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Minimizing pulmonary complication among mechanically ventilated patients: Implementing nursing protocol

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Abstract

Background: Application of mechanical ventilation is crucial for the resuscitation and all-encompassing care of patients in severe condition. While mechanical ventilation is a crucial life-saving management for numerous number of patients in critical care units, it can cause many pulmonary complications. Implementing nursing protocol can improve patient outcomes. This protocol emphasizes standardized care, early intervention, and multidisciplinary collaboration to enhance recovery and reduce complications.

Aim of the study: Investigate the impact of implementation of nursing protocol on minimizing pulmonary complication among mechanically ventilated patients.

Study design: Quasi - experimental research design (Study & control) used to accomplish the goal of the present research.

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: This research was conducted in critical care units, including the Chest Intensive Care Unit and the Intensive Care Unit, at the Cardio-thoracic Surgery Hospital and the Main Minia University Hospital in Minia City, Egypt.

Tools of data collection: One tool was utilized; it contains four parts. Part (I): Patient's Demographic Characteristic, Part (II): Medical Data. Part (III): Hemodynamic Parameters Assessment. Part (IV): Nursing Intervention Protocol.

Results: The current study results revealed that 7.5% & 6% of the study group post-nursing protocol compared with 19% & 15% of the control group receiving routine hospital care had ventilator-associated pneumonia and barotrauma complications, respectively, with a highly statistical significant difference between both groups documented with p-value (0.014, and 0.004), respectively. Implementation of nursing protocol have a direct effect on mechanically ventilated patient’s outcomes and minimizing pulmonary complication among study group.

Conclusion: Based on the research's findings, it can be confirmed that, implementation of nursing protocol for mechanically ventilated patients among study group was effective and showed significant improvements in the overall patients’ outcome compared with the control group.

Recommendations: Creating a training program for ICU nurses' in-service training to improve their practice and understanding of advanced nursing interventions that enhance the outcomes of patients on mechanical ventilation.

Keywords: Mechanical ventilation, mechanically ventilated patients’ outcomes, nursing intervention protocol, pulmonary complications

Introduction

Mechanical ventilation (MV) is a vital intervention in critical care units, offering crucial respiratory management to patients until they regain the ability to breathe independently. It is widely utilized for various indications, with approximately two-thirds of ICU patients requiring invasive ventilator support. The evolution of MV techniques and technologies has significantly enhanced patient outcomes and comfort [1, 2].

Mechanical ventilation (MV) is an essential aspect of critical management, ensuring vital respiratory support for patients who are unable to breathe sufficiently on their own [3]. Although mechanical ventilation is a crucial intervention, patients receiving this support face a high risk of complications. These include ventilator-associated pneumonia, prolonged ventilation dependency, barotrauma, extended weaning periods, and psychological effects such as delirium, all of which can hinder recovery. Moreover, other complications associated with critical care can develop, resulting in prolonged hospitalizations, higher healthcare expenses, and negative long-term outcomes for patients [4, 5].

Ventilator-associated pneumonia (VAP) is more common in patients receiving mechanical ventilation due to impairments in the body's natural defenses that typically protect the lungs and airways. VAP can complicate the weaning process, extending the need for mechanical ventilation. On average, it adds 4–9 days to the intubation period compared to patients without VAP, resulting in longer ICU stays and increased healthcare expenses. Moreover, VAP can significantly elevate the mortality rate, with patients developing this condition being twice as likely to die compared to those who do not experience it [6, 7].

One of the most common causes of infection-related complications and mortality in intensive care units (ICUs), especially in poor countries, is ventilator-associated pneumonia (VAP). VAP, the most common form of pneumonia in patients on mechanical ventilation with artificial airways, with significant clinical complications. It is linked to a twofold increase in mortality, elevated healthcare expenses, prolonged dependence on mechanical ventilation, and extended stays in both ICUs and hospitals [8, 9]. Ventilator-associated pneumonia (VAP) is characterized by the colonization of pathogens in the oropharynx that occurs more than 48–72 hours after intubation in a patient who did not have a pre-existing lung infection when mechanical ventilation was first initiated. The diagnosis is typically made by identifying the onset of symptoms on or after the day mechanical ventilation was started [10].

Ventilator-associated pneumonia (VAP) is diagnosed through a combination of clinical signs, symptoms, and imaging findings, such as lung consolidation observed on chest radiography (CXR) or computed tomography (CT) scans. Common clinical indicators include tachypnea, fever, crackles on lung auscultation without another obvious cause, leukocytosis, changes in respiratory secretion characteristics (e.g., purulent discharge), an increase in fractional inspired oxygen (FiO_2) by more than 10%, tachycardia or bradycardia, and respiratory distress. These symptoms usually appear 48–72 hours after mechanical ventilation is started and endotracheal intubation is performed [2, 11, 12].

A major and potentially lethal consequence for patients on mechanical ventilation is pulmonary barotrauma, which can present as pneumothorax. It occurs when air enters spaces outside of the alveoli, where it would not normally be found, often due to excessive pressure or over distension of the lungs during ventilation.**(13, 14)** Barotrauma typically results from the rupture of alveoli, causing tissue damage due to pressure imbalances in enclosed areas of the body. Increased morbidity and death have been linked to pulmonary barotrauma. Negative intrathoracic pressures are essential to human respiration in its normal state. Patients on mechanical ventilation, however, breathe through positive pressure. Positive pressure breathing, which is not physiological, could result in consequences including barotrauma [15, 16].

