Application of Modified Ventilator Bundle and Its Effect on Weaning and Ventilation Days among Critical Ill Patients

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ABSTRACT

Context: Modified ventilator bundle is the group of interventions supported by evidence to prevent ventilator-associated pneumonia and other related complications that commonly occurred in mechanically ventilated patients. Furthermore, it helps in reducing the mortality rates and hospital length of stay.

Aim: The current study aimed to apply a modified ventilator bundle and evaluate its effect on weaning and ventilation days among critically ill patients.

Methods: A quasi-experimental research (study/control group) design was utilized. This study was conducted at the following critical care units (surgical, medical, and cardiac care units) affiliated to Bani Suief University Hospital in Bani Suief city, Egypt. A Purposive sample of 100 mechanically ventilated patients was divided into two groups. The study group included patients who received a modified ventilator bundle, while the control group included patients who received routine hospital nursing care. Data collection tools included two tools. The first tool is a patient assessment record, and the second tool is the weaning process assessment checklists using burns wean assessment program score.

Results: 68.0% of the study group, compared with only (40.0%) of the control group, had a shorter duration of mechanical ventilation support between (4- 6) days with mean ± SD of 6.1 ± 1.6 and 7.3 ± 1.9, respectively after modified bundle implementation with statistical significance differences (p-value 0.005). The study group of patients obtained higher weaning scores than the control group according to burns weaning scores.

Conclusion: The study group demonstrated higher weaning scores and shorter ventilation support duration than the control group. Developing a simplified and comprehensive training associated with demonstrative booklet, including information about ventilator-associated pneumonia, components of modified ventilator bundle, and its importance for ventilated patients to improve nurses' knowledge and practice. Furthermore, replicating the current study on a larger probability sample from different geographical locations to generalize results.

Keywords: Modified ventilator bundle, weaning, ventilation days

1. Introduction

Mechanical ventilation (MV) has become the most commonly used mode of life support among critically ill patients in medicine today. Although MV is a life-saving intervention, it can produce many complications, some of which may be life-threatening as ventilator-associated pneumonia (VAP). VAP is a lower respiratory tract infection that develops in intubated patients for greater than 48 hours. VAP is the most common infection in ventilated patients and the second most common hospital-associated infection associated with a higher mortality rate between 20% and 70% and increases hospital lengths of stay in critical units by 4-13 days *(Ahmed et al., 2019).*

The modified ventilator bundle 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. Performance of this bundle associated with reduced VAP incidence decreased the risk of reintubation or intensive care readmissions, improved weaning strategies, and optimized patient recovery. To achieve this goal, the ventilator bundle includes the head of the bed elevation 30-45%, ventilator circuit care, peptic ulcer prophylaxis, DVT prophylaxis, endotracheal suctioning care, infection control measures, assessment for readiness to stop sedation and to start spontaneous breathing trials, oral care with the chlorhexidine and early mobilization *(Mart et al., 2019).*

Weaning covers the entire process of liberating the patient from mechanical ventilatory support and an

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endotracheal tube to independent breathing. This process consists of 3 key steps: The first step, when the patient's clinical conditions permit it, ventilation supports are progressively decreased (Ready weaning). The second step, a spontaneous breathing trial (SBT), assesses the patient's capability to breathe autonomously (Ready breathing), and in the third step, the patient is liberated from ventilation support (Ready extubating). The clinical goals of weaning are twofold: First, to promptly distinguish those patients who are ready to start the weaning process, and second, to improve the weaning regime to diminish the transition time from dependence to autonomy from MV *(Vetrugno et al., 2020)*.

