Effect of Implementing Modified Bundle of Care on Early Detection and Prevention of Ventilators Associated Pneumonia

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Abstract

Background*:* Critically ill patients with mechanical ventilator frequently experience ventilator associated pneumonia, which has devastating effects such as prolongation of mechanical ventilation, increase length of hospital stay, and increase mortality rate. **Aim of study** to evaluate the effect of implementing modified bundle of care on early detection and prevention of ventilator associated pneumonia in intensive care unit. Design**:** Quasi-experimental research design. **Setting:** Anesthesia Intensive Care Unit, Traumatology and Emergency Medicine Intensive Care Unit of Emergency hospital affiliated to Tanta University hospital. **Subjects:** A convenience sampling of 60 adult critically ill patients who admitted to the selected setting and divided into two equal groups; 30 patients in each (control and study groups). **Tools: three tools were used, Tool I:** Mechanically Ventilated Patients Assessment, tool **II** Four Score Level of Consciousness Scale and **tool III** Indicators of Ventilator associated pneumonia Assessment **Results:** A highly significant difference was detected between the study and control groups regarding VAP incidence after applying modified ventilator bundle which (P=0.000). The incidence of VAP was 76.67% in the control group compared with only 23.33% in study group after the 7th day of intervention with significant differences in which (P=0.00). **Conclusion:** Applying modified ventilator bundle had beneficial effect on preventing and decrease the incidence of VAP. **Recommendation:** modified ventilator bundle should be incorporated as a part of routine care of ventilated patients in ICU.

Key words: Early detection, Modified ventilator bundle, Prevention, Ventilator associated pneumonia

Introduction

Mechanical ventilation is often applied to critically ill patients in intensive care unit (ICU) which can result in various complications and bring substantial risks**. (Le Pape et al .,2022).** Ventilator associated pneumonia (VAP)

is recognized as a major problem worldwide and common healthcare associated infection among mechanical ventilated patients. It considers one of the most leading causes of death among patients in Intensive Care Unit **(Papazian et al., 2020).**

Ventilator associated pneumonia defined as type of infection which affect negatively on lung parenchyma in patients after invasive mechanical ventilation within 48–72 hours of admission. Centers for Disease Control and Prevention (CDC) update the definition of ventilator associated pneumonia to any condition that is associated with a decline in oxygenation and consider it type of ventilator associated event (VAE)**(Liu et al.,2020; Cillóniz et al., 2021).**

Modified bundle of care which is a series of interventions developed by the institute for healthcare improvement related to ventilator care that when implemented together will achieve significantly better outcomes than when implemented individually **(Amin, M et al., 2023).**The application of this bundle has a great effect in reduced the incidence of VAP, decreased the risk of reintubation, improved weaning strategies, and optimized patient recovery **(Emone et al.,2019; Klompas et al.,2022).**

Modified bundle of care consist of several steps integrated with each other includes hand hygiene before and after intubation procedure and patient contact, elevation head of the bed 30-45%, ventilator circuit care (High-level sterilization and storage of the ventilator tubing), endotracheal suctioning care,

oral care with cholorhixdine solution every 8 hrs, checking the residual gastric content before feeding ,early mobilization and keeping tracheostomy or endotracheal tube cannula balloon pressure at 20 to 30 cm H_2O, manually monitored and adjusted cuff pressure every 4 hours **(Triamvisit et al .,2021; Benjamin &Alqarni,2023).**

Critical Nurses have a key role in respiratory care and they responsible for implementing most of the VAP prevention strategies. They directly influence patient care and its outcomes **(Al-Sayaghi, 2021).** The nurses must compliance with modified ventilator bundle to achieve better outcome and less VAP incidence for patients **(Sekihara et al., 2023).**

Significance of the study

Mechanically ventilated patients are exposed to ventilator associated pneumonia which associated a major consequence as prolongation of mechanical ventilation use, increase length of hospital stay, prognosis of patients is very poor and difficult and the mortality rate very high. It considers one of the most leading causes of death among patients in Intensive Care Unit with incidence rate 38.4% among mechanical ventilated patient at Tanta University Hospitals (2019). Applying modified bundle of care can be a suitable intervention to control and prevent the danger of ventilator associated pneumonia. there is a few studies supported this points so that this study aimed to early detection and prevention of ventilator associated pneumonia which can achieved by

applying modified bundle of care **(Oznur et al.,2020).**

The aim of this study was to:

Evaluate the effect of implementing modified bundle of care on early detection and prevention of ventilator associated pneumonia in Intensive Care Unit.

Research hypotheses: -

Mechanically ventilated patients who will undergo to modified bundle of care are exhibit lower incidence of ventilator associated pneumonia compered to control group

Subjects and Method

Design: - A quasi experimental design.

Study settings: -

Anesthesia Intensive Care Unit and Traumatology and Emergency Medicine Intensive Care Unit in Tanta Emergency Hospital.

Study subjects: -

A Purposive sampling of (60) adult patients from the previously mentioned setting who fulfilling the inclusion and exclusion criteria will be assigned based on Epi-Info software statistical program according to the total population admitted per year to the intensive care unit and undergo endotracheal intubation (200),and the sample size will be calculated as the following

Z= confidence level 95%, d= Error proportion (0.05), P= population (40%).

Inclusion criteria of selection of subjects:

- Adult patients 21 to 60 years.

- Both sex.

- Newly intubated patient at the first 24-48 hours

- Having no prior signs and symptoms of pneumonia, no contraindication for head of bed elevation.

