Effect of Implementing Nursing Intervention Protocol on Reducing Selected Pulmonary Complications among Mechanically Ventilated Patients

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Abstract

Background: Mechanically ventilated patients are at high risk of developing pulmonary complications, which can prolong hospitalization and increase morbidity. Implementing a structured nursing intervention protocol is essential to improve patient outcome and prevent complications such as ventilator-associated pneumonia and pulmonary barotrauma. **Aim of the study:** Evaluate the effect of implementing nursing intervention protocol on reducing selected pulmonary complication among mechanically ventilated patients. **Research design:** Quasi - experimental research design (study & control) was utilized to fulfill the purpose of this study. **Subjects:** A purposeful sample of 80 adult mechanically ventilated patients (MV) was assigned in the current study, which started with the initiation of the MV connection. **Setting:** The current study was conducted at the following critical care units (Chest intensive care unit and Intensive Care Unit) affiliated to Cardio-thoracic Surgery Hospital and Main Minia University Hospital in Minia City, Egypt. **Tools of data collection:** One tool was utilized in the current study; it contains five parts. **First part:** Patient's Demographic Characteristic, **Second part:** Medical Data. **Third part:** Hemodynamic Parameters Assessment. **Fourth part**: Respiratory Parameters Assessment **Fifth part:** Nursing Intervention Protocol. **Results**: the current study results showed that 7.5% & 6% of the study group post-nursing intervention protocol compared with ١٩% & ١٥% of the control group receiving routine hospital care had ventilator-associated pneumonia and barotrauma complications, respectively, with a highly statistical significant difference between both study and control documented with p-value (0.014, and 0.004), respectively. Implementation of nursing intervention protocol have a direct effect on mechanically ventilated patient's outcomes and minimizing selected pulmonary complication among study group. **Conclusion:** Based upon the results of this study, it could be concluded that, implementation of nursing intervention protocol for mechanically ventilated patients had beneficial effect on reducing the incidence of selected pulmonary complications among study group compared to the control group. **Recommendations:** nursing intervention protocol should be incorporated as a part of routine care of ventilated patients in ICU, designing a comprehensive checklist to improve nurses' compliance with nursing structured nursing intervention protocol to prevent pulmonary complication.

Keywords: Barotrauma, Mechanical Ventilation, Nursing Intervention Protocol, Pulmonary Complication, Ventilator Associated Pneumonia.

Introduction

Mechanical ventilation (MV) is a life-saving intervention widely used in critical care settings to support patients with respiratory failure, compromised lung function, or inadequate oxygenation. It involves the use of a ventilator to assist or completely take over the breathing process, ensuring sufficient gas exchange and reducing the work of breathing **(Rubulotta *et al.*, 2024)**. Mechanical ventilation is commonly indicated in conditions such as acute respiratory distress syndrome (ARDS), chronic obstructive pulmonary disease (COPD) exacerbations, neuromuscular disorders, and post-surgical recovery. **(Berhe *et al.*, 2023)**.

Mechanically ventilated patients are at substantial risk of developing complications, including ventilator-associated pneumonia (VAP), prolonged dependency on ventilation, barotrauma, and hemodynamic instability. Additionally, extended weaning periods and adverse psychological effects, such as delirium and ICU-related anxiety, can further hinder patient recovery **(Zhu *et al.*, 2024)**. These complications not only increase the length of hospital stay and associated healthcare costs but also contribute to long-term morbidity and decreased quality of life for

survivors. Given these risks, implementing evidence-based nursing intervention protocols is essential in reducing complications, enhancing patient outcomes, and ensuring a safe and timely transition from mechanical ventilation to spontaneous breathing **(Hoang *et al.*, 2024; Meitner *et al.*, 2023)**.

Mechanically ventilated patients face a high risk of developing ventilator-associated pneumonia (VAP) due to disruptions in their natural pulmonary defense mechanisms. The insertion of an endotracheal or tracheostomy tube bypasses protective barriers, impairs mucociliary clearance, and provides a direct route for pathogens to enter the lower respiratory tract. Additionally, prolonged immobility, sedation, and compromised immune function further increase the risk of infection. Once VAP develops, it can significantly hinder the patient's ability to wean off mechanical ventilation, leading to prolonged ventilator dependence and an increased risk of further complications **(Mumtaz *et al.*, 2023; Rangappa, 2023)**.

The consequences of VAP extend beyond respiratory distress, as it has been shown to prolong intubation by an additional 4 to 9 days compared to patients who do not develop the infection. This extended duration of mechanical ventilation contributes to an increased ICU length of stay (LoS), higher healthcare-associated costs, and a greater burden on healthcare resources. More critically, VAP is associated with a significant rise in mortality rates, with affected patients facing nearly twice the risk of death compared to those who do not develop the condition **(Sabir *et al.*, 2022; Shebl *et al.*, 2022)**.

Ventilator-associated pneumonia (VAP) is diagnosed based on a combination of radiographic, clinical, and laboratory findings that indicate a new or worsening pulmonary infection in mechanically ventilated patients. A definitive diagnosis is often confirmed by the presence of new or progressive consolidation on chest radiography (CXR) or computed tomography (CT) scan, which suggests lung infiltration. In addition, VAP is characterized by a collection of clinical symptoms and signs, including tachypnea, fever, and respiratory crackles on auscultation without an alternative known cause. Laboratory findings such as leukocytosis or leukopenia further support the diagnosis, along with changes in the characteristics of respiratory secretions, including purulent pulmonary secretions **(Howroyd *et al.*, 2024; Mumtaz *et al.*, 2023)**.

Additional indicators of VAP include an increased requirement for oxygen supplementation, with a rise in the nominal fraction of inspired oxygen (FiO_2) by more than 10%, as well as cardiovascular instability, manifesting as tachycardia or bradycardia. Patients may also exhibit signs of respiratory distress, such as increased work of breathing and reduced oxygenation efficiency. Importantly, these clinical manifestations typically emerge within 48 to 72 hours following the insertion of an endotracheal tube and the initiation of mechanical ventilation. Given the serious consequences of VAP, early identification through careful monitoring of these symptoms and prompt implementation of preventive strategies are crucial in improving patient outcomes and reducing complications associated with prolonged mechanical ventilation **(Lua *et al.*, 2025; Rongrungruang *et al.*, 2025)**.

Pulmonary barotrauma, particularly in the form of pneumothorax, is a potentially life-threatening complication observed in mechanically ventilated patients. It occurs when excessive airway pressure leads to alveolar rupture, allowing extra-alveolar air to escape into areas where it is not normally present, such as the pleural space, mediastinum, or subcutaneous tissues **(Shrestha *et al.*, 2022)**. This condition arises due to the pressure imbalances created during mechanical ventilation, especially when high tidal volumes or elevated positive end-expiratory pressure (PEEP) settings are used. As a result, pulmonary barotrauma can lead to impaired gas exchange, hemodynamic instability, and, in severe cases, respiratory failure. Studies have shown that increased morbidity and mortality are closely associated with barotrauma, particularly in patients with underlying lung conditions such as acute respiratory distress syndrome (ARDS) or chronic obstructive pulmonary disease (COPD)**(Diaz R, 2023)**.