Nurses are integral to the care and management of mechanically ventilated patients, actively monitoring their condition and ensuring appropriate interventions, encompassing continuous monitoring, prevention of complications, and facilitation of recovery. Despite this vital role, variations in nursing practices and adherence to evidence-based guidelines often contribute to inconsistencies in patient outcomes. Without standardized care approaches, the risk of adverse events and poor clinical results increases, resulting in longer intensive care unit stays, increased medical expenses, and increased patient morbidity and fatality [17, 18].

Implementing nursing protocol is a proven strategy for addressing these challenges and enhancing the care of mechanically ventilated patients. Nursing protocols are structured, evidence-based guidelines designed to standardize care practices and improve patient outcomes. These protocols establish best practices for key interventions, including elevating the head of the bed between 30° and 45°, conducting daily oral care with chlorhexidine, and providing chest physiotherapy (vibration and percussion) [17, 19, 20].

This research focuses on evaluating the impact of implementing nursing protocol on the minimizing pulmonary complication among mechanically ventilated patients. Specifically, it aims to analyze the connection between following protocols and critical outcomes, such as the occurrence of complications, and the length of mechanical ventilation. The study will also explore the role of nursing protocols in fostering a culture of accountability and excellence in critical care settings.

Significance of the study

Mechanical ventilation is a crucial management procedure for critically ill, but it comes with risks of serious complications, many of which can be prevented. By effectively managing these risks, it is possible to reduce the duration of stay in the critical care units, minimize long-term physical, mental, and emotional harm to patients and their families, increase hospital reimbursement, and lower overall healthcare expenses [5, 21].

From a clinical perspective, this study emphasizes the importance of standardizing nursing care to improve patient outcomes. The purpose of the research is to investigate the effectiveness of nursing protocols, focusing on their potential to reduce complications like ventilator-associated pneumonia (VAP) and pulmonary barotrauma, while also shortening ICU stays. These improvements not only enhance patient recovery but also alleviate the physical and emotional burden on patients and their families [17, 22].

A recent study in Egypt found that mechanically ventilated patients are vulnerable for contracting ventilator-associated pneumonia and other complications, which are major consequences of prolonged mechanical ventilation. These complications contribute to extended hospital stays, poor patient prognosis, and high mortality rates. Ventilator-associated pneumonia is a primary contributor to mortality in ICU patients, affecting 38.4% of those on mechanical ventilation [19].

Data from the Intensive Care Unit at Minia University Hospital for (2022-2023) indicated that around 723 patients were admitted, with 63.8% of them on mechanical ventilation. Among these patients, 32.8% developed 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

Patients and Method

Aim of the Study

This study aimed to investigate the effect of a nursing implementation protocol in minimizing pulmonary complications in patients undergoing mechanical ventilation.

Research Hypothesis

H: patients who received the designed nursing protocol have more positive outcomes than those receiving routine hospital care.

Research Design

A quasi-experimental research design was adopted in this research, involving both a study group and a control group. The design was intended to investigate the relation between the independent variable (nursing protocol) and the dependent variable (outcome).

Setting

This study was carried out in intensive care units, specifically the Chest Intensive Care Unit and the Intensive Care Unit, at both the Cardio-Thoracic Surgery Hospital and Main Minia University Hospital in Minia City, Egypt.

Patients

A purposive sample of 80 adults mechanically ventilated (MV) patients was included in the study, from the beginning of mechanical ventilation. The patients were randomly divided into two equal groups. The first group, referred to as the study group, comprised 40 patients who received the full nursing intervention protocol. The second group, the control group, consisted of 40 patients who received routine hospital care throughout the MV period.

The sample size was determined using the [23] 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).

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

The selection of both groups in the current study was based on the following inclusion and exclusion criteria:

Inclusion Criteria

1. Intubated patients who were mechanically ventilated.
2. Newly admitted adult patients within the first twenty-four 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. Neuromuscular diseased patients.
5. Patients with terminal diseases.

Study Duration

The data for the study was gathered over a six-month period, spanning from May 2023 to October 2023".

Tools for Data Collection

The study utilized one tool, created by the researcher after conducting a thorough literature review.

Tool: "Patient Assessment"

Data were collected during the initial contact with patients and the tool consisted of four parts:

Part (I): Patient's Demographic Characteristic

It included five items—patient age, gender, residence, education, and occupation—that were gathered once for each group before the intervention.

Part (II): Medical Data

It includes six items: date of admission, current medical history, past medical history, smoking habits, date of discharge, and length of stay.

Part (III): Hemodynamic Parameters Assessment

This part, developed by the researcher to assess the patient's hemodynamic status, consists of seven items: axillary temperature (T), heart rate (HR), respiratory rate (RR), mean arterial blood pressure (MAP), central venous pressure (CVP) readings, arterial blood gases (ABG) monitoring (including pH, partial pressure of oxygen [PaO2], partial pressure of carbon dioxide [PaCO2], bicarbonate [HCO3], oxygen saturation [SaO2]), and laboratory investigations (hematocrit, leukocyte count, and electrolytes).

