lower airways and cause ventilator-associated pneumonia (VAP). The development of VAP has been linked to both micro aspiration and translocation of microorganisms from the mouth into the respiratory system[(1)]. According to estimates, 9 to 27% of patients who are mechanically ventilated experience VAP[(2)]. Depending on the environment and diagnostic criteria, VAP incidences might range from 5 to 40%. Beyond mortality, VAP consequently increases the length of ICU stays and incremental expenditures[(3)]. For every 1,000 days spent on a ventilator, the International Nosocomial Infection Prevention Consortium (INICC) recorded 13.6 incidences of VAP worldwide. Based on demographics and hospital settings, the incidence rate varies from 13 to 51 per 1,000 ventilation days[(4)], and infections like Pseudomonas and Acinetobacter cause more fatalities[(5)].

The VAP rate has been acknowledged as one of the quality indicators by the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Joint Commission on International Accreditation (JCIA) and expressed their appreciation for the decline in the VAP rate. The majority of hospitals are therefore under pressure to lower VAP rates by implementing standardized IHI (Institute of Health Care Improvement) recommended VAP bundle care, which calls for the simultaneous usage of the bundle's components such as elevating the head of the bed, taking daily sedative breaks, preventing peptic ulcers, and preventing deep vein thrombosis (DVT), daily oral care with chlorhexidine aimed at achieving noticeably greater results than when carried done separately[(6)]. The entire quality of healthcare services is heavily influenced by nurses[(7)]. Preventative measures and the nursing staff's skills in nursing care are crucial factors in lowering the likelihood of issues. In the critical care unit, complex observation and therapy must be provided in addition to high-intensity intervention and continuous monitoring[(8)]. A concern needs to be raised about nursing innovations in VAP prevention in patients on a ventilator.

VAP still complicates the course of 8 to 28% of patients receiving mechanical breathing despite significant advancements in technology and the application of effective-based procedures and has challenged the efforts to achieve the aim of a 0% VAP rate. Instead, the definitions are interpreted in different ways and had reported lower VAP rates, which could ban underestimation [(9)]. The healthcare system would benefit from strict adherence to the optimal cost-effective preventative strategy and its application might even be global. The VAP bundle's success and ongoing teaching programs, as well as practitioner adherence to the bundle guidelines, depend on teamwork between nurses and doctors [(10)]. Nurses' understanding of infection prevention and appropriate nursing care may make it more difficult for patients to adhere to evidence-based recommendations for preventing ventilator-associated pneumonia [(11)]. Regularly it is important to undertake interactive educational sessions and formal training sessions to gauge key personnel's proficiency with the VAP bundle, particularly in light of the high nurse turnover rate [(12)]. The technology for measuring and monitoring the ETT cuff has been a sign of optimism for nurses' future advancement when considering VAP management as a part of a technology-based innovation plan for nurses. Steps towards knowledge generalization include education, information exchange, and the introduction of innovations [(13,14)]. Nursing innovation interventions have been found to increase the efficiency of nurses' work in past studies [(15)].

In studies with the greatest reduction in VAP, the "IHI Ventilator Bundle" was utilized along with adequate endotracheal tube pressure in the cuff and subglottic suctioning. The ideal approach should combine multidisciplinary actions with comprehensive educational initiatives and measures of the bundle's compliance [(16)]. As a result, the investigator considered it necessary to contribute to raising the bundle components' compliance rate and to significantly reduce the occurrence of VAP through ongoing educational initiatives.

Problem Statement

An Evaluative Study to Determine the Effectiveness of Sensitizing Program on Compliance to Modified Evidence-Based VAP Bundle Practices on Ventilator Associated Pneumonia among the Patients on Mechanical Ventilator at Selected Tertiary Care Center, Chennai, India.

Objectives

1. To compare nurses' compliance scores on the modified VAP bundle during pre and post-implementation period.
2. To evaluate the impact of the sensitizing program on the adoption of modified, evidence-based VAP bundle practices for the treatment of ventilator-associated pneumonia.

Material and Methods Research Design

A quantitative evaluative approach and a prospective cohort interventional study with a quasi-experimental design using a non-equivalent control group were done to determine the incidence of VAP during a six-month period in a multidisciplinary intensive care units at two tertiary care centers.