Pulmonary complications are considered as the foremost common hospital-acquired risk associated with patients on a ventilator, and there are numerous avoidance techniques that can be connected by Intensive care unit (ICU) nurses in arrange to diminish the hazard of frequency of these complications in ICU**(Shudaifat *et al.*, 2021)**. A group of evidence-based nursing measures formulated in a nursing intervention protocol have been shown to have significant results in reducing pulmonary complications and improving outcomes in patients on mechanical ventilation**(Al-Sayaghi, 2021)**.

There are many recent nursing interventions that approved its effect on minimizing most common pulmonary complication as the following:

Elevation of the head of the bed (at 30º to 45º), daily oral care (with chlorhexidine), chest physiotherapy (vibration and percussion) and early mobilization, so this study focused on generalizing standardized applicable nursing interventions in a nursing protocol. Selected complication reduction has been achieved when the compliance of the main protocol components is achieved, that was revealed in a recent study so intensive care nurses are in the best position to bring the evidence based guidelines into practice as they are at the patient's bedside 24 hours a day and therefore they play substantial role in the prevention of complication**(N. Khalil *et al.*, 2021; Shudaifat *et al.*, 2021; Wang *et al.*, 2021)**.

Significance of the study

Ventilator associated pneumonia is the most frequent healthcare-associated infection (HAI), representing approximately 27% of all HAIs. Ventilator-associated pneumonia (VAP) is a serious complication that continues to affect patients on mechanical ventilation, with 5% to 40% of these patients end up developing lung infections**(Alshamrani *et al.*, 2019; Papazian *et al.*, 2020)**.

Furthermore, the mortality rate attributable to VAP is 27% and Length of stay in the intensive care unit is increased by 5 to 7 days3 and hospital length of stay 2- to 3- fold in patients with VAP. Also The cost of VAP is estimated to be an additional $40000 per hospital admission per patient with the disease and an estimated $1.2 billion per year **(Martinez-Reviejo *et al.*, 2023)**. Regarding Barotrauma, in a recent cohort study, it was concluded that patients who received non-invasive positive-pressure ventilation (NIPPV) demonstrated higher incidence of pulmonary barotrauma (77%) versus the incidence in IPPV cases (30%) as a complication of Mechanical ventilation **(Khan, 2023)**.

In Egypt, a recent study revealed that mechanically ventilated patients are exposed to ventilator associated pneumonia and other complication which is considered a major consequence of 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 **(Sayed, 2024)**.

In Egypt, also **(Noaman, 2021)** reported that the problem of VAP is still a challenge in many ICUs, also the incidence of VAP in Egyptian University Hospitals varied from 16 to 75%. Ain Shams University hospitals reported the highest incidence and Alexandria hospitals reported lowest one, whereas the incidence of VAP in Mansoura University hospitals was 22.6%.

Records of intensive care unit at Minia University Hospital in the year of **(2022-2023)** revealed that the number of patients admitted to intensive care unit was approximately 723 patients (63.8 % of them were on mechanical ventilation), 32.8% of them were suffering from pulmonary complications **(Hospital records of Minia University Hospital, 2022).** Sometimes patients not found bed with mechanical ventilation in ICU due to other patients spend long time on mechanical ventilation, so was from our duties to searches about solving the problem of long time mechanical ventilation for saving resources and reducing cost and complication of mechanical ventilation

Therefore, the current study aimed at conducting nursing intervention protocol based on extensive literature reviews for reducing selected pulmonary complication among mechanically ventilated patients and evoking an attention and inspiration for additional studies in this area.

Patients and Method

Aim of the Study

The Current Study Aimed to:

Evaluate the effect of implementing nursing intervention protocol on reducing selected pulmonary complication among mechanically ventilated patients.

Research Hypothesis

H_1: Selected pulmonary complications will be reduced among study group than in control group after implementing nursing intervention protocol.

H_2: Haemo-dynamic and respiratory parameters are improved in study group after intervention than in control group.

Research Design

A quasi-experimental research design (study & control groups) was utilized in the current study. The design is utilized to examine the relationship between variables containing an independent (nursing intervention protocol) and a dependent (effect).

Setting

The current study was conducted at the following critical care units (Chest intensive care unit and Intensive Care Unit) affiliated to Cardio-thoracic Surgery Hospital and Main Minia University Hospital in Minia City, Egypt.

Patients

A purposeful sample of 80 adult mechanically ventilated patients (MV) was assigned in the current study, which started with the initiation of the MV connection. The patients were divided randomly into two equal groups; the first, study group included 40 patients, and the patients received the nursing intervention protocol completely. The second, control group included 40 patients who received routine hospital nursing care during the MV period.

The sample size was estimated by using the **(Mohapatra, 2020)** formula, which is computed as ($n = z^2 \times p\ (1- p) / d^2$). Where n = sample size, Z = Z statistic for a level of confidence, P= expected prevalence or proportion (in proportion of one; if 20%, P = 0.02 and d = precision (in proportion of one; if 5%, d= 0.05).

$N= (1.96)^2 \times 0.04\ (1-0.04) / (0.05)^2 = 80$ patients.

Both groups in the current study were selected according to the following inclusion and exclusion criteria: -

Inclusion Criteria: -

1. Intubated patients who were mechanically ventilated.
2. Newly admitted adult patients within the first 24 hours of mechanical ventilation initiation.
3. Adult patients (18–65 years old) of both sexes
4. Tracheostomy patients.

Exclusion Criteria:

1. Patients with pneumonia or admitted with any chest infection
2. Patients with pneumothorax.
3. Spinal cord injury.
4. Patients with neuromuscular diseases.
5. Patients with terminal diseases.

Study Duration

The total data collections were collected over a period of six months starting from "May 2023 to October 2023".

Tools for Data Collection

One tool was utilized in the current study that was developed by the researcher after reviewing an extensive literature review.

Tool: "Patient Assessment":

It was collected in the first contact with patients and it contains five parts: -

First Part: Patient's Demographic Characteristic:

It consisted of (5) items used once for both groups pre intervention which involves the patient's age, gender, place of residence, educational level, occupation.

Second Part: Medical Data:

It consists of (6) items date of admission, current medical history, past medical history, smoking habits, date of discharge and length of stay.

Third Part: Hemodynamic Parameters Assessment:

This part was developed by the researcher to evaluate the patient's homodynamic status and consists of seven items that include Axillary Temperature (T), Heart rate (HR), Respiratory rate (RR), Mean Arterial Blood pressure(MAP), Central veins pressure(CVP) readings, Arterial Blood Gases monitoring (ABG): for (potential of hydrogen (PH), Partial Pressure of Oxygen (Pao2), Partial Pressure of carbon dioxide (Paco2), Bicarbonate (Hco3), oxygen saturation (Sao2) and lab investigation (Hematocrit, Leucocytes count and Electrolyte).