-Exclusion Criteria:

- Patients with neuromuscular disease

- Patient who transferred from another hospital's ICU

- Continuous sedation

- Patients who have cervical spine injuries

The sample was divided into two equal groups 30 patients in each as follows;

Group I: Control group consisted of 30 patients fulfilling the same inclusion criteria and received the routine nursing care introduced in the intensive care unit which includes (Elevation head of bed 30º-45º, Endotracheal suctioning only when indicated, oral care with 0.12% cholorhixdine).

Group II: Study group consisted of 30 patients fulfilling the inclusion criteria and received modified bundle of care for 7 consecutive days as following: Elevation head of the bed 30º-45º monitor the residual gastric content Securing the ETT, hand hygiene, Oral care by 0.12% cholorhixdine solution Endotracheal suctioning care maintenance of endotracheal tube pressure at 25–30 cm of H2O and monitoring every 4 hours ,early mobilization and cough augmentation techniques ,ventilator circuit care and daily sedation interruption .

Study tools:

Three tools were used in this study:-

Tool I: Mechanically Ventilated Patients Assessment Tool:-

This tool was developed by the researcher after reviewing the related

literature **(Besnard et al.,2022; Kharel & Bist ,2021; Emonet et al.,2019; Branson et al.,2022).**It included three parts as follows:-

Part (a) Patient's Demographic characteristics which included:-

Age, patient code, sex and gender

Part (b) Patient's clinical data which included:- patient current diagnosis, past medical, surgical history, history of smoking, prior antibiotic exposure, current medication, and type of sedation medication.

Part(c) Ventilator Parameter Assessment:-

To assess ventilator mode, Fraction inspired oxygen (fio$_2$), positive end expiratory pressure (peep), tidal volume, respiratory rate and peak inspiratory pressure, frequency of ventilator circuit filter change, type of intubation, and ETT cuff pressure.

Tool II: Four Score Level of Consciousness Scale: - .

This scale was developed by **Wijdicks et al., (2005)** to assess the patient's conscious level. It was used to assess critically ill patients who have undergone intubation and the scale includes the following 4 parameters: - (Eye responses, Motor responses Brainstem reflexes and Respiration)

Scorning system: -

The total point of four score was 16, each item of four domains eye response, motor response, brain stem reflexes, and respiration assessed scored 0–4 marks, 0 being for the worst, and four being the best. The total score range between 0 and 16

Tool III: Ventilator Associated Pneumonia Assessment. This tool consisted of two parts as follow:

Part (a):- Richmond Agitation-Sedation Scale (RASS). The scale was developed by **Sessler et al., (2002)** and is used for assessing arousal and guide sedation therapy to assess readiness for extubation

Scoring system

The RASS is a 10-point scale ranging from -5 to +4.

- Levels of sedation from -1 to -5
- Levels of agitation from +1 to +4
- RASS level 0 is "alert and calm." [8]

Part (b): - Indicators of Ventilator associated pneumonia Assessment

This part was developed by the researcher after review related literature **(Basyigit et al.,2017; Cawcutt et al.,2022).**

It was used to assess the indicators of VAP as the following: -

Clinical manifestations assessment as (Heart rate, body temperature, o2 saturation)

Laboratory investigation as (WBS count, microbiological culture results, arterial Blood Gases)

-Assess tracheal secretion volume and character and gastric residual volume

-Assessment presences of adventitious breathing sound as (Rales, wheezing, rhonchi)

Scoring system:

The scores of the items were summed-up and the total was divided by the number of the items, giving a mean score; means and standard deviations and it was computed**.**

Administrative process:

An Official Permission was obtained from the responsible authorities at the Faculty of Nursing, Tanta University to the director of the intensive Care Unit emergency hospital in Tanta University Hospital.

Informed consent:

An informed consent was obtained from the patient family to participate in the study after explaining the purpose of the study and confidentiality of collected data was preserved and assuring them of confidentiality of collected data.

Ethical consideration:

-An ethical consideration for the privacy and confidentiality of the data and results was concluded and explained to the patient the right to withdraw at any time of the study.

Approval of ethical committee was obtained from the faculty of nursing With Code number (127/11/22) & faculty of medicine (36103/11/22) to conduct the study.

Tools development:

The study tool (I) and tool (III) were developed by the researcher after review of the relevant literatures **(Besnard et al.,2022; Kharel & Bist ,2021; Emonet et al.,2019; Branson et al.,2022; Cawcutt et al.,2022)**, Tool (II) was developed by **Wijdicks** et al., (2005), Tool(III) part (A) was developed by Sessler **et al., (2002)**

Validity of the tools

Content validity:

The developed tools were tested for content validity and clarity of questionnaire by five experts in the Critical care and Emergency Nursing

and accordingly needed modifications were done, it was valid

Reliability

Reliability of the tool

- Reliability of the developed tool I part was tested by using alpha Cronbachs factor and it was 0.826

- Reliability of Four scale for conscious level assessment was the Interclass correlation coefficients (ICC) for all four scores 0.76   95% confidence intervals (CI 0.67–0.84) **(Miller et al .,2019)**

- Reliability of RASS score for sedation level assessment was the Interclass correlation coefficients (ICC) for all four scores 0.96 -95% confidence intervals (CI 0.92 - 1.0) **(Dias et al .,2020)**

- Reliability of the developed tool III part (B) tested by using alpha Cronbachs factor and it was 0.881.