Population and Sampling

About 390 patients on mechanical ventilators (180 patients were treated before implementation, and 210 patients were treated after implementation) utilizing a non-probability consecutive sampling technique, were chosen. Based on the Cohen d table considering α - 0.05, β- 0.80 and an expected effect size of 0.5, the required sample size of nurses was 64. About 135 registered critical care nurses were enrolled in the study.

Criteria for Sample Selection

Patients' Inclusion Criteria

• Patients using a mechanical ventilator for more than 48 hours
• Patients who never had pneumonia signs and symptoms
• Patients who are not receiving end-of-life care
• Patients' Exclusion Criteria
• Patients receiving ventilation with high-frequency oscillation
• Patients who underwent endotracheal intubation outside of the chosen location.

All licensed qualified nursing professionals with a degree or diploma who were on-site during the data-collecting period and had sufficient exposure to and experience in caring for patients on mechanical ventilators for longer than six months are considered to be qualified were included in the study.

Ethical considerations

After receiving approval and setting from the institutional ethics committee, the study was carried out. All study participants provided their informed permission and the researcher made clear that participation was entirely voluntary. They were also ensured of the anonymity and confidentiality of their responses.

Development of data collection instruments

The tools used in this study were background parameters, the clinical characteristics proforma for patients using mechanical ventilation, observation audit checklist on modified evidence-based VAP bundle, and Score for Clinical Pulmonary Infection (CPIS)[17]. The content validity as obtained from the field experts. The reliability of the observational audit checklist was tested by average intra-rater agreement (r = 0.43) and for CPIS checked by Cronbach's alpha (α= 0.757).

Data Collection Procedure

Tools were predetermined and pretested used to collect data on background parameters and clinical characteristics of CCU patients admitted during the six-month pre-implementation period. The practice of nurses regarding the IHI recommended VAP bundle and VAP rate was audited during the consecutive first three months of the pre-implementation period. The infection control nurse and unit nurse managers received training in auditing the VAP bundle of care. Following clearance from the infection control and critical care teams, the VAP bundle of care was updated to include specific evidence-based procedures, in addition to the IHI VAP bundle such as meticulous oral care with 2% chlorhexidine, hand hygiene, Q_4H ryles tube aspiration, subglottic suctioning and checking and maintaining cuff pressure (20 - 30cm of H_2O). Then a sensitizing program was meticulously planned and organized on the importance of a modified evidence-based VAP bundle for three weeks in 3 batches (three days per batch) covering all the shift nurses, through power point presentations, lectures, and demonstrations. Each session lasted for 1 hour. After the sensitizing program, the practice of nurses regarding modified evidence-based VAP bundle and VAP rate was audited during the postimplementation of three months. The gathered information was arranged for analysis. The infection control nurse, unit nurse managers, and researchers evaluated the components through on-site observation, records, equipment use, and routine patient evaluations.

STATISTICAL ANALYSIS

The incidence rate of VAP was calculated by the formula

$$\text{VAP rate} = \frac{\text{No. of VAP cases}}{\text{No. of Ventilator days}} \times 1000$$

In order to analyze the data, SPSS version 20.0 was used.

- Descriptive statistics, which include frequency, percentage, mean, and standard deviation.
- • Mann Whitney U test in inferential statistics was used to assess the effectiveness of the Sensitizing Program on Compliance to Modified Evidence-Based VAP Bundle Practices among nursing professionals.
- Linear Regression model to find the correlation between the compliance score of modified VAP bundle and CPIS

RESULTS Percentage Distribution of Background and the Patients' Clinical Parameters

The table1 shows the mean age, BMI, GCS, and ventilator days did not significantly differ from one another, APACHE II score considering the mortality rate of the study's participants both before and after the intervention period. The majority of them were males and moderatelevel workers and similar with respect to alcoholism in both the groups (table.2). The reason for admission and intubation did not vary in both group except for increased reason of cardiorespiratory problems following implementation. The majority of them were intubated orally and both groups were homogenous with respect to the presence of co-morbidities, an accident history, hospitalization, an infection, and previous antibiotic use except for the increased percentage of patients on antibiotics post-implementation group (table.3).