Scoring System of Hemodynamic Parameters:

The scoring system imposed assignment of one of two responses (normal and abnormal); "normal response" indicated a good outcome and was scored (1), and "abnormal response" indicated a poor outcome and was scored (0). Finally, the total score was calculated by dividing the sum of the of the number of yes responses by the total number of items mentioned above. A cutoff point for both parts was 60%. If the score was greater than or equal to 60%, this means a good outcome, and if the score was less than 60%, this means a poor outcome and a greater probability of complication.

Fourth Part: Respiratory Parameters Assessment. It is adopted from (Abdelaziz, 2020):

It consists of two sections:

1st Section: contains A baseline data assessment as "date of starting mechanical ventilation, mechanical ventilation type, mechanical ventilator mode, and mechanical ventilator parameters".

2nd Section: contains (7) items as following: " airway clearance, chest expansion, position of trachea, presence of respiratory secretions, characteristics of secretions if present, chest sounds, and chest x-rays".

Scoring System adapted from (Jeong et al., 2018):

The scoring system imposed the assignment one of two responses (normal and abnormal); "normal response" indicated a good outcome and was scored (1), and "abnormal response" indicated a poor outcome and was scored (0). Finally, the total score was calculated by dividing the sum of the number of yes responses by the total number of items mentioned above. A cutoff point for both parts was 60%. If the score was greater than or equal to 60%, this means a good outcome, and if the score was less than 60%, this means a poor outcome and a greater probability of complication.

Fifth Part: Nursing Intervention Protocol adapted from (Martinez-Reviejo et al., 2023; Roqué-Figuls et al., 2023; Sayed, 2024; Sekihara et al., 2023):

It consists of four items used only for the study group, which incorporate the four nursing interventions: oral care with chlorhexidine, elevation of the head of the bed at 30º to 45º, chest physiotherapy (vibration and percussion), and early mobilization with passive range of motion. Each intervention was done every shift (morning, evening and night) for three continuous days after initiation of MV if no contraindication.

Scoring System:

The scoring system imposed an assignment one of two responses (done and not done); the done response takes a score; (1) not done response takes (zero) score.

Tool Validity

Content validity was done to identify the degree to which the used tool measured what was supposed to be measured. The developed tool was examined by a panel of five expert's opinions in the field of the study, one professor, and four assistant professors of Medical Surgical Nursing at Faculty of Nursing, Minia University. The assessment focused on content coverage, clarity, relevance, applicability, wording, length, format, and overall appearance of the tools. Unanimously, all panel members (100%) concurred that the instruments used in the study were valid and aligned with the study's objectives, and all modifications were done as needed.

Tool Reliability

Tool reliability was done to identify the extent of tool items were measured with the study concept and their correlation with each other. Reliability was ascertained statistically by using the Alpha-Cronbach test to ensure that the study tools are reliable. Reliability of the homodynamic parameters assessment, respiratory parameters assessment and nursing intervention protocol items were (0.82, 0.79 and 0.84) respectively.

Pilot Study

A pilot study was carried out on 10% (8 patients) of the total sample of mechanically ventilated patients in the previously mentioned ICUs to verify the feasibility of the research implementation, applicability and objectivity of the study tools. Based on the results of the pilot study, no modifications were done to the data collection tools, so the patients who were included in the pilot study were also included in the actual study sample.

Ethical Considerations

Official permission to conduct the study was obtained from the ethical committee of research, faculty of nursing at Minia University, dean of the faculty of nursing at Minia University, director of the Cardiothoracic Surgery University hospital, director of the Main Minia University hospital, and the academics for research center and technology. Informed oral consent was obtained from the patient's relative, informing them that obtained data would not be included in any further research without a second consent after explanation of the aim, purpose, procedure, procedure, and nature of the study, and they had the right to refuse participation or withdrawal from the study independently at any time without any rationale.

For each subject, confidentiality and anonymity were guaranteed through the coding of all data and protecting the collected data.

Administrative Design:

Approval was obtained from the authorities of the Nursing Faculty, Minia University, and then written official letters were sent to the director of the Minia University hospital and the directors of the Cardiothoracic Surgery University hospital in New Minia City, including the aim and steps of the study to gather research data.

Study Procedure

Preparatory Phase

The current study was conducted by preparing different data collection tools. Also, obtaining a formal paper agreement and reviewing the current and relevant related literature and theoretical knowledge of the various related aspects using textbooks, articles, and periodical magazines are necessary in order to develop the data collection tools. All these measures were taken for a duration of about two months prior to conducting the study and ended by carrying out the pilot study.

Implementation Phase

Official permission is granted to advance with the proposed study, the researcher initiates data collection by visiting the assigned settings daily during the day shifts. The enrolled subjects and their family members were told individually about the purpose and nature of the study. Then, the researcher obtained oral consent from the patient's relatives, who agreed to participate in the study. Next, those patients were divided randomly into two equal groups; The researcher has begun a collection of data from the control group first by obtaining the patient's demographic and medical characteristics from the patient file and their patient relatives and performing a physical assessment of the hemodynamic parameters and respiratory parameters to set baseline data for enrolled patients on the first day after initiation of MV. The implementation period for this step was (45 minutes to 1 hour). The control group patients were provided with routine hospital nursing care during the mechanical ventilation connection by the critical care nurses. While, the study group patients have received the nursing intervention protocol measures by the researcher with the cooperation of the medical, nursing staff and nursing students' internship, it included:

1. Head of Bed Elevation 30º-45º

Elevating the backrest of the bed at 30º-45º to be in a semi-recumbent position is one of the most ordinary and effective nursing interventions, except if there is any contraindication. During turning the patient, any tubes and connections attached to the patient were observed as an ECG monitor, feeding tube, urinary catheter, and the arterial line to avoid pulling, stretching, or kinking these tubes.

2. Oral Care with the Chlorhexidine

Oral care encompasses routine oral assessment for the integrity of buccal mucosa, teeth, lips, palate, and tongue. Moisturizing the lips and the oral cavity that can be decontaminated mechanically or pharmacologically. Mechanical decontamination incorporates suctioning of the pharynx and mouth, and the use of a toothbrush ought to be implemented three times per day (once every 4 hours.) to eliminate dental plaque and bacteria from the tongue, teeth, and hard palate. Pharmacological decontamination includes the utilization of an antiseptic oral wash for antimicrobial features for lowering the incidence of pneumonia.

3. Chest Physiotherapy (Vibration and Percussion)

Chest physiotherapy was performed after auscultating the patient's chest every eight hours; the session took about 15-20 minutes as follows:

- Vibration

It was made during expiration, shaking the patient's chest to loosen secretion and dislodge it from its place so that it can reach the main bronchi. The cycle of vibrations took 10-15 minutes.