A pilot study:

It was conducted before the actual study on (10%) of the patients, to test the clarity, feasibility; relevance and applicability of the different items of the tools, accordingly needed modifications were done before the main study. The pilot study was excluded from the original study subject.

Data collection

-Data were collected over a period of 6 months, started from March 2023 to August 2023.

-Nursing Intervention modified VAP bundle was conducted on four phases as follows:

A- Assessment Phase:

- A primary assessment was done on the first day for all patients to determine

which patient met the inclusion criteria of the study.

- Assessment of patient demographic data, clinical history and ventilator data was obtained by the researcher through assessment by using the developed tool I part (A, B and C).

- Assessment level of consciousness was done using tool II on admission, 3rd and 7th day for study group and routine care for control group.

- Assessment effect of sedation and readiness for extubation was done by using tool III part (A) on admission, 3rd and 7th day for study group and routine care for control group.

- Assessment occurrence of ventilator associated pneumonia was done by using tool II part (B) on admission, 3rd and 7th day.

B-Planning Phase

The modified ventilator bundle was prepared based on the study subjects' needs assessments and literature review **(Miller et al., 2019; Zangirolami et al., 2020)** regarding improving the patient outcomes.

- The researcher prepared the important supplies such as cuff manometer, 0.12% cholorhixdine , tongue depressor, suction catheter, ventilator filter , 50cc catheter tip syringe

Expected Outcomes of this study:

-       Improve patients physiological parameters and enhance early extubation

- Decrease the incidence of ventilator associated pneumonia

C- Implementation Phase:

Group I (control group):

It was received the routine nursing care introduced in the intensive care unit which includes:

- Elevation head of bed 30º-45º, endotracheal suctioning only when indicated and oral care with 0.12% cholorhixdine.

Group II (Study Group)

-In this phase the modified ventilator bundle was carried out by the researcher for the study subjects throughout the following nine steps from the time of admission till seven consecutive days (1 week) after intubation in morning and afternoon shift. The content of bundle item was applied consequently.

1-Hand hygiene pre/post patient contact

2- Elevation head of the bed: -

-Patient was maintained in a semirecumbent position with head of the patient's bed was elevated 30-45 degree

3- Endotracheal suctioning: -

- Suction was applied only when patient needs it, abnormal breath sounds, visual secretions in the artificial airway, high peak pressure on ventilator and a saw tooth pattern on the ventilator waveform are indicators for suctioning as the following steps: -

- Hyper oxygenation before suction until patient oxygen saturation raised above 90% by provide 100% O2 on the ventilator.

- Suction pressure was kept below 200 mm Hg for a maximum of 15

- Hyper oxygenation after suction until patient's oxygen saturation raised above 90% by provided 100% O2

4- Oral care palate every 8 hrs: -

-After compilation of suction an oral care was performed as the following: -

- Assessment of oral cavity was done by Inspect top, sides and undersurface of tongue. Assess lips, back of throat and mucous membranes for any bleeding, odor, discharge or evidence of skin breakdown or ulceration
- Removed any denture then small amount of chlorhexidine 0.12% was putted in a cup
- Rolled tongue depressor with 4 X 4 gauze, and soaked in chlorhexidine solution and crubbed long teeth, tongue and gum line using small circular motion
- Repeated the steps until the mouth became clean and antifungal ointment was applied

5-Monitoring of Gastric Residual Volumes every six hours: -

- Attached 50cc syringe to naso gastric tube then negative aspiration applied
- If residual volume was < 125 ml, feeding was resumed as normal patient schedule
- If residual volume was >250ml, it was returned to patient and next feeding held until the residual return to less than 125 ml

6- Cuff pressure Maintenance: -

- Endotracheal tube cuff pressure checked every four hours by cuff manometer to maintained between 20-30cmh2o.
- The manometer attached to the syringe cuff inflated valve in pilot balloon, this will move the indicator to the actual cuff pressure.
- IF pressure more than 30 cmh2o, it was deflated by using syringe.
- IF pressure less than 20 cmh2o, it inflated was by using sphygmanometer part

7- Early mobilization

Patient level of activity was assessed based on the level of consciousness:

-If patient was unconscious the passive exercise was followed.

- The exercise divided into limb exercise (upper and lower) and chest exercise

Flexion-extension movements for both limbs upper and lower extremities.

- **Chest exercise included** cough augmentation technique as precaution

8-Ventilator circuit care

- Water condensation in ventilator circuit was drained and was discarded periodically at least every 8 hours or whenever it was collected.
- Bacterial filter was changed every day morning

9- Daily sedation interruption and daily assessment of readiness to extubate

- If patient on sedation , it was interrupted early in the morning shift and patient was assessed for readiness for weaning after physician order

D- Evaluation Phase :

After implementation of modified bundle of care, the researcher carried out a comparison between both groups to determine the effect of modified bundle of care on prevention of VAP among patients in intensive care unit and used tool II and III three times on admission, 3rd and 7th day.

Results

Table (1): Percentage distribution of the studied patients according to their demographic characteristics, clinical and ventilator data (n=60)

It was noticed that more than half (53.33%) of the studied patients in

control group compared to nearly one-third (30.00 %) of the studied patients in the study group were in the age group between (50-60) years old with the mean age of 47.70±9.259 and 41.57±11.924 years respectively.

As regard to gender, it was observed that one-half (50%) of the studied patients in the control group were male compared to (63.33%) in the study group.

Concerning current diagnosis, it was reported that less than one quarter (20.00%) and more than one-third (36.67) of studied patients of both control and study groups had cerebrovascular accidents respectively. **Additionally,** the same percentage (26.67%) in both control and study groups had polytrauma. Moreover, near to one third (30.00%, 26.67%) of patients in control and study groups had post-operative disorders respectively.