Table.1. Homogeneity of the Continuous Variables of Patients Using Mechanical Ventilators in Pre- and Post-Implementation Groups

Variables	Pre-Implementation group (n=180)		Post-Implementation group (n=210)		Mean difference	"t"	'p' value
	Mean	SD	Mean	SD			
Age	56.8	15.9	58.00	15.26	1.18	0.75	0.45
Height in cm	163.1	6.79	162.4	6.46	0.70	1.05	0.29
Weight in kg	67.6	10.7	67.9	13.6	0.32	0.25	0.79
BMI	25.3	4.3	35.5	14.9	10.2	0.96	0.33

GCS	7	3.1	7	3.5	0.29	0.87	0.38
Ventilator days	5.7	4.2	5.9	3.31	0.14	0.37	0.38
APACHE II score	21.70	7.67	21.74	6.93	0.04	0.05	0.95
Mortality rate	42.08	22.49	42.66	20.79	0.57	0.26	0.79
CPIS	2.92	2.06	2.1	1.27	0.817	4.76	**0.0001**

Table.2. Frequency and Percentage Distribution of Patient Mechanical Ventilator Patients' Demographics in the Pre- and Post-Implementation Groups

Background Parameters	**Pre Implementation group (n= 180)**		**Post-Implementation group (n=210)**		**χ^2 value**	**'p' value**
	f	%	f	%		
Gender					2.059	0.357
Male	121	87.2	136	64.8		
Female	58	32.8	74	35.2		
Nature of work					6.73	0.034
Sedentary	66	36.7	80	42.9		
Moderate	100	55.6	115	54.8		
Heavy	14	7.8	5	2.4		
Habit of smoking					**16.3**	**0.003**
Yes	15	8.5	3	1.4		
No	165	91.5	207	98.4		
Habit of alcoholism					5.11	0.163
Yes	36	20	30	18.6		
No	144	80	171	81.4		

Table.3. Frequency and Percentage Clinical Variables of Patients on Mechanical Ventilators Distributed Between Pre- and Post-Implementation Groups

Clinical Parameters	**Pre – implementation group (n= 180)**		**Postimplementation group (n=210)**		**χ^2 value**	**P value**
	f	**%**	**f**	**%**		
Primary Diagnosis					4.62	0.46
Respiratory Disorder	43	23.9	55	26.2		
Cardiovascular disorder	12	6.7	16	7.6		
Neurological Disorder	52	28.9	69	32.9		
Gastrointestinal disorder	19	10.6	25	11.9		
Others	54	30	45	21.4		
Reason for intubation					**18.45**	**0.018**
Neuromuscular Disorder	65	36.2	72	34.3		
Musculoskeletal Disorder	3	1.7	8	3.8		
Cardiorespiratory disorder	82	45.6	115	54.8		
Anesthesia	13	7.2	11	5.2		
Others	17	17	4	1.9		
Type of intubation					1.32	0.724
Oral	147	81.7	174	82.9		
Tracheostomy	32	17.8	34	16.2		
Nasal	1	0.6	2	1		
Presence of Comorbidities						
Coronary artery disease	32	17.8	52	24.8	2.79	0.09
Diabetes Mellitus	56	31.1	96	45.7	8.69	**0.003**
Hypertension	64	35.6	105	50	8.23	**0.04**
Respiratory disorder	14	7.8	26	12.4	2.23	0.13

Thyroid disorder	5	3.3	12	5.7	2.39	0.30
Cancer	28	15.6	25	11.9	1.10	0.29
Immune disorder	4	2.2	7	3.3	0.43	0.50
Renal disorder	18	10	20	9.5	0.25	0.87
Treatment for co-morbid illness	64	35.6	120	90	18.12	**0.001**
History of accident	22	12.2	17	8.1	1.83	0.17
History of infection within previous six months	4	2.2	4	1.9	0.04	0.82
Previous hospitalization in the past six months	21	11.7	14	6.7	2.96	0.08
Past use of antibiotics over the previous six months.	22	12.2	14	6.7	4.37	0.112
Receiving antibiotic	148	82.2	172	81.9	0.007	**0.93**

Incidence of VAP

Patients on mechanical ventilators experienced a substantial drop-in VAP rate from 6.7/1000 ventilator days in the pre-implementation group to 0.8/1000 ventilator days in the post-implementation group at $p<0.01$ (table.4) as recorded. Table 1 also represents the postimplementation period represented a large decrease in CPIS as well.