- Percussion

The researcher covered the patient's chest with a towel or piece of cloth, percussing sternum, ribs, breast, spine, or stomach were avoided. The hand was cupped to strike the chest. Percussion shouldn't be painful to the patient. Percussion was usually done for 3-5 min, and then the patient was motivated to cough after making percussion (if conscious) or suction if unconscious

4. Early Mobilization with range of motion

Early mobilization incorporates progressive mobilization exercises that begin upon hemodynamic and respiratory stabilization, usually within 24–48 hours of 20 minutes of flexion-extension movements for both limbs (one session/shift/day). The patient received ten repetitive upper and lower extremity ROM exercises.

ICU admission to forestall loss of muscle function and enhance mobility recovery. Early mobilization, which incorporates active assisted/passive range of motion; It consisted of by using the fifth part of the data collection tool, the researcher checks the implementation of nursing intervention protocol measures every shift to assure fulfillment of the aim of the study.

Evaluation Phase

After 72 hours on the fourth day of MV initiation, after the control group obtained routine hospital nursing care by critical care nurses and the study group obtained the nursing intervention protocol practices by the investigator, the studied groups were observed over three days using the second, third, and fourth parts of the study tool to assess any changes in hemodynamic and respiratory parameters and the presence of selected pulmonary complications. The executed implementation time for each assessment episode was 30–45 minutes.

Limitations of the Study

Finding is less amenable to generalization because it needs to be applied to a larger sample, including other geographical areas in Egypt, to be representative of the general population of patients in critical care units.

Results

Table (1): Frequency Distribution of the Studied Groups Regarding Their Demographic Characteristics (n= 80).

nographic Characteristics	Study Group (n= 40)		Control Group (n= 40)		Sig. test	P. value
	N	%	N	%		
Age / Years						
• 18 - <30	9	22.5	8	20.0	χ^2= 0.242	0.993Ns
• 30- <40	12	**30.0**	13	**32.5**		
• 40- <50	10	25.0	9	22.5		
• 50- <60	5	12.5	6	15.0		
• ≥60	4	10.0	4	10.0		
Mean ± SD	**39.9 ± 12.875**		**40.1 ± 13.565**		**t =0.076**	**0.940NS**
Gender						
• Male	25	**62.5**	29	**72.5**	χ^2 =0.912	0.634 NS
• Female	15	37.5	11	27.5		
Residence						
• Rural	28	**70.0**	23	**57.5**	χ^2 = 1.352	0.509 NS
• Urban	12	30.0	17	42.5		
Educational Level						
• Illiterate	15	**37.5**	14	**35.0**	χ^2 =0.777	0.855 NS
• Basic	6	15.0	9	22.5		
• Intermediate	15	37.5	13	32.5		
• Bachelor	4	10.0	4	10.0		
Occupation						
• Farmer	14	35.0	13	32.5	χ^2 =0.488	0.922 NS
• Employee	16	**40.0**	18	**45.0**		
• House Wife	8	20.0	8	20.0		
• Retired	2	5.0	1	2.5		

Table (1): Shows that slightly more than one third of the study and control groups were within the age group of 30- >40 years (30.0 &32.5 %) respectively. Regarding to gender, it was seen than more than half of the study and control groups were male (62.5% & 72.5%) respectively. Concerning residence, more than half (70%) of study group, compared to (57.5%) of the control group, came from rural area. The same table displays that 37.5% of the study & 35% of the control groups, respectively, were illiterate. In regards to occupation, 40% of the study group compared to 45% of the control group were employees.

Table (2): Frequency Distribution of the Studied Groups Regarding Their Medical Data (n= 80).

Medical Data	Study Group (n= 40)		Control Group (n= 40)		Sig. Test	P. value
	N	%	N	%		
Medical Diagnosis						
• Cardiac diseases	9	22.5	4	10.0	χ^2 =3.259	0.680 NS
• Respiratory diseases	10	**25.0**	11	**27.5**		
• Cerebrovascular diseases	5	12.5	5	12.5		
• Hemodynamic instability	6	15.0	10	25.0		
• Traumatic injury	0	0	0	0		
• Cardiac arrest	6	15.0	7	17.5		
• Surgical emergencies	4	10.0	3	7.5		
Past Medical History						
• None	16	**40.0**	12	**30.0**	χ^2 =3.976	0.590 NS
• Hypertension	11	**27.5**	12	**30.0**		
• Diabetes mellitus	8	20.0	9	22.5		
• Cardiac disease	2	5.0	5	12.5		
• Respiratory disease	1	2.5	2	5.0		
• Liver diseases	2	5.0	0	0		
Smoking Habits						
• Smoker	18	**45.0**	21	**52.5**	χ^2 =0.450	0.502 NS
• Non-smoker	22	55.0	19	47.5		

Table (2): Illustrates that (25%) of the study group, compared with (27.5%) of the control group, were admitted with respiratory diseases**.** Regarding past medical history, it was observed that (40%) of the study group compared with 30% of the control group hadn't past medical history, while (27.5%) of the study group compared with (30%) of the control group had hypertension. Concerning smoking habits, it was shown that (45%) of the study group, compared with (52.5%) of the control group, were smokers. Lastly, there were no statistically significant differences between studied groups according to their medical data.

Table (3): Frequency Distribution of the Studied Groups Regarding to Mechanical Ventilation Type (n=80)

Type of Mechanical Ventilation	Study Group (n= 40)		Control Group (n= 40)		Sig. Test	P. value
	N	%	N	%		
• **Invasive**	31	77.5	34	85.0	0.693	(0 .390) NS
• **Non-Invasive**	9	22.5	6	15%		

Table (3): illustrates that, 77.5% of the study group compared with 85% of the control group had invasive mechanical ventilation with no statistically significance differences between both groups

Table (4): Frequency Distribution of the Studied Groups Regarding to Mechanical Ventilator Mode (n=80)

Type of Mechanical Ventilation	Study Group (n= 40)		Control Group (n= 40)		Sig. Test	P. value
	N	%	N	%		
• **CPAP Mode**	4	10	4	10	3.802	(0.049) *
• **SIMV Mode**	20	50	25	62.5		
• **PSV Mode**	5	12.5	1	2.5		
• **Bi-PAP Mode**	3	7.5	0	0		
• **ACV Mode**	8	20	10	25		

NB:

CPAP: Continuous Positive Airway Pressure

SIMV: Synchronized Intermittent Mandatory Ventilation.

PSV: Pressure Support Ventilation.

Bi-PAP: Bi-Level Airway Pressure.

ACV: Assist-Control Ventilation

Table (4): Displays that almost half (50%) of the study group, compared with less than two thirds (62.5%) of the control group, were on synchronized intermittent mandatory ventilation mode. While, the minority (7.5% & 0%) of both study and control groups were on Bi-Level Airway Pressure, with statistically significant differences among both groups documented by P-value (0.049).