Reference Ranges

The normal reference ranges for hemodynamic parameters include temperature between 36.5–37.4 °C, heart rate ranging from 60 to 100 beats per minute, and mean arterial pressure (MAP) between 70–100 mmHg. Respiratory rate should be between 12 to 20 breaths per minute, while peripheral oxygen saturation (SpO2) is ideally ≥ 95%. Central venous pressure (CVP) should be within the range of 5–12 mmHg. For arterial blood gas (ABG) monitoring, the pH should be between 7.35 and 7.45, the partial pressure of carbon dioxide (PaCO2) should be between 35–45 mmHg, and oxygen saturation (SaO2) should range from 80 to 100% [24].

Scoring System of Hemodynamic Parameters

The scoring system assigned one of two responses (normal or abnormal). A "normal response," indicating a good outcome, was scored as 1, while an "abnormal response," indicating a poor outcome, was scored as (0). The total score was determined by simply taking the total number of items mentioned and dividing it by the number of "yes" answers. A threshold of 60% was set, where a score of 60% or higher indicated a positive outcome, while a score below 60% suggested a negative outcome and a greater likelihood of complications.

Part (IV): Nursing Intervention Protocol adapted from [19, 20, 25, 26]

It consists of four items used only for the study group, which incorporate the four nursing interventions: oral care with chlorhexidine, elevation head of bed (30º-45º), and chest physiotherapy (vibration and percussion). 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 conducted to assess how well the tool measured its intended variables. A panel of five experts in the field, consisting of one professor and four assistant professors from the Medical Surgical Nursing department at the Faculty of Nursing, Minia University, reviewed the developed tool. The assessment focused on factors like the extent of content, clarity, relevance, practical application, phrasing, length, layout, and overall presentation. All panel members (100%) unanimously agreed that the tool was valid and appropriately aligned with the study's objectives, and all suggested modifications were implemented.

Tool Reliability

Tool reliability was assessed to determine how well the items measured the study concepts and their correlation with one another. Reliability was statistically evaluated using the Cronbach's Alpha test to ensure the consistency of the study tools. The reliability coefficients for the hemodynamic 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 conducted with 10% of the total sample (8 patients) of mechanically ventilated patients from the ICUs that previously mentioned to evaluate the applicability of the research process, as well as the objectivity of the study tools. Following the pilot study, no changes were made to the data collection tools. Consequently, the patients involved in the pilot study were also included in the main study sample.

Ethical Considerations

The study received approval from the ethical committee at the Faculty of Nursing, Minia University, as well as from the dean of the Faculty of Nursing, Minia University, the director of the Cardiothoracic Surgery University Hospital, the director of the Main Minia University Hospital, and the academic team at the Research Center and Technology. Informed oral consent was obtained from the patients' relatives, who were provided with details about the study's purpose, procedures, and nature. They were assured that participation was voluntary and that they could refuse or withdraw at any time without needing to offer an explanation. To ensure confidentiality, all collected data were coded, and participants' identities were kept anonymous.

Administrative Design

Approval was secured from the relevant authorities at the Faculty of Nursing, Minia University. Subsequently, official signed letter was directed to the director of main Minia University Hospital and the director of the Cardiothoracic Surgery University Hospital in New Minia City, detailing the study's objectives and outlining the steps for data collection.

Study Procedure

Preparatory Phase

The current study involved the development of various data collection tools, obtaining formal written consent, and reviewing relevant literature and theoretical concepts related to the study's topics. This process included consulting textbooks, articles, and periodicals to guide the creation of the data collection instruments. These preparatory activities were carried out over a period of approximately two months prior to the start of the study, leading up to the execution of the pilot study.

Implementation Phase

After obtaining official approval, the researcher visited the chosen sites during day shifts to begin collecting data. Oral agreement was gained from the patients' relatives after each patient and their family received a briefing on the study's goals and methods. The patients were subsequently split into two equal groups at random. Data collection began with the control group, where the researcher gathered demographic and medical information from patient files and family members, followed by a physical assessment of hemodynamic parameters to establish baseline data on the first day of mechanical ventilation (MV). This process took about 45 minutes to an hour. While the control group received standard hospital care during the MV period, the study group followed a nursing intervention protocol, implemented by the researcher in collaboration with the medical and nursing teams, as well as nursing interns. The protocol included the following measures:

1. **Head of Bed Elevation 30º-45º:** One of the most common and effective nursing interventions is elevating the backrest of the bed to a semi-recumbent position, typically at 30º-45º, unless contraindicated. During patient repositioning, careful attention was given to ensure that any attached tubes and connections, such as the ECG monitor, feeding tube, urinary catheter, and arterial line, were properly managed to prevent pulling, stretching, or kinking of these lines.
2. **Oral Care with the Chlorhexidine:** Oral care includes routine examination of the buccal mucosa, teeth, lips, palate, and tongue to ensure their integrity. It involves moisturizing the lips and oral cavity, with cleaning performed through mechanical or pharmacological methods. Mechanical decontamination entails suctioning the pharynx and mouth, as well as brushing the teeth with a toothbrush three times daily (every 4 hours) Mechanical decontamination is used to eliminate plaque and bacteria from the tongue, teeth, and hard palate. Pharmacological decontamination involves the

application of an antiseptic oral rinse with antimicrobial properties, which helps decrease the risk of pneumonia.