Table.4. Comparison of VAP Rate in both pre- and post-implementation group

The Groups	VAP incidence	Total vent days	VAP Rate/1000 days	95% CI of VAE rate		'Z' value 'p' value
				Lower	Upper	
Preimplementation group (n=180)	7	1039	6.7	0.001	0.01	2.411 P=0.015
Postimplementation group (n= 210)	1	2561	0.8			

Comparison of Compliance Scores of Nurses on Modified VAP Bundle in both before and after the implementation period

The compliance score significantly improved in the post-implementation phase following the sensitizing program (table.5). With a Z value of 16.149 ($p<0.001$), the overall total mean rank of all the components indicated a considerable improvement in the post-implementation group (280.8) vs the pre-implementation group (95.99).

Table.5. Comparison of Practice Scores of Nurses on Evidence-Based Modified VAP Bundle in Critical Care Unit for Pre- Implementation and Post- Implementation Group of Patients

Correlation and regression between compliance to modified bundle components and Clinical Pulmonary Infection Score.

The regression table 6 projects there was no significant impact caused by each component of the evidence-based modified VAP bundle individually on the Clinical Pulmonary Infection Score. But there was a significant impact on CPIS when considered as a whole comprehensive bundle with F value of 21.25 at $P<0.001$. It is also evident from fig.1 that the CPIS score decreased with the increase in the compliance score.

Components	Pre-Implementation Group (n=180)	Post-Implementation Group (n=210)	"U"	"Z"	'p' value
	The mean rank	The mean rank			
Elevation of head end	179.56	209.16	21769	3.360	P<0.001
Meticulous Oral care	185.47	204.1	20706	1.68	P=0.083

Q_4H					
Sedation vacation	94.50	262.07	37080	18.554	P<0.001
Peptic Ulcer Prophylaxis	197.83	193.50	18480	2.169	P<0.001
Deep vein Thrombosis Prophylaxis	197.83	193.50	18480	2.169	P<0.05
Hand Hygiene	101.34	276.20	35848	15.629	P<0.001
Ryles tube aspiration Q_4H	94.57	262.01	37068	17.383	P<0.001
Subglottic suctioning	94.17	282.36	37140	18.053	P<0.001
Endotracheal cuff pressure monitoring	97.90	279.24	36485	17.313	P<0.001
Total	95.99	280.8	36812	16.149	P<0.001

Table.6. Regression Between Clinical Pulmonary Infection Score and Evidence Based Modified VAP Bundle Components

Components	**Coefficients**		**'t' value**	**'p' value**
	B	**β**		
Constant	4.15		4.38	0.000
Elevation of head end	1.33	1.44	1.39	0.16
Meticulous Oral care	-0.23	-0.123	0.71	0.47
Sedation vacation	-.010	-0.053	0.34	0.73
Peptic Ulcer Prophylaxis	-0.049	0.087	0.557	0.57
Deep vein Thrombosis Prophylaxis	-1.4	-1.57	1.53	0.13
Hand Hygiene	-0.005	-0.003	0.02	0.98
Ryles tube aspiration	-0.28	0.176	1.51	0.13
Subglottic suctioning	-0.34	0.186	1.53	0.12
Endotracheal cuff pressure monitoring	-0.24	0.162	1.22	0.22
Total	**-0.06**	**-0.22**	**4.61**	**0.000**

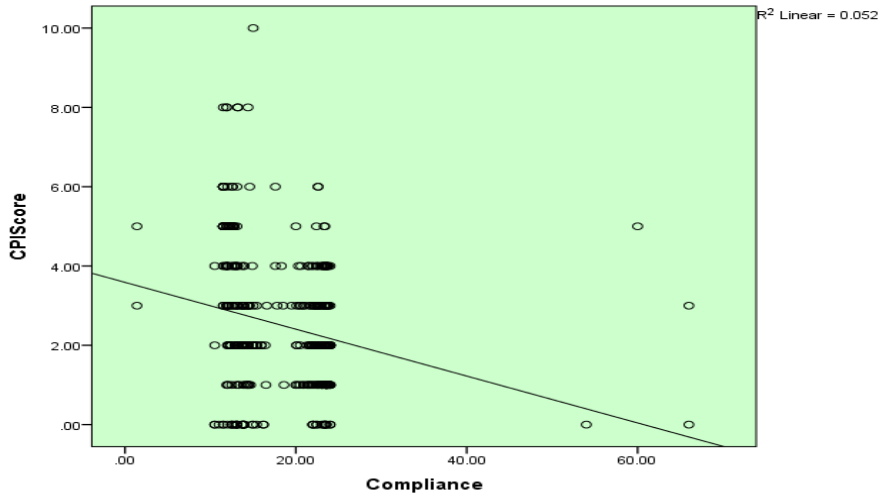

Fig. 1. Regression between CPI Score and Compliance Score of CCU Nurses to Evidence-Based Modified VAP Bundle Discussion