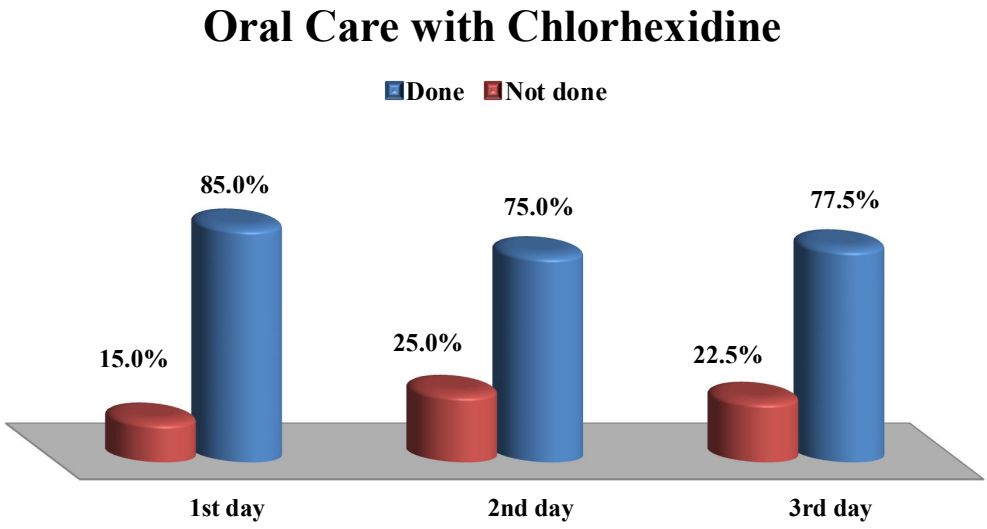

Figure (1): Frequency Distribution of Implementing Oral Care with Chlorohexidine among Study Group.

Figure (1): illustrate that 85% of the study group were implementing oral care on the first day, while 75% of them were implementing oral care on the second day, and 77.5% of them were implementing oral care on the 3rd day.

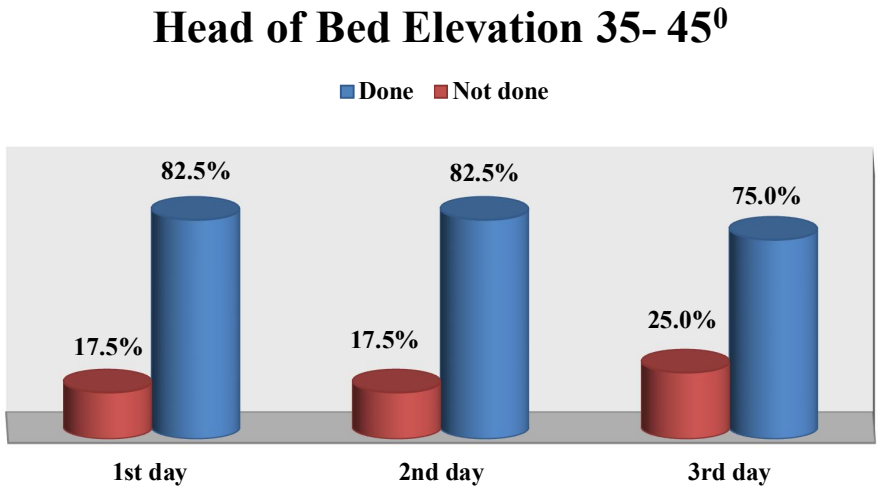

Figure (2): Frequency Distribution of Implementing Head of Bed Elevation 30º-45º among Study Group.

Figure (2): displays that 82.5% of the study group had an elevated head of bed 30º-45º on the 1st day, 82.5% of them on the 2nd day, and 75% of them on the 3rd day.

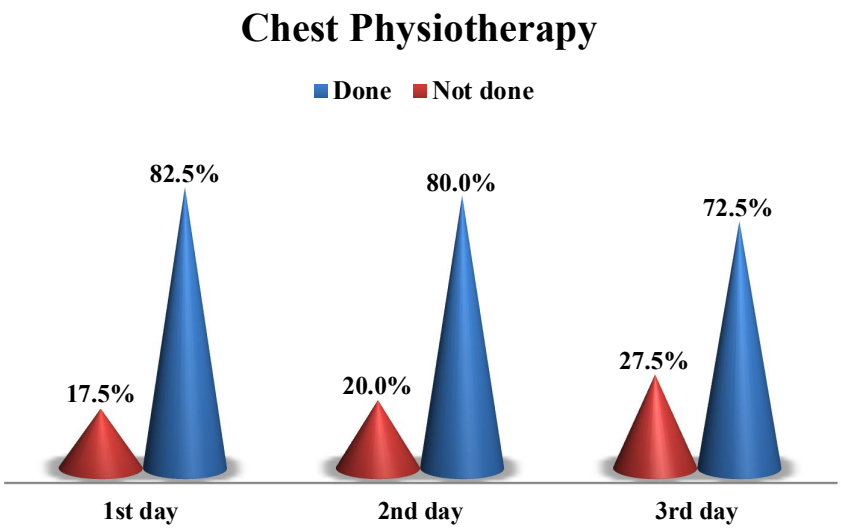

Figure (3): Frequency Distribution of Implementing Chest Physiotherapy among Study Group.

Figure (3): shows that 82.5% of the study group had done chest physiotherapy on the 1st day, 80% of them on the 2nd day, and 72.5% on the 3rd day.

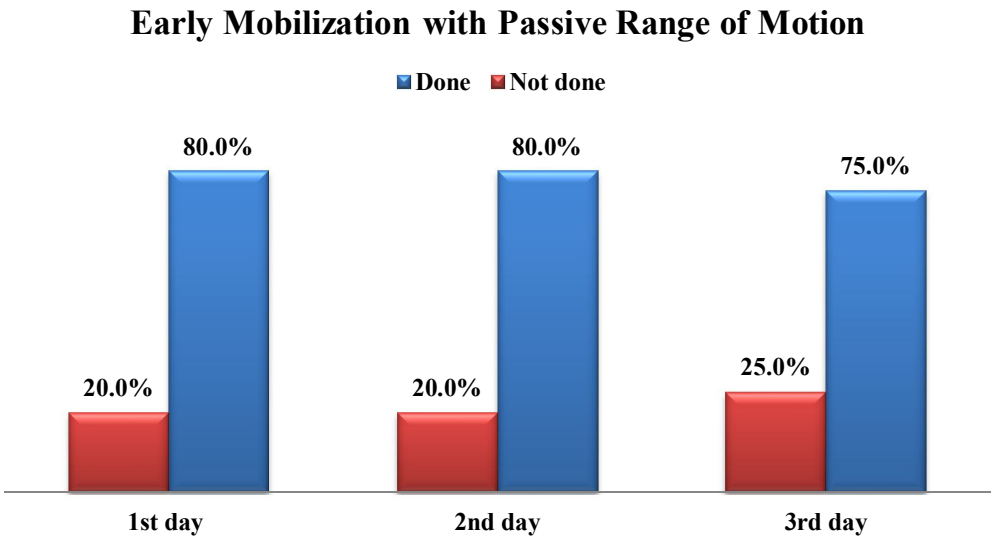

Figure (4): Frequency Distribution Early Mobilization Times Implementation with Passive Range of Motion among Study Group.

Figure (4): Displays that 80% of the study group had early mobilization with passive range of motion on the 1st and 2nd days, while 75% on the 3rd day.