3. **Chest Physiotherapy (Vibration and Percussion):** Chest physiotherapy was administered every eight hours after auscultating the patient's chest. Each session lasted approximately 15-20 minutes and included the following steps:

- **Vibration:** The chest physiotherapy was performed during expiration, with the aim of shaking the patient's chest to loosen and dislodge secretions, allowing them to move toward the main bronchi. The vibration cycle lasted for 10-15 minutes.
- **Percussion:** The researcher covered the patient's chest with a towel or cloth, ensuring that percussion was avoided over the sternum, ribs, breast, spine, or stomach. The hand was cupped to gently strike the chest, ensuring that percussion was not painful for the patient. This procedure typically lasted for 3-5 minutes, after which the patient was encouraged to cough if conscious, or suction was performed if the patient was unconscious.

Evaluation Phase

After 72 hours, on the fourth day of mechanical ventilation initiation, the control group continued to receive routine hospital nursing care from critical care nurses, while the study group followed the nursing intervention protocol under the investigator's supervision. Over the next three days, the two groups were monitored, and changes in hemodynamic status and the presence of selected pulmonary complications were assessed using the second, third, and fourth parts of the study tool. Each assessment session took approximately 30–45 minutes.

Limitations of the Study

The findings have limited generalizability and should be tested on a larger sample, including patients from various geographical regions in Egypt, to more accurately reflect the broader population of patients in critical care units.

Results

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

Demographic 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 just over one-third of both the study and control groups were in the 30–40 age range, with 30.0% and 32.5% in each group, respectively. In terms of gender, the majority of participants in both groups were male, with 62.5% in the study group and 72.5% in the control group. Regarding residence, 70% of the study group and 57.5% of the control group lived in rural areas. The table also highlights that 37.5% of the study group and 35% of the control group were illiterate. As for employment status, 40% of the study group were employed, while 45% of the control group had jobs.

Table (2) shows that 25% of the study group and 27.5% of the control group were admitted due to respiratory conditions. In terms of past medical history, 40% of the study group and 30% of the control group reported no previous health issues, while 27.5% of the study group and 30% of the control group had a history of hypertension. Regarding smoking habits, 45% of the study group and 52.5% of the control group were smokers. No statistically significant differences were found between the two groups based on their medical data.

Table 2: Distribution of Medical Data among the Studied Groups (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 (3): Frequency Distribution of the Studied Groups According to Their Homodynamic Parameters at Baseline and Post Nursing intervention protocol & Hospital Routine care (N= 80):

Homodynamic Parameters	At Baseline				Post-Intervention& Hospital Routine Care			
	Study (N=40)		Control (N=40)		Study (N=40)		Control (N=40)	
	N	%	N	%	N	%	N	%
Axillary Temperature								
Normal	30	75.0	28	70.0	27	67.5	18	45.0
Hypothermia	1	2.5	1	2.5	0	0	0	0
Hyperthermia	9	22.5	11	27.5	13	32.5	22	55.0
χ^2 (P. value)	0.269 (0.874) NS				4.114 (0.043)*			
Heart rate								
Normal	30	75.0	26	65.0	26	65.0	11	27.5
Bradycardia	2	5.0	2	5.0	5	12.5	9	22.5
Tachycardia	8	20.0	12	30.0	9	22.5	20	50.0
χ^2 (P. value)	1.086 (0.581) NS				11.396 (0.003)**			
Respiratory rate								
Normal	19	47.5	22	55.0	25	62.5	11	27.5
Bradypnea	10	25.0	8	20.0	3	7.5	8	20.0
Tachypnea	11	27.5	10	25.0	12	30.0	21	52.5
χ^2 (P. value)	0.489 (0.783) NS				10.172 (0.006)**			
Mean Arterial pressure (MAB)								
Normal	29	72.5	27	67.5	19	47.5	12	30.0
Low	5	12.5	7	17.5	10	25.0	15	37.5
High	6	15.0	6	15.0	11	27.5	13	32.5
χ^2 (P. value)	0.405 (0.817) NS				2.747 (0.253)NS			
Central Venous Pressure (CVP) reading								
Normal	21	52.5	28	70.0	24	60.0	17	42.5
Low	13	32.5	5	12.5	8	20.0	13	32.5
High	6	15.0	7	17.5	8	20.0	10	25.0
χ^2 (P. value)	4.632 (0.099) NS				2.608 (0.271)NS			
Arterial Blood Gases (ABG) reading pH within normal (7.35-7.45)								
Yes	27	67.5	24	60.0	29	72.5	20	50.0
No	13	32.5	16	40.0	11	27.5	20	50.0
χ^2 (P. value)	0.487 (0.485) NS				4.266 (0.039)*			
PaCo2 within normal level (35-45)mmHg								
Yes	25	62.5	23	57.5	26	65.0	14	35.0
No	15	37.5	17	42.5	14	35.0	26	65.0
χ^2 (P. value)	0.208 (0.648) NS				7.200 (0.007)**			
Hco3 within normal level (22-26) mEq/L								
Yes	27	67.5	24	60.0	24	60.0	12	30.0
No	13	32.5	16	40.0	16	40.0	28	70.0
χ^2 (P. value)	0.487 (0.485) NS				7.273 (0.007)**			
Oxygen saturation SaO2 (95%-100%)								
Normal	32	80.0	23	57.5	29	72.5	18	45.0
Low	8	20.0	17	42.5	11	27.5	22	55.0
χ^2 (P. value)	4.713 (0.030)*				6.241 (0.012)*			