The critical care nurses have a major role in preventing hospital-acquired infections overall and VAP in particular by ensuring optimal care for mechanically ventilated patients. They can contribute a lot to VAP prevention by reducing risk factors, implementing relevant preventive measures, identifying early signs for VAP, and prompt management. Beyond these, ICUs nurses should be monitoring respiratory functions, regular monitoring of vital signs for patients to immediate detections of any complications, adequate nutritional support, maintenance of application of the "modified ventilator care bundle," and adherence to weaning protocols *(Alsharari et al., 2020).*

2. Significance of the Study

Mechanical ventilation is a life-saving intervention, but it poses significant clinical and economic challenges due to the risk of complications. Approximately 30% of patients treated with MV experience a difficult or prolonged weaning process *(Kasem et al., 2019).* Patients who experience difficulty in weaning need a longer hospital stay and have higher morbidity and mortality rate. Consequently, trials to decrease the duration of weaning are desirable to reduce the length of MV connection and its related complications. Standardized weaning practices are safe and effective in reducing the time spent on MV. However, the evidence supporting their use in practice is inconsistent. The discordant results of studies may reflect that weaning protocols differ in composition and are implemented in different environments by various health care providers *(Khalil et al., 2018).*

Few research studies were conducted nationally on the ventilator bundle practices. Their effect on weaning from MV and their findings illustrated that implementation of modified ventilator bundle practices might enhance the weaning process, reduce the incidence of such complications, improve the quality of patient care, improve the prognosis of the patient's condition, and this, in turn, would decrease the average length of ICU stay, decrease long term physical, cognitive, and psychological harm to patients and their family; improve hospital reimbursement and decrease health care costs *(Khalil et al., 2018).* Eventually, this research might generate attention and motivation for further studies in this area.

3. Aim of the study

This study aims to apply a modified ventilator bundle and evaluate its effect on weaning and ventilation days among critically ill patients.

3.1. Research Hypotheses

The following research hypotheses were formulated to fulfill the aim of this study.

- The study group patients for whom all modified ventilator bundle elements were applied completely would have higher weaning scores than the controls.
- The study group patients for whom all modified ventilator bundle elements were applied completely would have less mechanical ventilation days compared to the controls.

4. Subjects & Methods

4.1. Research design

Quasi-experimental research (study/control group) design was utilized in the current study. Quasi-experiment is an empirical study used to estimate the causal impact of an intervention on its target population without random assignment. The design, according to *Usadọlọ (2016),* can be used to examine the relationship between independent (cause) and dependent (effect) variables. Therefore, the design is most appropriate to investigate the effect of the modified ventilator bundle on weaning and ventilation days.

4.2. Research setting

The current study was conducted at the following critical care units (surgical, medical, and cardiac care units) affiliated to Bani Suief University hospital in Bani Suief City, Egypt. Beni-Suief university hospital was constructed in 1985 and offered primary, secondary, and tertiary health care services for Beni-Suef Governorate situated 110 km south of Cairo. It consisted of two parts one educational part composed of classes for teaching and training of medical and nursing students, while the second part comprises 33 out-patient clinics and 27 in-patient departments in different medical specialties and five critically care units.

4.3. Subjects

A purposive sample of 100 mechanically ventilated patients was assigned in the current study, starting from the initiation of MV connection until extubate. The patients were divided randomly into two equal groups. In the first study group (n= 50)**,** the patients received the modified ventilator bundle practices completely. In the second control group (n= 50)**,** the patients received routine hospital nursing care during the MV period. Both groups of the study were selected according to the following inclusion and exclusion criteria.

Inclusion criteria

- Patients with a Glasgow coma scale more than or equal (9 scores).

- The study included patients of both gender and their age between (20-65).
- Patients on invasive mechanical ventilation.
- No scheduled surgery in the following 72 hours.

Exclusion criteria

Patients were excluded if:

- Patients have a brain stem infarction.
- Patients have neuromuscular diseases.
- Patients with multiple organ dysfunction syndromes
- Patients with major cardiac-thoracic or abdominal surgery
- The patient who admitted with a chest infection or any other systemic infection.
- Pregnant patients

Sample size: The sample was calculated using the following equation according to Epi info, version 3.5. Based on the confidence level of 95%, power 85%, and a 20% recurrence rate *(Krishnappa et al., 2018).*

$$N = \frac{\mathrm{t2x\ p(1-p)}}{\mathrm{m2}}$$

Description:
N = required sample size
t = confidence level at 95 % (standard value of 1.960)
p = total no of the mechanically ventilated patients who admitted in the previous mentioned ICUs
m= margin of error at 5 % (standard value of 0.050).