Table (5): Frequency Distribution of the Studied Groups According to Their Mechanical Ventilation Duration Days Post Nursing intervention protocol & Hospital Routine care (N= 80):

Mechanical Ventilation(MV) Duration	Study Group (N=40)		Control Group (N=40)		Test of Significance	p-value
	N	%	N	%		
Length of Stay on MV:						
• 3-6 Days	22	55.0	6	15.0	**t = -4.790**	**0.000****
• 7-10 Days	13	32.5	17	42.5		
• >10 Days	5	12.5	17	42.5		
Mean ± SD	**6.52 ± 2.698**		**10.25 ± 2.698**			

Table (5): illustrates that, more than half (55%) of the study group post nursing intervention protocol, compared with only less than fifth (15.0%) of the control group who receiving hospital routine care had short

length of stay on MV between 3- 6 days with mean ± SD (6.52 ± 2.698) and (10.25 ± 2.698) respectively with statistical significance differences P – value 0.000**.

Table (6): Frequency Distribution of the Studied Groups According to Their Physical Assessment Parameters (hemodynamic and respiratory parameters) Post Nursing intervention protocol & Hospital Routine care (N= 80):

Physical Assessment Parameters	Study Group (N=40)				Control Group (N=40)				χ2	P. value
	Stable		Unstable		Stable		Unstable			
	N	%	N	%	N	%	N	%		
- Hemodynamic parameters	24	**60.0**	16	40.0	10	25.0	30	**75.0**	**10.026**	**0 .002****
- Respiratory parameters	25	**62.5**	15	37.5	13	32.5	27	**67.5**	**7.218**	**0 .007****

NS = not significance *P – value ≤ 0.05 **P – value ≤ 0.01

Table (6): shows that, three fifth (60%) of the study group compared with only one quarter (25%) of the control group had stable hemodynamic parameters with statistical significant differences between both groups documented with p-value (0 .002**). Furthermore, more than three fifth (62.5%) of study group compared with less than one third (32.5%) of control group had stable respiratory parameters with statistical significant differences between both groups documented by (P-value = 0 .007**).

Table (7): Percentage Distribution of the Studied Groups Regarding Pulmonary Complications Occurrence Post Nursing Intervention Protocol (n= 80).

Type of Mechanical Ventilation	Study Group (n= 40)		Control Group (n= 40)		Sig. Test	P. value
	N	%	N	%		
• VAP complication	3	7.5	8	19	**4.978**	**(0.014) ***
• Barotrauma complication	2	6	6	15	**6.132**	**(0.004) ****

Table (7): Illustrates that 7.5% & 6% of the study group had ventilator-associated pneumonia and barotrauma complications post-nursing intervention protocol, respectively, compared ١٩% & ١٥% of the control group receiving routine hospital care having ventilator-associated pneumonia and barotrauma complications. Finally, there was a highly statistical significant difference between both study and control group related to ventilator associated pneumonia (VAP) and barotrauma occurrence documented with p-value (0.014, and 0.004), respectively.

Discussion

Patients receiving invasive mechanical ventilation are at risk for numerous complications, including pneumonia. Ventilator-Associated Pneumonia (VAP) is one of the popular Intensive Care Units (ICUs) nosocomial infections with a prevalence rate of ten to seventy percent. The frequency of VAP is about twenty percent **(Hussein, 2020)**.

Ventilator-Associated Pneumonia is the most common ICU acquired pneumonia among invasive mechanically ventilated patients. VAP is recognized as a major issue worldwide, and common healthcare-associated infection(HAI) among developing countries associated with mortality, longer length of stay, and associated cost burden among patients **(Kharel *et al.*, 2021)**

The presence of air in the pleural cavity, known as pneumothorax, is a serious complication of mechanical ventilation that is linked to increased morbidity and mortality. It is a life-threatening condition found in the differential diagnosis of respiratory failure and chest pain, and it necessitates prompt identification and treatment. Pneumothorax is a life-threatening complication of mechanical ventilation that, if left untreated, has a high mortality rate. Thoracic trauma or iatrogenic injuries, such as complications of central line positioning, regional blocks, or mechanical ventilation, are the most common etiologies of Pneumothorax in mechanically ventilated patients **(MubdirHadiDhakeel, 2021)**.

Therefore, the current study was aimed to apply and evaluate the effect of implementing nursing intervention protocol on reducing selected pulmonary complications among mechanically ventilated patients

As regard to demographic characteristics among the studied groups, the current study findings illustrate non-statistically significant

differences were seen between the two studied groups concerning the demographic and medical variables, which indicates that the two groups were nearly homogenous.

The findings of the present study showed that nearly one-third of the study and control groups their age ranged between "30– 39" years old with mean age ± SD (39.9 ± 12.87) and (40.1 ± 13.56) years, respectively. A finding of the current study explains by the researcher perspectives that, this similarity in age distribution reflects an important baseline characteristic that ensures comparability between the two groups.

The age range observed in the study likely corresponds to the typical demographic of mechanically ventilated patients in critical care settings, often including individuals with acute or chronic health conditions requiring respiratory support. The comparable mean ages and standard deviations between the groups further validate that any differences in outcomes are less likely influenced by age and can be attributed more confidently to the intervention being evaluated.

This result is in contrast with **(A. M. Shaban, El-Mokadem, N. M., & Abdallah, S. E., 2021)** whose study showed that, The mean age of the participants in the study group and control group was (57.79 ±2.87 and 58.40 ±4.42) years old respectively. This outcome was additionally negated by **(S. S. Amin, El Mokadem, N. M., Doha, N. M., & Abdullah, S. E., 2023)** who showed that there was no statistically significant difference between both study and control groups (P > 0.05) with mean age ± SD (51.9667 ± 12.02) and (54.6667 ± 8.88) years, respectively.

This result is also in contrast with **(Aziz, 2020)** who reported that more than third of study and control groups were in the age group of (51-65) years old with mean age± SD (45±16.5) and (46±14) among study and control groups respectively. However, this contradicts **(Younes *et al.*, 2022)** who concluded that it noted that the mean age of the intervention group was 45.37 ± 9.07 years as compared to 42.47 ± 8.92 years of the control group with no statistically significant difference between the two groups(p-value=0.17).

As regards gender, the current study found that greater than two-thirds of the study and control subjects were males. The finding of this study is explained by the researcher perspectives that; males have a higher risk than females because of high exposure to major stresses, occupational related hazards, and frequent use of hookahs and cigarettes.

The current study finding was consistent with **(Ghiani, 2020)** found that males were represented greater than two-thirds in mechanically ventilated patients. On the same line, this finding is compatible **(S. S. Amin, El Mokadem, N. M., Doha, N. M., & Abdullah, S. E., 2023)** who referenced that males represent more than half of both control and study groups. In addition, the study done by **(Hammouda *et al.*, 2022)** who reported that more than two-thirds of the study and control subjects were males.