Table (3) shows that there were no statistically significant differences between the study and control groups at baseline, except for oxygen saturation, which had a p-value of 0.030. The table also indicates that there were statistically significant differences between the study group, which received the nursing intervention protocol, and the control group, which received routine hospital care, in terms of temperature, heart rate, respiratory rate, and ABG values (pH, PaCO2, HCO3, and O2 saturation). The p-values for these differences were 0.043, 0.003, 0.006, 0.039, 0.007, 0.007, and 0.012, respectively

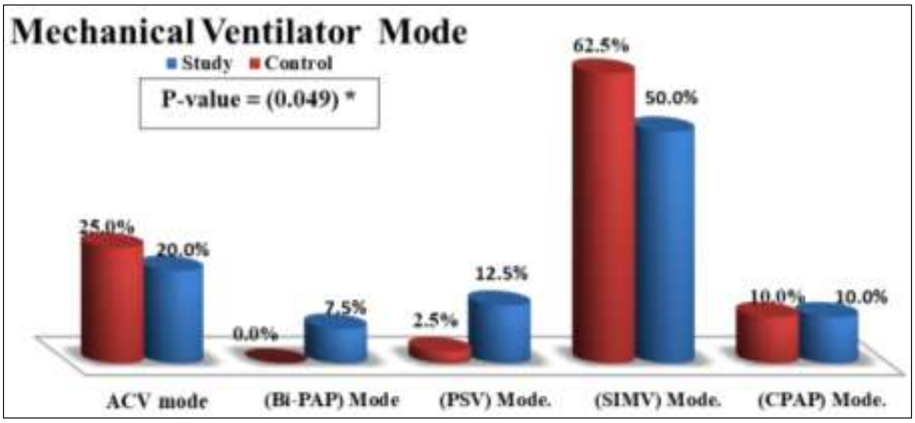

Fig 1: Frequency Distribution of the Studied Groups Regarding to Mechanical Ventilator Mode (n=80)

Figure (1) illustrates that 50% of the study group, compared to 62.5% of the control group, were on synchronized intermittent mandatory ventilation mode. Meanwhile, only 7.5% of the study group and 0% of the control group were on Bi-Level Airway Pressure. Statistically significant differences between the two groups were found, with a p-value of 0.049.

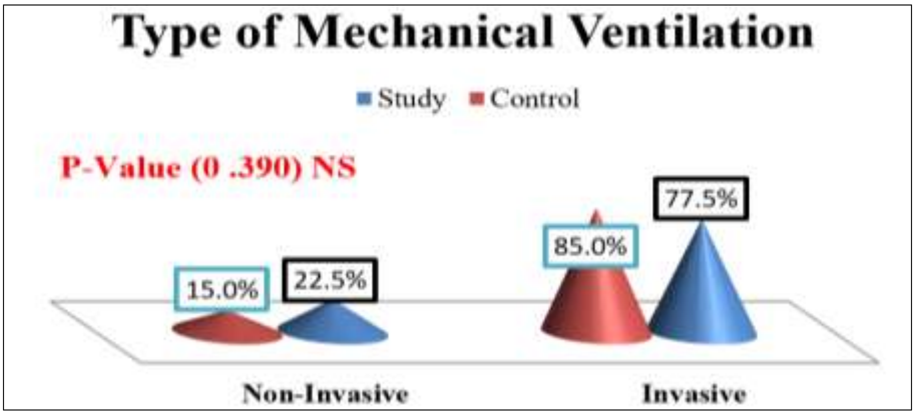

Fig 2: Distribution of the Studied Groups by Type of Mechanical Ventilation (n=80)

Figure (2) shows that 77.5% of the study group, compared to 85% of the control group, received invasive mechanical ventilation, with no statistically significant differences between the two groups.

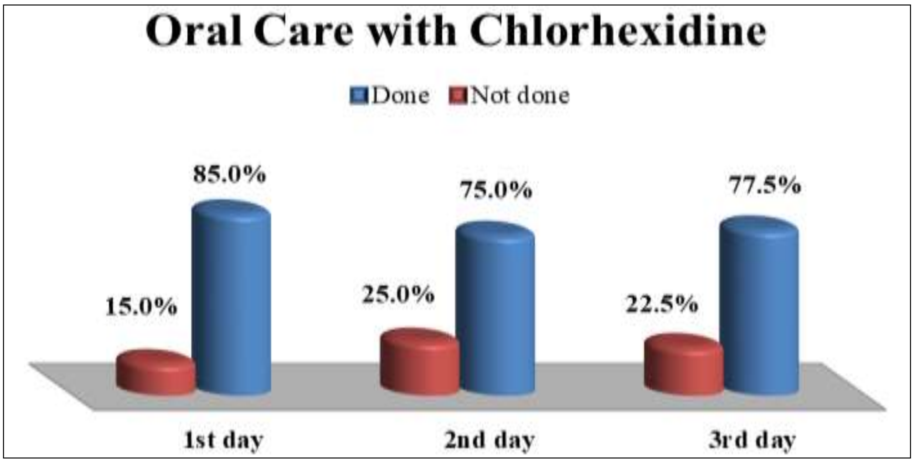

Fig (3): Frequency Distribution of Implementing Oral Care with Chlorohexidine among Study Group.