4.4. Tools of the study

Two tools were utilized to collect data pertinent in the current study:

4.4.1. Patient Assessment Record

The researcher developed this tool after revising an extensive literature review. It includes the following:

Patient's demographic and medical characteristics. It consists of ten items used once for both groups, including the patient's age, gender, marital status, place of residence, occupation, educational level, smoking habits', date of ICU admission, the reason for ICU admission, and initial mode of ventilation support.

4.4.2. Weaning Process Assessment Checklist

The researcher used the Burns Wean Assessment Program score for both studied groups once every day after 72 MV initiation hours until extubating. This tool was adopted from *Burns et al. (1990),* and it is used to systematically assess and track the weaning progress of the MV patients.

Scoring system

BWAP score requires assignment one of 2 responses (yes or no) "Yes "response indicates that the items are present scored "1" while "No" response indicates that the items are not present scored "ZERO." BWAP score is calculated by dividing the total number of yes responses by 26 (the total number of BWAP factors). A cutoff point for the instrument is 50%. If the score was more than or equaled 50%, this means that the patients were more likely to be weaned successfully. Furthermore, if the score was less than 50%, this indicates that the patients were more likely to have unsuccessful weaning. The presented findings indicated to the cases that are successfully weaned.

4.5. Procedures

The tools' content validity was done to identify the degree to which the used tools measure what was supposed to be measured. The developed tool was examined by a panel of five experts in critical care medicine and critical care nursing specialty.

The reliability of all study tools was tested using Cronbach's test to identify the extent of tools items were measured with the study concept and its correlation. It ranged from (0.81) for the first tool and (0.79) for the second tool.

A pilot study was carried out on 10% (10 patients) of the total sample of mechanically ventilated patients in the previously mentioned ICUs to test the feasibility of the research process, objectivity, and applicability of the study tools. Based on the pilot study results, no modifications were done for data collection tools, so the patients who shared in the pilot study were included in the actual study sample.

Ethical considerations: Official permission to conduct the study was obtained from the ethical committee of research at Minia University, dean of the nursing faculty at Minia University, directors of Bani Suief University Hospital, academic for research center and technology. Patients in this study were entirely voluntary who was explained about the aim, purpose, procedure, and nature of the study and had the right to refuse to participate or withdraw from the study at any time without any rationale. Informed oral consent was obtained from the patients' relatives and informed them that obtained data would not be included in any further research without a second consent. Confidentiality and anonymity of each subject were ensured through coding of all data and protecting the obtained data.

Preparatory phase: The current study was conducted by preparing different data collection tools, besides obtaining a formal paper agreement, which was taken in duration about two-month duration before conducting the study and ended by carrying out the pilot study.

Implementation phase: Once the official permission is granted to proceed with the proposed study. The researcher initiated the data collection by visiting the assigned settings daily during the day shifts. Next, those patients were divided randomly into two equal groups; the researcher started a collection of data from the control group by obtaining the patient's demographic and medical characteristics from the patient file and their relatives (Tool 1) on the first day. The implementation time for this tool was (30 minutes)

The control group patients were received routine hospital nursing care during the MV connection by critical care nurses that includes: Elevating the backrest of the bed between 30-45 %, sedation interruption, and daily assessment of readiness to extubate, deep venous thrombosis prophylaxis, and peptic ulcer prophylaxis. Also used closed suctioning system, patient hygiene, enteral nutrition, patient monitoring, and drug administration.