In **regard to past medical history,** it was noticed that the most common comorbid disease (46.67%, 33.33%) both control and study groups was diabetic and on antidiabetic medication respectively.

It was observed that more than one half **(**56.67%) and nearly half (46.67%) of patients in both control and study groups were on SIMV mode respectively, Moreover, the majority (86.67%) both control and study groups were intubated via ETT.

Table (2): Percentage distribution of the studied patients according to their total four score throughout the periods of study (n=60)

There were no significant differences among control and study groups regarding their total four score on admission and 3rd day. **While a** significant difference was observed between the both groups on 7th day post intervention in which **P=0.019***

Table (3): Mean scores of vital signs of the studied patients throughout periods of study (n=60)

It was found that; mean scores of heart rate in the control group was increased from admission to 7th day without significant difference. Also, there was a significant increase in mean scores of heart rate of study group but within normal range from admission to 7th day of study.

Also it was observed that, mean score of temperature among patients in the control group significantly increased from admission to 7th day with a strong significant difference at **P=0.000,** On the other hand**,** the mean temperature score among patients in the study group relatively stable from admission to 7th day respectively.

Additionally, it was found that there was a significant decrease in O_2 saturation among patients in the control group from admission to the 7th day with **P= 0.000***compared to a significant increase of O_2 saturation from admission to 7th day among studied patients in the study group with **P= 0.017*.**

Table (4): Percentage distribution of the studied patients regarding chest assessment throughout the period of study (n=60)

This table clarified that, the majority (83.33%, 80.00%, 86.67%) among

control group had small, thin and clear respectively secretion respectively on admission, while on 7th day near to half and more (56.67%,46.67%) had abundant and thick secretion respectively and more than third of them (40.00%) had cloudy secretion with significant difference **P= 0.000*.**

On the other hand, more than half of study group (60.00%) had small secretion and the vast majority of them (96,67%) had thin and clear secretion on admission on7th day high percentage of patients (86.67%,73.33%,76.67%) still had small, thin and clear secretion respectively .

Moreover, the majority of patients among both control and study group (90.00%, 83.33%) had normal breathing sounds on admission. while, on 7th day near to half (43.33%) of patient in control group had crackles or rhonchi breathing sound with significant difference with **P=0.000*** compared to only one quarter (26.67%) in study group.

Table (5): Percent distribution and mean score of the studied patients regarding VAP indicators throughout periods of study (n=60).

This table revealed that there was a significant difference between control and study regarding microbiological culture where P=**0.001*, 0.000*** on 3rd and 7th day of study respectively.

Also this table showed that, there was significant increase in mean score of WBC from on admission on 7th day among control group with **P=0.000*** .While, the mean score in study group was increased but within normal range from with significant difference

between control and study groups with P level=**0.000*** on 3rd and 7th day

Also, It was noticed that there was a significant increase of mean score of gastric residual volume of control group with statistical significant difference between control and study groups regarding total gastric residual volume on 7th day after intervention at P level=**0.017***

Concerning mean score of endotracheal

It was noticed that there was a strong significant difference between both study and control groups related to mean score of endotracheal tube cuff pressure on admission, 3rd and 7th day with **P 0.000*.**

Table (6) Percent distribution of the studied patients regarding occurrence of VAP throughout periods of study (n=60)

It was illustrated that, the incidence of VAP was higher in the control group (60.00%,76.67%) than the study group (16.67%,23.33%) on 3rd and 7th day post implementation of modified VAP bundle with significant differences were observed between two groups with P= **0.001*, 0.000*** on 3rd and 7th day.

Table (7) Relation between demographic characteristics and current diagnose of the studied patients and VAP incidence throughout the period of study (n=60)

It was noticed that, more than one third (36.67%) and near to one quarter (20.00%) of VAP patients in control group were in age group (40<50) and (50<60) years old respectively, versus (16.67%) among patients who had VAP in study group aged between (50-60)

years old group with significant relation between age and VAP occurrence among study group with P = 0.022*. **Additionally,** it was concluded that, nearly half (43.33%) of VAP patients in control group were male compared to only (16.67%) in study group without significant relation between gender and VAP incidence. **Moreover,** the most common diagnose of patients who had VAP in control group was polytruma (23.33%) while, most patients who had VAP in study group was diagnosed as cerebrovascular accident (10.00%)

Table (1): Percentage distribution of the studied patients according to their demographic characteristics, clinical and ventilator data (n=60)

Characteristics	The studied patients (n=60)				χ^2 P
	Control group (n=30)		Study group (n=30)		
	N	%	N	%	
Age (in years)					
(21-<30)	3	10.00	7	23.33	0.274 0.600
(30-<40)	3	10.00	6	20.00	
(40-<50)	8	26.67	8	26.67	
(50-60)	16	53.33	9	30.00	
Range	(26-58)		(22-58)		t=1.225
Mean ± SD	47.70±9.259		41.57±11.924		P=0.230
Gender					
Male	15	50.00	19	63.33	FE
Female	15	50.00	11	36.67	0.435
Current diagnosis					
Acute respiratory distress syndrome	2	6.67	1	3.33	3.148 0.533
Poly trauma	8	26.67	8	26.67	
Acute respiratory failure	5	16.67	2	6.67	
Post-operative disorder	9	30.00	8	26.67	
Cerebrovascular accident	6	20.00	11	36.67	
Past medical history					
Respiratory diseases	1	3.33	0	0.00	4.110 0.128
Heart diseases	7	23.33	7	23.33	
Renal diseases	2	6.67	2	6.67	
Hepatic failure	1	3.33	0	0.00	
Neurological diseases	1	3.33	0	0.00	
Diabetic	10	33.33	14	46.67	
Cancer	3	10.00	5	16.67	
Mode of ventilator					
AC	4	13.33	5	16.67	0.601 0.740
CPAP	9	30.00	11	36.67	
SIMV	17	56.67	4	46.67	
Type of intubation					
ETT	26	86.67	26	86.67	FE
Tracheostomy	4	13.33	4	13.33	1.00