With respect to residence and educational level, it was observed that, almost two thirds of the study group and more than half of the control group belonged to rural areas, while more than one third of them were illiterate. Finding of the current study is explained by the researcher perspectives that, most of the governorate in Upper Egypt is villages with a low degree of health care services and restricted access to medical care at Minia city and vast majority of people in rural Upper Egypt are illiterate because of rural culture, environmental factors and low socioeconomic status.

The current study finding was compatible with the study conducted by **(Eweas *et al.*, 2021)** who clarified that more than two-thirds of them belonged to rural areas and less than half of the study and control groups were illiterate.

As regards occupation, the study's outcomes highlighted that a more than one third of the study and control group was employee. This finding was contradicted by **(Eweas *et al.*, 2021)** who found that more than one third of the study participants was farmer.

On comparing the study and control groups by their medical characteristics, the study revealed that there was no statistically significant difference between both groups by their distribution of the diseases. As respects the purpose behind ICU admission, about one quarter of the study and control groups the main cause was respiratory disease followed by cardiac diseases.

The finding of this study is explained by the researcher perspectives that, respiratory and cardiac problems are the leading causes that compromises pulmonary circulation, normal ventilation process, and lunge compliance of the human body and henceforth they are the most widely recognized diagnosis among the mechanical ventilated patients. Also, the results of the current study may be explained by the researcher as respiratory issues are the major factors undermining the pulmonary circulation and regular ventilation processes,

making them the most prevalent diagnosis among patients on mechanical ventilation.

This outcome was similar with the study conducted by **(O. M. Ahmed, W. Y. Mohammed, M. M. Abd Elnaeem, *et al.*, 2023)** who found that regarding the cause of ICU admission, respiratory disease was the common cause in both study and control group with no statistically significant difference between them in this respect. This outcome was consistent with the study conducted by **(S. S. Amin, El Mokadem, N. M., Doha, N. M., & Abdullah, S. E., 2023)** who found that more than half of study group and control group, the leading cause of ICU admission was respiratory diseases.

On the other hand, the current study finding has contradicted with **(M. W. Ahmed *et al.*, 2023)** who showed that more than two thirds of the study and control groups the greatest purposes behind patient's admission were a head injury. The same as reported by **(Weheida *et al.*, 2022)** who said that regarding medical history, highest percentage of the study and control group had a medical history of cerebrovascular stroke, diabetes, and cerebral hemorrhage. This finding could be due to the nature of ICU admission as it was an emergency ICU that received many patients traumatized by a road traffic accident.

Regarding past medical history, the current revealed that approximately the highest percentage of the study and control group has no past health history, while almost one quarter of both groups has hypertension followed by diabetes mellitus, with no statistical significance difference between the two groups regarding to past medical history.

This finding supported by **(O. M. Ahmed, W. Y. Mohammed, & S. S. Mohamed, 2023)** who showed that the majority of both groups with no comorbidity. On the same line the current study results additionally were similar to **(Aziz, 2020)** who revealed that the highest percentage of both group had no past medical history, while near to quarter of study group and almost one third of control group had hypertension disease.

The current study finding consistent with the previous study by **(M. Amin *et al.*, 2023)** who illustrated that The most evident comorbidity in both groups was hypertension followed by diabetes mellitus. No statistically significant differences were noted between the two groups.

Regarding to smoking habits, the current study illustrated that more than one than one third of the study group compared with more than half of the control group were smoker. Finding of the current study explained by the researcher perspectives that; smoking increases the risk for growing more serious health issues as heart disease, lung failure/cancer, and stroke and may increment the risk of getting pneumonitis, likewise smoking causes inflammation, oxidative stress and protease-anti-protease imbalance of the lung tissue. Consequently, they need to utilize ventilation support as a life-saving intervention.

This outcome was similar with the study conducted by **(Eweas *et al.*, 2021)** whose study findings showed that nearly half of the study and control groups were smokers with no statistical differences between both studied groups. This result was conformity with the study done by **(N. S. Khalil *et al.*, 2018)** who showed that nearly half of the study and control group was smoker and there was no significant statistical differences were found between them.

This results were disagree with **(Safavi *et al.*, 2023)** who found that more than half of both study and control groups were nonsmokers with no statistical significant differences between them. The present study finding was in disagreement with **(Benjamin *et al.*, 2023)** who displayed that the vast majority of both groups were non-smoker.

As regards mechanical ventilation type, the current study illustrated that more than two thirds of both study and control groups were on invasive ventilation type. The finding of the current study is explained by the researcher perspectives that invasive ventilation presented in endotracheal tube (ETT) and tracheostomy tube is the most common type in ICUs. The current study was consistent with **(Kaur *et al.*, 2022)** who found that more than half of studied groups were on invasive ventilation.

Regarding to mechanical ventilator mode, the outcome illustrated that most of both study and control groups were connected with SIMV mode. The finding of the current study explains by the researcher perspectives that: in light of the fact SIMV mode reflects common clinical practice in managing mechanically ventilated patients. SIMV is frequently utilized in critical care settings due to its flexibility and benefits in facilitating both mandatory and spontaneous breaths.

The current study was consistent with **(Sayed, 2024)** whose study results revealed that SIMV mode was the most common mode used for nearly half of studied patient in both control and study group. Simultaneously, the present study finding was in agreement with **(Abdelaziz**

Mohammed *et al.*, 2023) who found that around two thirds of the study groups were on SIMV mode.

Related to the application of nursing intervention protocol measures, "30°-45° elevation of head of bed and oral care with chlorhexidine, chest physiotherapy and early mobilization with passive range of motion" which include some approaches of vital importance and help to achieve success when applied totally, are becoming more and more important and recommended more often in national and international guidelines.

The applications were conducted at high rate during the three days of MV initiation. The application rate was rather high at morning shift, then the rate declined dramatically at evening and night shifts. The researcher proposed that the noted outcome can be ascribed to increasing work load and fewer staff number was speculated to be the reason of this decline.

The current study finding supported by **(Karagözoğlu *et al.*, 2018)** who found that 30°-45° elevation of bedheads and daily oral care with chlorhexidine applications were conducted at the rate of 100%, While the application rate was rather high at 08.00-16.00 shift, the rate declined dramatically at evening (14%) and night (7%) shifts. The current study finding supported by **(Liu *et al.*, 2020)** who found that there were highly statistically significant differences between the study and control groups related to implementing oral care and 30°-45° elevation of head of bed.

The current study was opposite to the study done by **(Abd-alraheem *et al.*, 2020)** whose study results showed that regarding the frequency of oral care, oral care provided to approximately half of the patients once or twice daily not at three shifts to all study groups.

Effectiveness of implementing nursing intervention protocol versus routine hospital nursing care on reducing selected pulmonary complications among mechanically ventilated patients:

Related to the comparison between the study and control groups by their duration of mechanical ventilation / days after nursing intervention implementation, the current study finding illustrated that more than half of the study group were staying on MV for a shorter duration (3-6 days), on the other hand, almost one third of control group were staying on MV for a longer duration (7-10 and >10). with a highly statistically significant difference between both studied groups study and control groups (P-value .005), mean length of stay ± SD were (6.52 ± 2.698) and (10.25 ± 2.698) respectively.