While data collection from the study group was started after finishing from the control group, the researcher obtained patient's demographic and medical characteristics from patient file and their patient relatives and (Tool 1) on the first day. The implementation time for this tool was (30 minutes). The study group patients were received a modified ventilator bundle by the researcher with the medical and nursing staff's cooperation. It included the head of bed elevation 30º-45º is one of the most simple and effective nursing interventions unless there is contraindicated. Oral care consists of routine oral assessment for the integrity of lips, teeth, buccal mucosa, palate, and tongue and using routine oral care applied three times per day (once every 8 hours). Early mobilization typically within 24-48 hours of ICU admission includes active/passive range of motion, postures, respiratory muscle training, and cough augmentation techniques such as percussion.

Endotracheal suctioning care using open suctioning system technique, performed suction only when indicated (avoid routine suction) including prior pulmonary auscultation and avoiding the instillation of a 0.9% saline or any other type of solution. Care related to the suctioning including the position of the patient in semi fowler's position; hand washing before and after the procedure and wear sterile gloves: hyperoxygenation of the patient according to agency policy before suctioning; do not apply suction for longer than 10 seconds; allowing at least 30-second intervals between suctioning; replacement of suction systems and monitor ETT cuff pressure regularly using a cuff pressure manometer which should be the standard of care for each intubated patient.

Daily sedation interruption and daily assessment of readiness to extubate allowed the patient to 'wake up' from their medicine-induced sleep. During this period, the patients are assessed for neurological recovery and readiness for extubating or re-sedated if required, with the medical staff's cooperation. The medical staff prescribed deep venous thrombosis prophylaxis, the use of anti-embolic stockings, and peptic ulcer prophylaxis.

Ventilator circuit care included drain and discards periodically any condensate that collects the mechanical ventilator's tubing periodically (at least every 8 hrs) before repositioning the patient.; humidify respiratory circuit using humidity and heat exchange filter; replace humidifiers every 5 to 7 days or as clinically indicated (visibly soiled or malfunctioning) ; replace the ventilator circuit with each new patient and when the circuit becomes soiled or malfunctioning; cleanse reused respiratory equipment, such as resuscitation bag and nebulizer after each use; use sterile Ambu bag/disinfect it before. Finally, specific practices related to infection control measures include hand hygiene and wear sterile gloves and patient hygiene, enteral nutrition, and drug administration.

Evaluation phase: After 72 hours on the fourth day of MV initiation, the control group received routine hospital nursing care by critical care nurses, and the study group received the modified ventilator bundle by the researcher. The patients were started to be assessed for readiness to wean from the mechanical ventilator daily using the weaning process assessment checklist (BWAP score) (Tool II) once every day till the patient extubated. The implementation time for this tool was (30-45 minutes).

4.6. Data analysis

Data were summarized, tabulated, and presented using descriptive statistics in a frequency distribution, percentages as a dispersion measure. A statistical package for the social science (SPSS), version (22) was used for statistical analysis of the data, as it contains the test of significance given in standard statistical books. Chi-square was used to compare frequencies and correlation between the study variables. Probability (P-value) is the degree of significance of the results. (p-value > 0.05) was considered not significant (NS), (P-value ≤ 0.05) was considered significant (S), and the (p-value ≤ 0.01) was considered highly significant (HS).

5. Results

Table 1 shows that 60.0% of the study group compared with 68.0% of the control group, their age ranged between 40-59 years with mean age/SD of 48.1±11.3 and 51.1±9.8 years, respectively. Regarding gender, 64.0% of the study group compared with 70.0% of the control group were males. According to marital status, 78.0% of the study group compared with 90.0% of the control group were married. Regarding residence, 62.0% of the study group compared with 72.0% of the control group lived in the rural area. Related to their educational level, 48.0% of the study group compared with 42.0% of the control group cannot read and write; therefore, most of them were occupied as workers/farmers (38%, 46%) for study control group respectively. Lastly, there were no statistically significant differences between the study and control groups according to their demographic characteristic.

Table 2 illustrates that 60.0% of the study group compared with 44.0% of the control group do not smoke. Regarding the reason for ICU admission, 24.0% of the study group, compared with 10.0% of the control group, were admitted with severe cardiac complaints. Lastly, there were no statistically significant differences between both studied groups according to their medical characteristic.