Table (2): Percenta4ge distribution of the studied patients according to their total four score throughout the periods of study (n=60)

Level of Consciousness	The studied patients (n=60)													
	Control group (n=30)						χ² P	Study group (n=30)						χ² P
	On admission		At 3rd day		At 7th day			On admission		At 3rd day		At 7th day		
	N	%	N	%	N	%		N	%	N	%	N	%	
Unconscious	14	46.67	10	33.33	9	30.00	5.027 0.285	10	33.33	7	23.33	6	20.00	8.086 **0.044***
Semi -conscious	16	53.33	17	56.67	17	56.67		16	53.33	14	46.67	10	33.33	
Full conscious	0	0.00	3	10.00	4	13.33		4	13.33	9	30.00	14	46.67	
Range **Mean ± SD**	**(1-12)** 7.80±3.295		**(3-13)** 9.27±2.677		**(1-13)** 9.23±3.540		F=2.065 P=0.133	**(4-13)** 9.27±3.084		**(4-13)** 10.07±3.051		**(3-13)** 11.63±3.489		F=1.369 P=0.261
Control Vs Study **χ² , P**	4.667 , 0.097		3.820 , 0.148		**7.970 , 0.019***									

(0-8) Unconscious   (9-12) Semi- conscious   (13-16) Full conscious *
Statistically significant at level P<0.05

Table (3): Mean scores of vital signs of the studied patients throughout periods of study (n=60)

Vital Signs	The studied patients (n=60) Range Mean ± SD							
	Control group (n=30)			F P	Study group (n=30)			F P
	On admission	At 3rd day	At 7th day		On Admission	At 3rd day	At 7th day	
Heart rate	(66-112) 90.40±13.10	(77-127) 105.07±14.14	(70-132) 110.00±15.75	1.010 0.368	(66-110) 87.27±12.54	(68-166) 94.17±23.79	(62-130) 91.50±18.84	**15.096** **0.000***
Temperature	(36.3-38.0) 37.10±0.44	(36.9-39.0) 38.00±0.73	(36.8-39.3) 38.36±0.77	**28.815** **0.000***	(36.7-37.8) 37.173±0.34	(36.5-38.5) 37.243±0.54	(36.5-39.0) 37.41±0.73	1.410 0.250
Oxygen saturation	(80-99) 92.77±3.63	(80-95) 88.27±3.63	(70-96) 83.60±7.37	**23.449** **0.000***	(80-99) 93.80±5.14	(83-100) 94.60±3.87	(90-100) 95.73±2.36	**12.809** **0.017***

* Statistically significant at level P<0.05

Table (4): Percentage distribution of the studied patients regarding chest assessment throughout the period of study (n=60)

Chest assessment	The studied patients (n=60)													
	Control group (n=30)						χ^2 P	Study group (n=30)						χ^2 P
	On Admission		At 3rd day		At 7th day			On admission		At 3rd day		At 7th day		
	N	%	N	%	N	%		N	%	N	%	N	%	
1.Secretion amount Small Abundant Abundant, purulent	25 5 0	83.33 16.67 0.00	9 21 0	30.00 70.00 0.00	6 17 7	20.00 56.67 23.33	**39.324** **0.000***	18 11 1	60.00 36.67 3.33	19 10 1	63.33 33.33 3.33	26 4 0	86.67 13.33 0.00	6.250 0.181
2.Consistency ▪ Thin ▪ Thick ▪ Sticky	24 6 0	80.00 20.00 0.00	11 17 2	36.67 56.67 6.67	7 14 9	23.33 46.67 30.00	**28.711** **0.000***	29 1 0	96.67 3.33 0.00	21 8 1	70.00 26.67 3.33	22 6 2	73.33 20.00 6.67	8.783 0.067
3.Color ▪ Clear ▪ Cloudy ▪ Yellow ▪ Green	26 4 0 0	86.67 13.33 0.00 0.00	9 13 7 1	30.00 43.33 23.33 3.33	7 12 3 8	23.33 40.00 10.00 26.67	**40.673** **0.000***	29 1 0 0	96.67 3.33 0.00 0.00	25 5 0 0	83.33 16.67 0.00 0.00	23 5 2 0	76.67 16.67 6.67 0.00	7.636 0.106
4.Respiratory breath sound ▪ Normal ▪ Crackles or rhonchi ▪ Wheezing	27 3 0	90.00 10.00 0.00	2 21 7	6.67 70.00 23.33	7 13 10	23.33 43.33 33.33	**51.650** **0.000***	25 5 0	83.33 16.67 0.00	18 12 0	60.00 40.00 0.00	21 8 1	70.00 26.67 3.33	6.116 0.191

 * Statistically significant at level P<0.05

Table (5): Percent distribution and mean score of the studied patients regarding VAP indicators throughout periods of study (n=60).