Figure (3): 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.

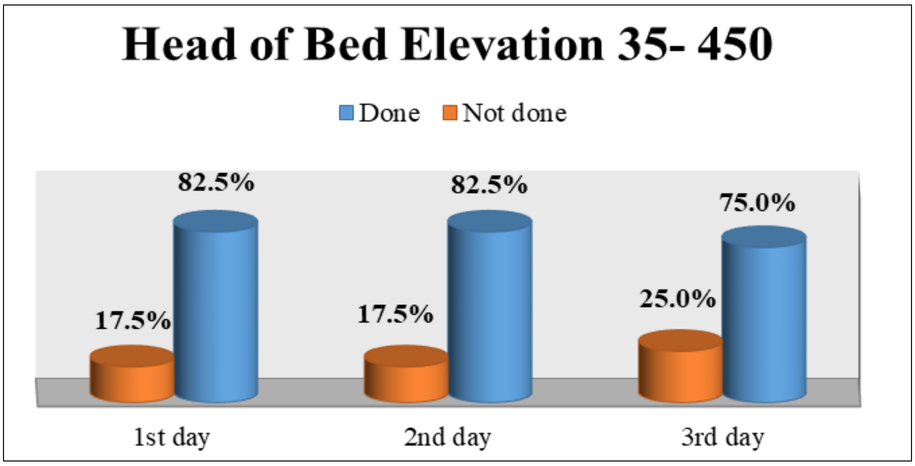

Fig 4: Frequency Distribution of Implementing Head of Bed Elevation 30º-45º among Study Group.

Figure (4): 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.

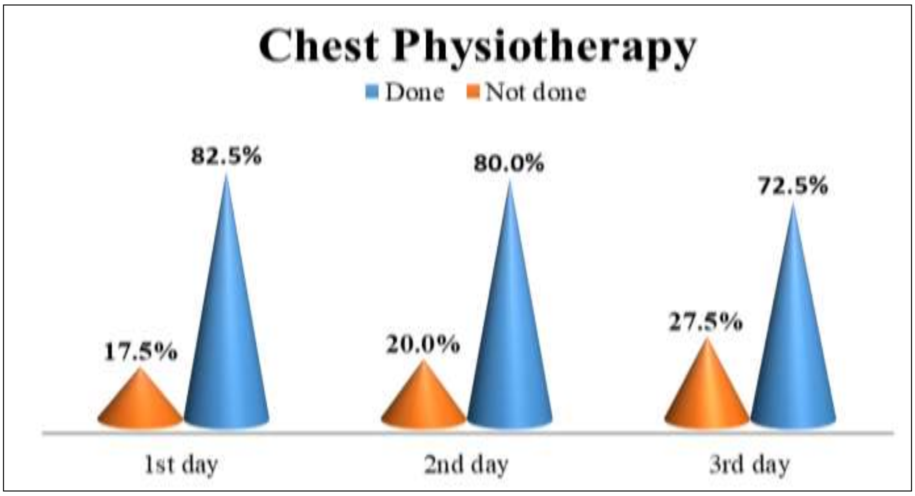

Fig 5: Frequency Distribution of Implementing Chest Physiotherapy among Study Group.

Figure (5): shows that 82.5% of the intervention group had done chest physiotherapy at 1st day, 80% of them on the 2nd day, and 72.5% on the 3rd day.

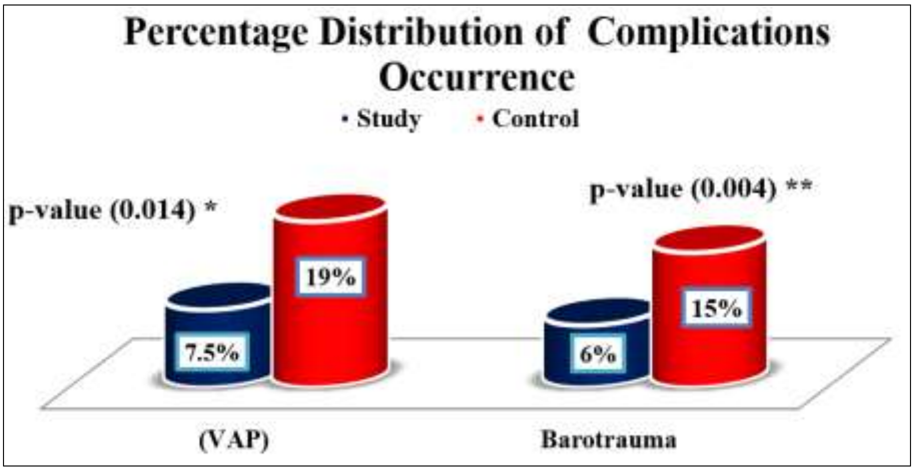

Fig 7: Percentage Distribution of the Studied Groups Regarding Pulmonary Complications Occurrence Post Nursing Intervention Protocol (n= 80).

Figure (7): The data shows that 7.5% and 6% of the study group developed ventilator-associated pneumonia and barotrauma complications following the nursing intervention protocol, respectively, while 19% and 15% of the control group, which received standard hospital care, experienced these complications. A highly significant statistical difference was found between the study and control groups regarding the incidence of ventilator-associated pneumonia (VAP) and barotrauma, with p-values of 0.014 and 0.004, respectively.