Figure 1 illustrates that 70.0% of the study group compared to 76.0% of the control group on synchronized intermittent mandatory ventilation mode.

Table 3 shows that 58.0% of the study group while 26.0% of the control group had successful weaning score on the fourth day (first observation), (65.9%) of the study group while only (34.0%) of the control group had successful weaning score at fifth day (second observation), 69.2% of the study group but (55.3%) of the control group had successful weaning score at sixth day (third observation).

Besides, 93.8% of the study group compared with only

63.3% of the control group had successful weaning score on the seventh day (fourth observation), 100% of the study group compared to 82.6% of the control group had a successful weaning score on the eighth day (fifth observation). Finally, the last observation indicates that 100% of the study group compared to 95% of the control group had a successful weaning score on a ninth day (sixth observation). There were statistically significant differences between the study and control groups in the 1st, 2nd, 3rd, and fourth observations (P-value ≤ .001, 002, 0.05, and 0.025), respectively.

Table 4 illustrates that 68.0% of the study group, compared with only 40.0% of the control group, had a shorter duration of mechanical ventilation support between 4-6 days with mean± SD of 6.1 ± 1.6 and 7.3±1.9 respectively after modified bundle implementation with statistical significance differences (P-value .005).

Table (1): Comparison between study and control groups' demographic characteristic (n= 100).

Demographic data	Study group (n= 50)		Control group (n= 50)		X^2	P-value
	No.	%	No.	%		
Age/years						
20 - 39	11	22.0	6	12.0	2.937	0.568
40 - 59	30	60.0	34	68.0		
≥60	9	18.0	10	20.0		
Mean ± SD	48.1±11.3		51.1±9.8			
Gender						
Male	32	64.0	35	70.0	0.407	0.523
Female	18	36.0	15	30.0		
Marital status						
Single	3	6.0	1	2.0	1.245	0.475
Married	39	78.0	45	90.0		
Widow	8	16.0	4	8.0		
Residence						
Urban	19	38.0	14	28.0	1.131	0.288
Rural	31	62.0	36	72.0		
Occupation						
Employee	11	22.0	9	18.0	0.756	0.860
Worker/ farmer	19	38.0	23	46.0		
Housewife	16	32.0	15	30.0		
Retired	4	8.0	3	6.0		
Educational level						
Cannot read and write	24	48.0	21	42.0	2.866	0.581
Basic	2	4.0	6	12.0		
Secondary	16	32.0	13	26.0		
Bachelor	8	16.0	10	20.0		

Table (2): Comparison between study and control groups according to their medical characteristic (n= 100).

Variables	Study group (n= 50)		Control group (n=50)		X^2	P-value
	No.	%	No.	%		
Smoking habits						
Smoker	20	40.0	28	56.0	2.564	0.109
Not smoker	30	60.0	22	44.0		
Reason for ICU admission						
Severe cardiac complain	12	24.0	5	10.0	5.033	0.656
Extremely respiratory complain	5	10.0	7	14.0		
Severe cerebrovascular complain	5	10.0	6	12.0		
Hemodynamic instability	10	20.0	7	14.0		
Traumatic injury	4	8.0	6	12.0		
Inhaled toxic substance	4	8.0	5	10.0		
Cardiac arrest	6	12.0	8	16.0		
Surgical emergencies	4	8.0	6	12.0		