Laboratory investigation	The studied patients (n=60)													
	Control group (n=30)						χ^2 P	Study group (n=30)						χ^2 P
	On admission		At 3rd day		At 7th day			On Admission		At 3rd day		At 7th day		
	N	%	N	%	N	%		N	%	N	%	N	%	
Microbiological culture Negative Positive	30 0	100.00 0.00	12 18	40.00 60.00	7 23	23.33 76.67	**39.333 0.000***	30 0	100.00 0.00	25 5	83.33 16.67	23 7	76.67 23.33	**7.500 0.024***
Control Vs **Study** χ^2 , **P**	-		**FE , 0.001***		**FE , 0.000***									
WBC count (×10^3) Range Mean ± SD	(4.63-11.80) 7.77±1.93		(6.25-15.34) 10.95±2.45		(5.11-21.50) 14.19±4.94		**F=27.101 P=0.000***	(4.68-10.20) 7.70±1.46		(4.88-20.00) 9.69±4.44		(5.30-12.60) 8.37±2.21		**F=3.476 P=0.035***
Control Vs **Study** **t , P**	0.166 , 0.869		**4.195 , 0.000***		**3.708 , 0.000***									
Gastric Residual Volume monitoring	(0-120) 31.67±35.02		(0-150) 66.83±40.74		(0-220) 88.17±54.23		**12.574 0.000***	(0-200) 33.33±40.03		(0-240) 47.50±72.62		(0-230) 45.83±68.63		0.466 0.629
Control Vs **Study** **t** **P**	0.172 0.864		1.441 0.155		**2.458 0.017***									
Endo tracheal tube cuff pressure monitoring	(14-80) 40.59±18.70		(10-74) 44.16±20.44		(11-92) 42.93±22.14		0.236 0.790	(20-30) 25.27±3.69		(17-31) 24.41±3.19		(16-30) 24.33±3.56		0.665 0.517
Control Vs **Study** **t** **P**	**4.309 0.000***		**5.230 0.000***		**4.678 0.000***									

Table (6) Percent distribution of the studied patients regarding occurrence of VAP throughout periods of study (n=60)

	The studied patients (n=60)													
	Control group (n=30)						χ^2 P	Study group (n=30)						χ^2 P
	On admission		At 3rd day		At 7th day			On admission		At 3rd day		At 7th day		
	N	%	N	%	N	%		N	%	N	%	N	%	
Not VAP	30	100.00	12	40.00	7	23.33	**39.333**	30	100.00	25	83.33	23	76.67	**7.500**
VAP	0	0.00	18	60.00	23	76.67	**0.000***	0	0.00	5	16.67	7	23.33	**0.024***
Control Vs Study χ^2 **, P**	-		FE , 0.001*		FE , 0.000*									

Table (7) Relation between demographic characteristics and current diagnose of the studied patients and VAP incidence throughout the period of study (n=60)

Characteristics	The studied patients (n=60) VAP incidence							
	Control group (n=30)				Study group (n=30)			
	Not VAP		VAP		Not VAP		VAP	
	N	%	N	%	N	%	N	%
Age (in years)								
(21-<30)	0	0.00	3	10.00	5	16.67	2	6.67
(30-<40)	0	0.00	3	10.00	6	20.00	0	0.00
(40-<50)	2	6.67	6	20.00	8	26.67	0	0.00
(50-60)	5	16.67	11	36.67	4	13.33	5	16.67
F , P	2.39 , 0.49				**9.59 , 0.022***			
Gender								
Male	5	16.67	13	43.33	14	46.67	5	16.67
Female	2	6.67	10	33.33	9	30.00	2	6.67
t , P	FE , 0.39				FE , 1.00			
Current diagnosis								
Acute respiratory distress syndrome	0	0.00	2	6.67	1	3.33	0	0.00
Poly trauma	1	3.33	7	23.33	7	23.33	1	3.33
Acute respiratory failure	1	3.33	4	13.33	1	3.33	1	3.33
Post-surgery	3	10.00	6	20.00	6	20.00	2	6.67
Cerebral accidents	2	6.67	4	13.33	8	26.67	3	10.00
F , P	2.47 , 0.65				1.73 , 0.78			

Discussion

Ventilator-associated pneumonia (VAP) remains one of the most common infections in patients requiring invasive mechanical ventilation **(Papazian et al., 2020).** The current study hypothesized that mechanically ventilated patients who will undergo to modified bundle of care are exhibit lower incidence of

VAP compered to control group.

As regard patients' demographic data, the finding of the present study revealed that more than half of patients in the control group and one third of patients in the study group aged between (50-60) years old. This may be attributed to that increased in age associated with chronic diseases, long-term malnutrition, lowering their immune function and making them more vulnerable to incidence of VAP than young individuals **(Kepekci, 2020)** This may be attributed to that increased in age associated with chronic diseases, lowering immune function and making them more vulnerable to VAP than young individuals **(Kepekci, 2020).** This finding was in agreement with **Baidya et al.,(2021)** who found that the majority of studied patients were in the age group between (50 to 60) years**.** On the other hand, this finding was contradicted by result of study which investigated the effect of evidence based guidelines for prevention of Ventilator-associated Pneumonia, and revealed that the majority of studied patients were in the middle age group **(Cheema& Rao, 2019**)

Also the present study showed that, half of the studied patients in control group and more than half in study group were male with no significant difference between both

groups regarding their demographic characteristics.