The researcher's viewpoint suggests that adopting adjusted standardized nursing intervention practices can lower the occurrence of such complications, enhance patient prognosis and care quality, consequently shortening the duration of ventilation support and hospital stays on average. Additionally, the preventive methods applied to patients, who are staying at ICUs on mechanical ventilators, is very important, and the most important indicator of effectiveness of treatment and care is the number of days spent on mechanical ventilation.

The current study was consistent with **(O. M. Ahmed, W. Y. Mohammed, & S. S. Mohamed, 2023)** who illustrated that in relation to duration of mechanical ventilation, a highly statistically significant difference was put into evidence between study and control group with p-value of (<0.001**).

On the same line, the current study also was similar to **(Weheida *et al.*, 2022)** who found that a statistically significant difference between control and study group patients related to the length of stay within the intensive care unit and duration of the patient on a mechanical ventilator at p ≤0.001. Besides, the current study finding disagreed with the study done by **(Sepahyar *et al.*, 2021)** who found that there no statistical significant difference between both studied groups.

At the same line, **(Triamvisit *et al.*, 2021)** reported that although The length of stay on MV was reduced among intervention group it did not show statistical significance (11.88 vs. 15.42 days, P=0.217). Also, **(Kallet, 2019)** stated, execution of a full elements of ventilator care bundle is correlated with decreases in ventilation days and improve their patient results. Furthermore, **(A. M. Shaban, El-Mokadem, N. M., & Abdallah, S. E., 2021)** whose study results reported that that there was a highly statistically significant decrease in the duration of mechanical ventilation and ICU length of stay in the study group compared to the control group post intervention.

Regarding to percentage distribution of the studied groups regarding pulmonary complications occurrence post nursing intervention protocol, the current study findings showed that very low percentage of the study group post-nursing intervention protocol, compared with high percentage of the control group receiving routine hospital care had ventilator-associated pneumonia and barotrauma complications. Finally,

there was a highly statistical significant difference between both study and control group related to ventilator associated pneumonia (VAP) and barotrauma occurrence documented with p-value (0.014, and 0.004), respectively.

The highly significant differences highlight the effectiveness of the protocol in mitigating these complications. Also, these results emphasize the critical role of evidence-based nursing protocols in reducing complications, improving patient safety, and supporting better recovery for mechanically ventilated patients

Regarding incidence of VAP, the current study was in an agreement by **(A. M. Shaban *et al.*, 2021)** whose study findings Illustrates that there was a highly statistically significant reduction in the incidence of VAP rate in the study group compared to the control group post intervention $p < 0.001$. In the study group 26.9% of the participants have VAP while 69.2% of participants in the control group have VAP. There was a 22% reduction in the VAP incidence rate in the study group than in the control group.

Moreover, the current study consistent with **(M. Amin *et al.*, 2023)** whose study results showed that there was a statistically significance difference in the occurrence of VAP between both groups on days 7 and 9 (P=0.014, 0.003 respectively), and the incidence of VAP was greater among the control group than in the intervention group with a highly statistically significant difference between them.

On the same line, the current study finding was augmented by **(M. W. Ahmed *et al.*, 2023)** who stated that it was discovered that the study group with ventilator care bundle implementation had a significantly shorter ICU stay, lower VAP, and a lower rate of delirium than control group. Additionally, **(Weheida *et al.*, 2022)** reported that a substantial statistically significant decrease in the CPIS means score VAP after implementing the ventilator care bundle.

Furthermore, **(Safavi *et al.*, 2023)** concluded that designing and implementing simple and evidence-based guidelines can reduce the risk and incidence of VAP in the intensive care units. Then, the length of hospital stays and the costs will be reduced both for the patients and the healthcare system. At the same line, **(Sayed, 2024)** who 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 as **(Hassan *et al.*, 2022)** which used the modified ventilator bundle to prevent and decrease the incidence of VAP. They reported that the ventilator bundle compliance was associated with decreased VAEs occurrence, specifically IVAC and PVAP.

Additionally, the study finding agreed with another study conducted by **(Younes *et al.*, 2022)** who concluded that twice-daily multimodality chest physiotherapy interventions in the form of MH, endotracheal suctioning, patient positioning plus chest percussion and mechanical chest vibration had a better effect on decreasing VAP occurrence as well as enhance patient`s clinical outcome. Also, **(Fortaleza *et al.*, 2020)** reported that there was a positive impact of reducing VAP incidence after the introduction of a bundle for prevention of ventilator-associated pneumonia in medical-surgical intensive care units.

On the other hand, the findings of the current study was different from what was reported by **(Goel *et al.*, 2019)** who found that VAP prevention bundle did not significantly decreased the VAP incidence rate post intervention. A possible explanation of the study findings may be attributed to using a different VAP prevention bundle that focused only on head of bed elevation (HoB) and daily sedative interruption.

Regarding incidence of barotrauma (pneumothorax), the current study was in an agreement by **(Abdelaziz, 2020)** whose study results showed that the majority of patients in the control group was complicated (e.g. pneumothorax) versus just half of the patients in the study group. The same as reported by **(Kallet, 2019)** who concluded that ventilator bundles had a great effect on reducing VAE and pulmonary complication among mechanically ventilated patients.

Also, **(Hammouda *et al.*, 2022)** reported that The findings of this study illustrated that almost three quarters of the bundle group was simply weaned from IMV in comparison with one-third of the control group with a highly statistically significant difference ($p < .001$). This finding is related to the use of competent VCB practices that significantly reduced the incidence of ventilator-associated complications and improved the patients' outcomes.

Furthermore, the current study was augmented by **(Aly Mohammed *et al.*, 2020)** who reported that in relation to pulmonary complication (Barotrauma and VAP) complications, it was founded that control group had higher rate of complications than study group after implementing nursing care protocol.

Conclusion

Based on the results of the present study, it can be concluded that applying nursing intervention protocol had a beneficial effect on decreasing incidences of selected pulmonary complications as (ventilator associated pneumonia and barotrauma) among study group compared to the control group.

Recommendations

For Nurses:

1- Designing an in-service training educational program for the ICUs nurses to upgrade nurses' knowledge pulmonary complications among mechanically ventilated patients.

2- Strict supervision and follow up of nurses' adherence with implementation structured nursing protocol with their patients.

3- Developing a simplified and comprehensive guidance booklet including basic information about VAP as; definition, precipitating factor and nursing role towards prevention, components of ventilator bundle and its importance.

4- Nursing protocol checklist should be developed and appropriately followed by all nursing staff to prevent VAP and other complications in ventilated patients.

Recommendations for furthers researches

5- Replication of the study on a larger probability sample from other geographical locations in Egypt to grantee the generalizability of the study.

6- Future research ought to be conducted to implement a structured nursing intervention protocol and assess its effect on VAP and barotrauma rate, hospital expenses, time-span of MV connection, hospital and ICU stay among mechanically ventilated patients

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