Table 4: Multiple Linear Regression Model Evaluating the Relationship Between Ventilator Associated Pneumonia Occurrence and Nursing Intervention Protocol.

Nursing Intervention Protocol	Ventilator Associated Pneumonia Occurrence					
	R2	Adjusted R2	B±SE	F	t	p-value
Oral Care with the Chlorhexidine	0.546	0.538	2.336±0.172	4.191	8.180*	0.008**
Head of Bed Elevation 30º-45º	0.613	0.551	2.270±0.179	3.095	8.475*	0.032*
Chest Physiotherapy	0.428	0.090	2.162±0.180	1.771	1.500	0.160

Table (4) predicts that, implementing nursing intervention protocol has a direct effect on decreasing the occurrence of ventilator associated pneumonia, the regression model, shows specially that implementing oral care with the chlorhexidine, head of bed elevation 30º-45º and early mobilization with range of motion (Independent factor) will decrease the occurrence of ventilator associated pneumonia (Dependent factor) as documented by p value (0.008, 0.032, 0.026) respectively.

Table 5: Multiple Linear Regression Model Evaluating the Relationship Between Barotrauma Complication Occurrence and Nursing Intervention Protocol.

Nursing Intervention Protocol	Barotrauma Complication Occurrence					
	R2	Adjusted R2	B±SE	F	t	p-value
Oral Care with the Chlorhexidine	0.398	0.339	2.164±0.154	2.314	1.876	0.083
Head of Bed Elevation 30º-45º	0.576	0.546	2.190±0.155	3.286	8.287*	0.025*
Chest Physiotherapy	0.408	0.392	2.172±0.152	2.303	1.092	0.084

Table (5) predicts that, implementing nursing intervention protocol will decrease the occurrence of Barotrauma complication, the regression model, shows specially that The risk of occurrence of barotrauma is decreased by 3.2 times by using head of bed elevation 30º-45º as documented with p value (0.025).

Discussion

Patients on invasive mechanical ventilation are vulnerable to various complications, including pneumonia. Ventilator-Associated Pneumonia (VAP) is a common nosocomial infection in Intensive Care Units (ICUs), with a prevalence rate ranging from 10% to 70%. The occurrence of VAP is approximately 20% [27].

Pneumothorax, the presence of air in the pleural cavity (iatrogenic barotrauma), is a severe complication of mechanical ventilation associated with increased morbidity and mortality. It is a life-threatening condition often included in the differential diagnosis of respiratory failure and chest pain, requiring immediate identification and treatment. Barotrauma is a critical complication of mechanical ventilation that, if untreated, can lead to high mortality. The most common causes of pneumothorax in mechanically ventilated patients are thoracic trauma or iatrogenic injuries, such as complications from central line placement, regional blocks, or mechanical ventilation itself. [28].

Regarding the demographic characteristics of the studied subjects, the results of this study revealed that nearly one-third of both the study and control groups were aged between 30 and 40 years, with mean ages of 39.9±12.87 years and 40.1±13.56 years, respectively. The researcher believes that this similarity in age distribution serves as a crucial baseline characteristic, ensuring comparability between the two groups.

This result is in contrast with (Shaban, 2021) [29] whose study revealed that the mean age of the participants in the study group was 57.79±2.87 years, while in the control group, it was 58.40±4.42 years. This outcome was additionally negated by (Amin, 2023) [30] the study demonstrated that there was no statistically significant difference between the study and control groups (p> 0.05), with mean ages of 51.97±12.02 years for the study group and 54.67±8.88 years for the control group, respectively.

In terms of gender, the current study found that less than two-thirds of the study group and nearly three-quarters of the control group were male. The researcher attributes this finding to the fact that males tend to have a higher risk than females due to greater exposure to significant stressors, occupational hazards, and more frequent use of hookahs and cigarettes.

The current study finding was consistent with (Ghiani, 2020) [31] found that males were represented greater than two-thirds in mechanically ventilated patients. On the same line, this finding is compatible (Amin, 2023) [30] who referenced that males represent more than half of both control and study groups. In addition, the study done by (Hammouda *et al*., 2022) [32] who reported that the majority of participants in both the study and control groups were male.

On comparing the study and control groups by their medical characteristics, the findings of the study demonstrated no statistically significant variation between the study and control groups in terms of disease distribution. Regarding the primary reason for ICU admission, around one-fourth of patients in both groups were admitted due to respiratory