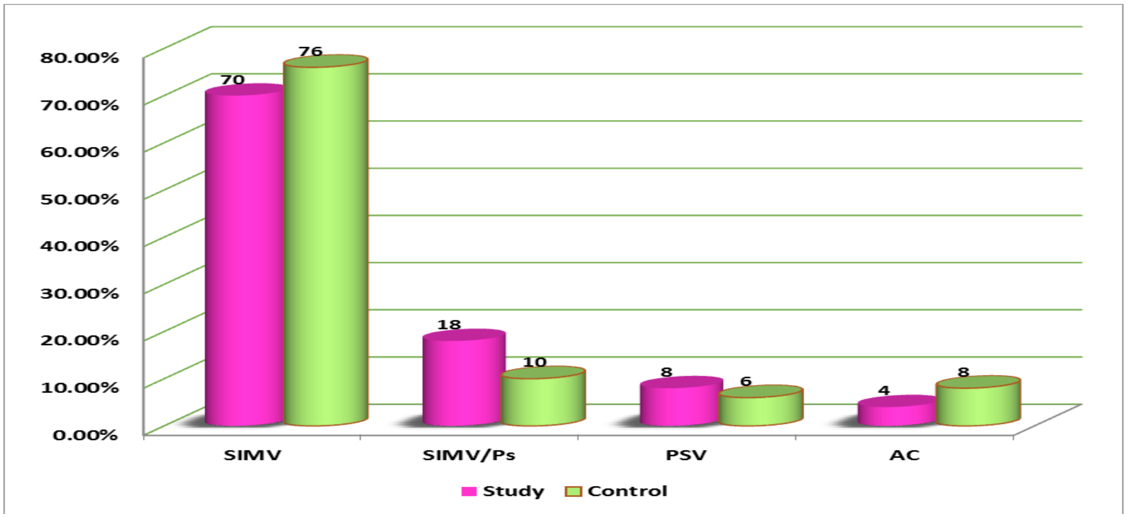

Figure (1): Percentage distribution of the study and control groups according to their initial mechanical ventilator mode (n= 100).

Table (3): Comparison between study and control groups according to their Burns wean score after modified bundle implementation at first to sixth observations (n= 100).

Total score	Study group (n= 50)		Control group (n= 50)		X [2]	P-value
	No.	%	No.	%		
1st observation (4th day)						
Unsuccessfully weaned	21	42.0	37	74.0	10.509	0.001
Successfully weaned	29	58.0	13	26.0		
2nd observation (5th day)						
Unsuccessfully weaned	15	34.1	31	60.0	9.232	0.002
Successfully weaned	29	65.9	16	34.0		
3rd observation (6th day)						
Unsuccessfully weaned	8	30.8	17	44.7	1.265	0.05
Successfully weaned	18	69.2	21	55.3		
4th observation (7th day)						
Unsuccessfully weaned	1	6.3	11	36.7	5.007	0.025
Successfully weaned	15	93.8	19	63.3		
5th observation (8th day)						
Unsuccessfully weaned	0	0.0	4	17.4	1.979	0.159
Successfully weaned	10	100.0	19	82.6		
6th observation (9th day)						
Unsuccessfully weaned	0	0.0	1	5.0	0.363	0.547
Successfully weaned	7	100.0	19	95.0		

Table (4): Comparison between study and control groups according to their mechanical ventilation duration/days after modified bundle implementation (n= 100).

Mechanical ventilation duration	Study group (n= 50)		Control group (n= 50)		X [2]	P-value
	No.	%	No.	%		
Mechanical ventilation days						
4- 6 days	34	68.0	20	40.0	7.890	0.005
7- 9 days	16	32.0	30	60.0		
Mean ± SD	6.1±1.6		7.3±1.9			

6. Discussion

Institute for Healthcare Improvement developed the concept of "ventilator bundles" to help healthcare providers reliably deliver the best possible care for patients undergoing particular treatments with inherent risks. A modified ventilator bundle is considered a "package" of evidence-based practices guidelines designed to reduce VAP rates, improve weaning strategies, and promote adherence to evidence-based protocols and guidelines to decrease ventilation days *(Alsoda et al., 2020)*. Therefore, the current study was conducted to apply a modified ventilator bundle and evaluate its effect on weaning and ventilation days among critically ill patients.