 This result was supported by **Battaglini et al., (2023) ; Charles et al., (2023)** who revealed that more than half of subjects in study group and nearly half of patient in control group were male without any significant difference between both groups regarding their socio demographic. Incontrast, those findings were disagreed with **Dongol et al., (2021)** who illustrated that more than half of the studied patients were female**.**

Concerning medical diagnosis, the most common diagnosis for admission in ICU for both study and control groups in current study were cerebrovascular accidents, polytrauma and post-operative disorder. This could attribute to that the setting of data collection were mainly specialized to receive complicated cases as cerebrovascular accidents, traumatized patients and others diagnosis**.** This could attribute to that the setting of data collection were mainly specialized to receive complicated cases as cerebrovascular accidents, traumatized patients and others diagnosis**.** This result was in the same line with **Akbiyik et al., (2021)** who reported that more than third of studied patient had cerebrovascular accident followed by one quarter of post- traumatic patients .On the other hand, those findings were contradicted by **Nisar et al., (2023)** who reported that more than half of studied patient had respiratory disorder specially lobber pneumonia

As regard to past medical and medication history, the current study showed that the most common comorbid disease among studied patients of control and study groups

had diabetes mellitus and on antidiabetic medication. This may be attributed that large number of studied patient were elderly and had chronic diseases especially cardiovascular and metabolic disorders that increased risk for development of diabetes mellitus. This may be attributed that large number of studied patient were elderly and had chronic diseases especially cardiovascular and metabolic disorders that increased risk for development of diabetes mellitus.

Natarajan & Sistla, (2022) supported this result and concluded more than one third of studied patients had diabetes and on insulin therapy. On the other hand, those findings were contradicted with **Steen et al., (2021)** who reported that the majority of studied patient had pulmonary disease, followed by peripheral vascular disease.

In concerns of mechanical ventilator mode, the result of the current study presented that SIMV mode was the most common mode used for nearly half of studied patient in both control and study group. This result was conformity with a study conducted by **Maes et al., (2021)** who found that SIMV mode used in two third of studied patient .**Conversely,** most of the studied patients in **Carpio& Mora, (2023)** study were on assist control mode and all studied patient were intubated via tracheostomy.

As related to total score of four scale, the present study showed a significant differences among study and control groups regarding their total four scale score on the 7th day after applying modified ventilator bundle. These findings may be due effect of applying modified ventilator bundle which composed of several steps that improve conscious level as spontaneous breathing trial, daily sedation vacation and early mobilization **(Alkhazali et al., 2021).** These findings may be due effect of applying modified ventilator bundle which composed of several steps that improve conscious level as spontaneous breathing trial, daily sedation vacation and early mobilization **(Alkhazali et al., 2021).**

This result was in the same line with the study which illustrated that total four scale score significant differences between studied groups at end of study with improvement in conscious level in study group (**Eweas et al., 2022**) On the other hand, **Hassan& Elsaman, (2022)** study contradicted to the current study findings and concluded that no significant differences was observed among study and control groups regarding their total four

Concerning mean score of vital sings, the current study represented increased mean score of heart rate and significant increased in body temperature among patient in control group compared with study group on 7th day . This might attributed to that increasing in heart rate and temperature is a primary indicator for infection **(Danasu et al., 2019).** This might be attributed to that increasing in heart rate and temperature is a primary indicator for infection **(Danasu et al., 2019).** These findings were consistent with research by **Momenzadeh et al., (2023)** which showed that the mean score of heart rate and body temperature in control group was increased than among patients in study group at the end of study period.

However, these findings inconsistent with **Niu et al., (2022)** study who found that the mean score of heart rate and body temperature remain close to normal range among patients of both control and study groups throughout study period.

In relation to O₂ saturation, the present study revealed that mean of O2 saturation significantly decreased among control group compared to significant improved in O₂ saturation among patients in study group This might be related to that modified ventilator bundle included suction by correct technique which result in improved breath sounds, decreased secretions, and improved oxygen saturation **(Jalal et al., 2022)..** This might be related to that modified ventilator bundle included suction by correct technique which result in improved breath sounds, decreased secretions, and improved oxygen saturation **(Jalal et al., 2022).**

These findings were in the same line with **Elrefaey& Zidan, (2020) and Awad et al., (2022)** study which stated that O₂ saturation significantly improved among the intervention group using ventilator bundle versus significant deterioration in control group. However, **Sepahyar et al., (2021)** study contradicted with present study which found there were no difference or improvement in O₂ saturation among both control and study groups.

Regarding chest assessment in studied patients, the current study illustrated that there was a significant change in more than half patients among control group related to tracheal secretion from small, thin and clear secretion on admission to abundant, sticky and cloudy secretion on the 7th day of study.

This might be due to most cases who had VAP the amount and consistency of secretion changed from clear and small amount to abundant and sticky or thick secretion **(Rizk et al., 2022).** This might be due to most cases who had VAP the amount and consistency of secretion changed from clear and small amount to abundant and sticky or thick secretion **(Rizk et al.,2022).**

These results were consistent with **Abdelaziz et al., (2020)** who concluded that the amount of tracheal secretion increased to abundant and sticky secretion at 7th day of study among the control group. While **Rahimibashar et al., (2020)** was inconsistent with theses result which reported that the amount of tracheal secretion was small in amount without increased or significant change among studied patients.

Respiratory breath sound, it was notified that breathing sounds significantly changed from clear to wheezy chest sound among third of patients in control group versus small percentage in study group on 7th day post intervention

Our finding matched with **Sherburne et al., (2022)** study who stated that around half of studied patient in the control group had wheezy chest sound. Other studies by **Kaur et al., (2022); Huynh & Abdeen, (2023)** reported that nearly to one third of control group had wheezy chest sound.