In our investigation, there was not a noticeable distinction in the mean age, BMI, GCS, ventilator days, APACHE II score, and the patients on mechanical ventilators death rate included during the preliminary implementation, and post-implementation period. About onethird of patients were with the diagnosis of neurological disease. Half of the patients were intubated orally for a cardio-respiratory issue in the pre-implementation and postimplementation groups, respectively. These findings were corroborative by the data of a national campaign on VAP bundle implementation in Belgian intensive care units where the chief reason for intubation is hypoxia [(18)].

The prevalence of comorbidity and other risk variables that are thought to contribute to the inability to wean off of cardiovascular illness contributed to the development of VAP and the need for a mechanical ventilator, diabetes mellitus, hypertension, respiratory disorder, thyroid disorder, cancer, immunological disorders, and renal disorders, history of trauma treated with antibiotics for infection within previous six months between the patient groups that received the intervention before and after. The aforementioned findings are consistent with data from using prospective cohort research, identical risk variables were found to be the cause of the weaning trials' failure, including all the cases examined had recent pulmonary and/or extrapulmonary infections, most of them had disturbances in trace elements and electrolytes, few had endocrine disturbances in the form of hypothyroidism, nutritional deficiency and few had other co-morbid issues such as hepatic or renal impairment [19].

In the pre-implementation period, 7/180 patients developed ventilator-associated pneumonia (VAP). According to the IHI standard, successful implementation of bundle care requires more than 95% compliance in each item to provide maximum preventative effects, the compliance rate in the pre-implementation period was unacceptable [20]. The study's conclusions suggested that a program for VAP prevention in ICUs be created and put into effect. Therefore, continuous education and encouraging healthcare professionals' cooperation with bundle care remains crucial. Moreover, the results also project the necessity of a revised protocol for the prevention of VAP. In the post-implementation group, only 1 out of 210 patients on mechanical ventilators experienced VAP. The VAP rate significantly dropped in the group after adoption. The findings supported Dorothy's investigation of the effect of ventilator-associated pneumonia (VAP) bundle adherence, which revealed a drop from 10.2 cases per 1000 ventilator days to 3.4 cases per 1000 ventilator days. The trial's compliance with the VAP bundle revealed an increase in each individual SICU, ranging from 53% and 63% to 91% and 81% [21].

The results above show that the nurses should be consistently and adequately encouraged or reinforced for adhering to the approved criteria in order to accomplish the desired goal of stopping nosocomial infection. It is crucial to regularly conduct frequent educational programs to support and increase nurses' knowledge and expertise [22]. To increase nurses' level of expertise and raise the standard of nursing care, evidence-based recommendations for providing intubated patients with treatment in intensive care units must be implemented and disseminated [23].

The mean rank of compliance ratings significantly increased during the postimplementation period. Oral care for people who are seriously ill was difficult for patients with oral or facial injuries. The improvement in the practice score was comparatively higher related to components such as sedation vacation, subglottic suctioning, and cuff pressure monitoring. The study findings were congruent with a study by Amanda et al [24], after the sensitizing program, the compliance score of the nurses significantly increased for each of the modified VAP bundle's components, including bed head elevation, insufficient fluid in the ventilator circuit, oral hygiene, and cuff pressure. Similar findings were observed in the Belgian investigation that the cuff pressure measurement increased from 27% to 90% and head posture increased from 54% to more than 90% and subglottic increased from 5.8% to 24.7% [18].

A meta-analysis that comprised 13 randomized controlled studies represents endotracheal tubes with dorsal subglottic suction adapters that have been demonstrated to lower VAP rates by draining the secretions just above the cuff opening lumen, found an overall risk reduction of 0.55 with the utilization of the procedure [26]. It is apparent from the study results it is necessary to frequently check and keep the cuff pressure on the endotracheal tube within the recommended range (25-35 cm H_2O) at least once every four hours to prevent inflation that is both too low and too high. A deviation from pressure on the cuff is caused by pathophysiological conditions, environmental changes, and changes in body position. Ventilator-associated pneumonia is brought on by contaminated secretions that move through an under-inflated cuff and aspirate into the lungs through creases that are created. Excessive inflation limits proper perfusion, which results in ischemia and tissue damage and increases pressure on the tracheal mucosa [27].