Two matched groups were recruited to achieve the aim of this study. Regarding demographic characteristics of the studied samples, the current study shows that nearly two-thirds of the study and control groups' ages ranged between 40-59 years old with mean age ±SD of 48.1 ± 11.3 and 51.1 ± 9.8 years respectively with a non-statistically significant difference between both groups. The current study's finding explains that most people above forty years are more at risk for many health problems such as cardiac/respiratory/kidney/hepatic and neurological disease due to the aging process and physiological changes.

This finding is congruent with *Kao et al. (2019).* They studied "National bundle care program implementation to reduce ventilator-associated pneumonia in intensive care units in Taiwan." They reported no statistically significant difference between the study and control groups regarding mean age ± SD (49.57± 6.39) and (49.42±5.35) years, respectively. This result was also similar to *Irani et al. (2020).* They studied, "The effect of oral care with Miswak versus chlorhexidine on the incidence of ventilator-associated pneumonia." They illustrated a non-statistically significant difference between both study and control groups (P >0.05). Regarding their mean age ±SD, it was (33.65 ±13.50) and (34.83 ± 13.95) years, respectively.

Regarding gender, the current study finds that more than two-thirds of the study and control groups were males. The finding of the current study explained by the researcher points of view that; males have a greater risk than females due to high levels of calcification in their arteries besides high exposure to occupational hazards, stresses, and frequent use of cigarette smoking. The current study finding was agreed by *Kasem et al. (2019);* they mentioned that males represent three-quarters of both study and control groups. Moreover, the current study finding disagrees with *Lavallée et al. (2019);* they studied "The effects of care bundles on patient outcomes: A systematic review and meta-analysis." They illustrated that; most of the studied groups were females.

Regarding smoking habits, the current study illustrates that nearly half of the study and control groups were smokers with no statistical differences between both studied groups. Finding of the current study explain by the researcher points of view that; smoking increases the risk for developing more serious health problems as lung failure/cancer, heart disease, and stroke and may increase the risk of developing pneumonitis, also smoking causes oxidant stress, inflammation, and protease-anti-protease imbalance of the lung tissue. Therefore, they could need to use ventilation support for life-saving intervention.

The current study finding was agreed by *Abdalrazika and Elghonemib (2019).* They studied the "Assessment of gradient between partial pressure of arterial carbon dioxide and end-tidal carbon dioxide in acute respiratory distress syndrome." They found that less than half of the patients on non-invasive ventilation support were smokers. Study findings also opposite to *Polmear et al. (2017).* They studied "Effect of intensive care unit admission on smoker's attitudes and their likelihood of quitting smoking." This study showed that; the highest percentage of ICU admitted patients were smokers.

On comparing the study and control groups by their reason of ICU admission, nearly half of the study and control groups, the main reason was a cardiorespiratory disease. The current study's finding explains that; respiratory and cardiac problems are the leading causes of compromising normal ventilation process, pulmonary circulation, and lunge compliance of the human body. Hence, they are the most common diagnosis among mechanically ventilated patients.

This result was supported by *Osman et al. (2020),* who study "The incidence of ventilator-associated pneumonia in a tertiary-care center: Comparison between pre-and post-VAP prevention bundle." They reported that about half of the study group had respiratory disease, which was the main reason for ICU admission. Furthermore, the present study finding contradicted with *Kudiyarasu (2016),* who conducted a study to assess the effectiveness of ventilator bundle on prevention of ventilator-associated pneumonia among patients on a mechanical ventilator at selected hospitals, Erode, and found that about half of both experimental and control groups the central nervous system diseases is the main reason for ICU admission and mechanical ventilator connection.

Regarding initial ventilation mode, the result shows that the majority of both study and control groups were connected with synchronized intermittent mandatory ventilation mode (SIMV). The finding of the current study explains by the researcher points of view that; because in the SIMV mode, the patients are partially dependent on MV, the ventilator breath is synchronized with patient inspiratory effort and has been described as the most effective and efficient mode of ventilation, especially in the ICU. These modes encourage the use of patients' respiratory muscles and facilitate spontaneous breathing trials, which would enhance early weaning.