As regard to VAP indicators

The current findings revealed that there was a significant increase in WBC count mean control group, while the mean of WBC count was within normal rang among study group, with a significant difference among

both control and study group on 3rd and 7th day. The suggested reason for these findings that increased WBC count in control group is an important immune response that indicates the presences of infection **(Nanao et al.,2021)** .However ,normal WBC count in intervention group may be related applying modified ventilator bundle. The suggested reason for these findings that increased WBC count in control group is an important immune response that indicates the presences of infection **(Nanao et al.,2021)** .However ,normal WBC count in intervention group may be related applying modified ventilator bundle

Abdelaleem et al., (2021) study supported the same findings which reported that WBC count significantly increased among the studied patients in the control group compered to intervention group. On the other hand, **Werner et al., (2022)** contradicted with these findings which concluded that the change in the WBC count was slightly between both control and intervention group without significant difference

Microbiological culture, the present study found that the percentage of positive culture significantly increased on 7th day in control group with significant difference between both groups on 3rd and 7th day **p=0.000*.**

Findings were in the same line with many study which used the modified ventilator bundle to prevent and decrease the incidence of VAP as in **Chai et al., (2022); Eweas et al., (2021); Buterakos et al., (2022) and Albin et al.,(2022)** which concluded that the percentage of positive microbiological

culture increased in the control group more than study group with significant difference.

Gastric residual volume, the present study showed that the gastric residual volume significantly increased among patients in control group compared to minimal change among study group with highly significant difference among both control and study groups on 7th day post intervention person awake. The suggested reason for these findings is that the gastric intolerance GRV>250 cc may increase risk of vomiting ,aspiration and incidence of VAP and based on modified ventilator bundle gastric residual volume for patient in study group checked every six hours and returned if >250ml , while the control group not received this intervention .The suggested reason for these findings is that the gastric intolerance GRV>250 cc may increase risk of vomiting ,aspiration and incidence of VAP and based on modified ventilator bundle gastric residual volume for patient in study group checked every six hours and returned if >250ml , while the control group not received this intervention.

This result was in concordance with **Barkhordari et al., (2022)** study who concluded a significant increase in residual volume among control group with significant difference between both groups. On the contrary, **Wang et al., (2019)** reported that gastric residual volume significantly increased for both control and study groups and increased risk for VAP.

Concerning endotracheal tube cuff pressure, the findings of the current study clarified that endotracheal cuff pressure reading was maintained in normal rang

among patients in study group while exceeded than normal range among patients in control group with highly significant differences among both groups on 3rd and 7th day

This result was supported by **Marjanovic et al.,(2021)** who found that the endotracheal cuff pressure reading were within normal rang 20-30cmh$_2$o among the intervention group compared with the control group. However, **Nazari et al., (2020)** study illustrated that more than half of patients among control group had normal endotracheal tube cuff pressure within 20-30cmh$_2$o versus only less than one quarter among study group. **Regarding occurrence of VAP,** the present study found that the incidence of VAP was higher in the control group than the study groups on 7th day post implementation of modified ventilator. These findings were in the same line with many study which used the modified ventilator bundle to prevent and decrease the incidence of VAP as in **Chai et al., (2022); Eweas et al.,(2021); Buterakos et al.,(2022) and Albin et al.,(2022)** which concluded that the percentage of positive VAP cases increased in the control group more than study group with significant difference.

Relation between demographic characteristics and current diagnose of the studied patients and VAP incidence

The current study indicated that elderly people were liable to acquire VAP than young people patients in control and study groups with significant relation between old age and VAP occurrence among study group**.**

Several studies that examined the risk factors for VAP found that old age was strongly associated with the occurrence of VAP **(Tuteja et al., 2022;Hou et al.,2019).**In contrast to our findings, **Robba et al .,(2020)** concluded that individuals who acquired VAP were younger with age less than 40 years old.

The current study showed that, the common gender among VAP patients in both control and study groups were. This is consistent with **Thapa et al., (2023)** study who discussed gender variation and incidence of VAP and revealed that male had a higher incidence of VAP more than female. Versusly, **Belay et al., (2022)** showed that females were more likely to develop VAP than male.

Moreover, the present study illustrated that the common diagnosis among VAP patients in control group was poly trauma while, common diagnosis among VAP patients in study group was cerebrovascular accident.

These findings in agreement with **Vacheron et al., (2022)** study which showed that the cerebrovascular accident increase risk for VAP incidence. On the other hand, **Battaglia & Hale, (2019)** study illustrated that critically ill patients with cancer were more risk for VAP in there study due to their often immunocompromised state.

Conclusions

Based on the results of the present study, it can be concluded that applying modified ventilator bundle had beneficial effect on preventing and decreasing incidences of ventilator associated pneumonia among study group compared to the control group.

Recommendations

1- Upon completion of this study, it can be recommended that:

1. For nurses

1- Modified ventilator bundle should incorporated as a part of routine care of ventilated patients in ICU

2- Design comprehensive checklist to improve nurses' compliance with modified ventilator bundle to prevent VAP

2. For education and training

1- Nursing curriculums should be involved a special course about VAP and its prevention bundle.

2- Development of in-service training programs for ICU nurses to improve their knowledge and practice regarding VAP prevention bundle

3. For research

1- Replication of the study on large probability sample in different hospitals in order to generalize the result.

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