In our study, the regression analysis reveals there was no significant impact caused by each component separately on the Clinical Pulmonary Infection Score. But there was a significant impact on CPIS when considered as a whole comprehensive bundle and the CPIS score decreased with the increase in the nurses' compliance score. The results compared with a similar study also showed DVT prophylaxis and sedation breaks had no significant impact on ventilator-associated events (VAE) whereas stress ulcer prophylaxis trended toward an increased risk of VAE [28].

The study's findings strongly suggest that encouraging and supporting nurses to apply their knowledge into practice, adopting acceptable guidelines for evidence-based practice requirements for revision of the protocol, and providing nurses with training on the updated strategies for VAP prevention measures are crucial in order to significantly reduce the prevalence of ventilator-associated pneumonia over the long term. These findings are in line with a related study in which the incidence of ventilator-associated pneumonia was statistically similar before and after intervention, but adherence to ventilator care bundle items was considerably higher [29]. Further, Narang reported that the introduction of the concept of a "ventilator bundle" significantly reduced the incidence of VAP by 24.2% and 12% among the surgical patients and medical group respectively [30].

Continued nursing education and timely regular feedback are important for maintaining a low VAP rate. The study's findings also showed that implementing the evidence-based modified VAP bundle by itself had no effect on VAP. However, VAP didn't considerably decline until daily compliance with each part of the evidence-based modified VAP bundle was audited and carers received monthly feedback. This implies that efforts to lower VAP may only be effective in environments with high levels of compliance with all the bundle aspects and ongoing, stringent supervision [31]. In order to achieve the consistent objective of zero VAP, the researcher suggests that frequent reminders of the importance of the bundle components and ongoing, rigorous inspection of the nurses' compliance may be more beneficial than education.

The findings of this study duplicate study on the knowledge of nurses working in an intensive care unit about ventilator-associated complications and their prevention. Nurses' awareness of VAP problems and their prevention increased during the post-test [32].

Similar efforts were described by Joiner et al [33] regarding the multidisciplinary quality improvement team revised protocol to close the gap between current and best care. The incidence of VAP dropped dramatically from 26 to 16 VAP cases per 1000 ventilator days after the improved strategy was implemented.

A similar experience was described in another study conducted by Hawe et al [34] in Scotland, where after implementation of the VAP bundle through education, feedback, and daily goal-setting, compliance improved from 0% to 54% and VAP rates decreased radically from 19.17 to 7.5 cases per 1000 ventilator days. Another study found that the daily goal-round patients' incidence of VAP was 67% lower than the pre-goal-round patients among trauma patients [35]. Further, VAP prevention strategies were educated to healthcare workers in a medical intensive care unit, the median composite score across the study dramatically increased and the rate of VAP decreased [36] . Similarly, during a national campaign, the VAP rate decreased [18] . Also, VAP episodes were reduced in ventilated neonates, Pinnilla et al [37] . In a prospective cohort study [38] conducted among mechanically ventilated neurosurgical patients, the occurrence rate of VAP was significantly reduced in the cohort group compared to the control group.

Previous studies also reported the effectiveness of comprehensive training programs in improving the knowledge of nurses in hospital-acquired infection control among ICU nurses[39]. This implies that strict surveillance and high levels of compliance with all the bundle elements are necessary for the efforts to reduce VAP to be successful [31]. This demonstrated that consistent training initiatives can enhance the expertise of nursing professionals.

Conclusion

The above study results emphasize the significance of consistent and ongoing education and feedback. The study recognizes that strict adherence to each element of the evidence-based modified

VAP bundle, frequent audits, and monthly feedback is more effective in consistently achieving zero VAP.

Limitations

The study's rigor could not be increased by conducting a randomized trial. There was no real control group in the study. The details regarding staff structure were omitted because the change in staff structure was insignificant during the study period and did not have a significant enough impact on the study's findings.

Recommendations

- Similar study can be done as randomized control trials
- The study can be conducted for a longer period of one or two 2 years to assess the sustainability of the results.
- The VAP bundle can be customized to the patients according to their reason for mechanical ventilators and other clinical characteristics.

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Conflict of Interest: Nil

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Author's contribution

SD designed the study, SD and LSB collected data, ASA analysed the data and SD drafted the manuscript. LSB and ASA participated in manuscript revision and contributed to data interpretation. All the authors agreed on the final version of this article.

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