The current study finding was consistent with *Abd-Elbaky, and Mohammed (2020).* They studied the "Effect of various body positions on the measurement of endotracheal tube cuff pressure among critical patients." They found all of the studied patients remained attached to the mechanical ventilator on SIMV mode during the MV connection. Moreover, the present study finding was the opposite of *Martí-Hereu and Maranón (2017).* They studied "Time of elevation of the head of the bed for patients receiving mechanical ventilation and its related factors." They showed that more than half of the studied groups connected with assisted/controlled ventilation mode.

Concerning weaning scores, the current study finding shows that the study group that utilized the full individual components of the modified ventilator bundle obtained higher weaning scores compared with the control group who did not utilize all individual elements together with statistically significant differences between the study and control groups in the 1st, 2nd, 3rd, and fourth observation (*P*-value ≤ 0.001, 002, 0.05 and .025) respectively. The finding of the current study explain by the researcher points of view that implementation of modified ventilator bundle practices may reduce the incidence of such complications, improve the quality of patient care, improve the prognosis of patient condition, and this, in turn, would improve the weaning process. These findings are supporting the first research hypothesis.

The current study was supported by *Khalil et al. (2018)*, who studied "Patients weaning from mechanical ventilation complete versus incomplete ventilator bundle implementation." They illustrated that the study group got higher weaning scores than the control group after ventilator care bundle application, with the significant statistical difference between both studied groups were; (p-value =0.001). Furthermore, the current study was conformity by *Mart et al. (2019).* They reported that ventilator bundle practices' performance reduces the mortality rate, ventilation days, and hospital length of stay, besides that improved the weaning strategies.

Regarding the comparison between the study and control groups by their duration of mechanical ventilator/days after modified bundle implementation, the study shows that more than two-thirds of the study group, while only two-fifths of the control group were staying on MV for a shorter duration (4-6 days), and nearly one-third of the study group compared with more than half of control group were staying on MV for longer duration (7-9) days with a statistically significant difference between both studied groups (P-value 0.005), mean length of stay ±SD were 6.1 ± 1.6 and 7.3 ± 1.9 respectively.

Finding of the current study explained by the researcher points of view that implementation of modified ventilator bundle practices may reduce the incidence of such complication, improve the quality of patient care, improve the prognosis of patient condition and this, in turn, would decrease the average length of ventilation support and hospital length of stays. This finding is supporting the second research hypothesis.

The current study finding was supported by *Khalil et al. (2018).* They reported that most of the compliant group has got a shorter length of MV/days (3–6) when compared to the noncompliant group of patients whose most lengths of stay of ventilation connection between (7-10 days) after bundle implementation with the statistically significant difference between both studied groups. Mean length of stay ±SD was 7.3±0.70 and 8.1±0.79, respectively. Furthermore, the study finding was in agreement with another study conducted by *Montasser (2017),* who found a significant statistical difference between cases with complete and incomplete ventilator bundle implementation groups regarding MV connection duration. Furthermore, *Chen et al. (2015)* reported that multidisciplinary bundle care decreased the ventilator days.

7. Conclusion

Based on the current study results and research hypothesis, the following can be concluded: The study group of patients who received complete modified ventilator bundle practices would get higher weaning scores and shorter mechanical ventilator connection compared to the control group who received routine hospital nursing care.

8. Recommendations

Recommendations related to nurses

- A modified ventilator bundle checklist must be developed and appropriately followed by all nursing staff to prevent VAP and other ventilated patients' complications.
- Ventilator bundle checklist must be a basic part of ventilated patients' charts.

Recommendation related to patients

- Modified ventilator bundle should be replicated on multiple types of diagnosis among mechanically ventilated patients.

Recommendations for furthers researches

- Future research should be conducted to apply a modified ventilator bundle and evaluate its effect on VAP rate, hospital cost, length of MV connection, and length of hospital and ICU stay among mechanically ventilated patients.
- Replication of the study on a larger probability sample from different geographical locations in Egypt ensures the study's generalizability.

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