conditions, while, cardiac diseases being the second most common cause.
This outcome was similar with the study conducted by (O.M. Ahmed, W.Y. Mohammed, M.M. Abd Elnaeem, *et al*., 2023) [33] who found that regarding the cause of ICU admission, Respiratory disease emerged as the predominant cause of ICU admission in both the study and control groups, with no significant statistical variation observed between the two groups in this aspect. This outcome was consistent with the study done by (Amin, 2023) [30] who found that in both the study and control groups, respiratory diseases were the most prevalent reason for ICU admission, with no statistically significant difference observed between the two groups in this regard.
On contrary, the current study results has contradicted with (M.W. Ahmed *et al*., 2023) [34] it was found that over two-thirds of both the study and control groups were admitted due to head injuries. The same as reported by (Weheida *et al*., 2022) [35] who said that a significant proportion of both the experimental and control groups had medical histories of cerebrovascular accidents, diabetes mellitus, and cerebral hemorrhages. This trend may be attributed to the emergency nature of the intensive care unit (ICU), which frequently admits patients traumatized by a road traffic accident.
Regarding past medical history, the present study reported that approximately the highest percentage of the study and control group has no past health history, while more than one quarter of both groups had hypertension followed by diabetes mellitus, with no significant difference between both groups regarding to past medical history.
This finding supported by (O.M. Ahmed, W.Y. Mohammed, & S.S. Mohamed, 2023) [36] who displayed that high proportion of two groups were with no comorbidity. Moreover, the current study results additionally were similar to (Aziz, 2020) [37] 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.
As regards both physical assessment of hemodynamic parameters between both study and control groups, according to vital signs (Temperature, respiration, pulse, Mean blood pressure, the current study found no statistically significant differences between the study and control groups at baseline. However, post-intervention, the study group exhibited significant improvements in temperature, heart rate, and respiratory rate compared to the control group receiving routine hospital care.
Based on baseline hemodynamic measures such as temperature, respiration rate, pulse rate, and mean blood pressure, the results show no statistically significant changes between the study and control groups. This baseline equivalency shows that both groups had similar physiological states before the intervention, which is crucial for reducing bias and guaranteeing the validity of the study's findings.
However, the statistically significant differences observed post-intervention between the study group (receiving the nursing intervention protocol) and the control group (receiving routine hospital care) highlight the impact of the implemented nursing protocol. Improvements in vital signs such as temperature, heart rate, and respiratory rate in the study group suggest that the protocol effectively addressed critical aspects of patient management.
The results of this study were in line with the study conducted by (Ahmed Sayed, 2020) [38] who found that, there were highly statistically significant difference in vital signs between intervention and control group especially respiratory rate and heart rate. The present finding was similar to the study launched by (Abdelaziz, 2020) [39] they discovered that, in terms of hemodynamic measures, patients in the control group had higher heart rates, body temperatures, and respiration rates. These differences were statistically significant ($p=<0.05$) after the intervention when compared to the study group.
This outcome was consistent with a research carried out by (Sayed, 2024) [19] They discovered that on the seventh day, patients in the control group had a significantly higher body temperature and a higher mean heart rate score than those in the study group. This might be explained by the fact that rising body temperature and heart rate are two of the main signs of illness.
Regarding to Arterial Blood Gases (ABG) reading, the current study displayed that there was a high statistical significant difference between study group and control group post intervention in relation to pH PCO_2, and HCO_3. the finding of this study was in similarity with (Aziz, 2020) [37] who found that there is statistically significant difference within normal range between study group and control group in the 3rd day in relation to PH, PCO2, PO2, SaO2 and PF ratio P=0.01,0.05,0.04,0.03,0.03 respectively. This finding of the current study was consistent with (Abdelaziz, 2020) [39] the research findings demonstrated that, with regard to arterial blood gas, there was a statistically significant difference between the two groups in terms of PH, Pao2, Paco2, Hco3, and Sao2 following intervention in the study group as opposed to the control group.
Related to oxygen saturation, the present study found that more than two-thirds of the study group had normal vital signs, compared to fewer than half of the control group. These findings were in the same line with (Sayed, 2024) [19] their research findings demonstrated that the control group's mean O2 saturation dramatically dropped while the study group's patients' O2 saturation greatly improved.
Regarding to mechanical ventilator mode, the results showed that the majority of both the study and control groups were connected to SIMV mode. According to the researcher's viewpoints, the current study's findings clarify that: given that SIMV mode reflects standard clinical practice in the management of patients on mechanical ventilation. 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) [19] their research showed that, for over half of the patients in the control and study groups, SIMV mode was the most often utilized mode. Simultaneously, the present study finding was in agreement with (Abdelaziz Mohammed *et al*., 2023) [40] they discovered that around two-thirds of the study groups were on SIMV mode. The present study finding was opposite of the study conducted by (O.M. Ahmed, *et al*., 2023) [36] who claimed that more than three quarters of the groups under study were using AC mode.

As regards mechanical ventilation type, the present study has demonstrated that over two-thirds of both the study and control groups were receiving invasive ventilation. According to the researcher's opinion, the most prevalent method of invasive ventilation in intensive care units is tracheostomy tubes and endotracheal tubes (ETTs). The current study was consistent with (Kaur *et al*., 2022) [41] who found that more than half of studied groups were on invasive ventilation.

Related to the application of nursing intervention protocol, national and international standards are increasingly recommending "30°-45° elevation of head of bed and oral care with chlorhexidine, chest physiotherapy," which comprise certain crucial strategies that, when used completely, assist achieve success.

The applications were conducted at high rate during the three days of MV initiation by assistance of staff nurses and intern nursing students. The morning shift had a relatively high application rate, while the evening and night shifts saw a sharp drop in the rate. According to the researcher, the observed results may be attributed to an increase in workload, and a decrease in staffing was hypothesized as the cause of this deterioration and a lack of awareness of the significance of nursing procedure for patient outcomes.

The present study finding supported by (Karagözoğlu *et al*., 2018) [42] 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 study finding supported by (Liu *et al*., 2020) [43] 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 research finding was opposite to the study done by (Abd-alraheem *et al*., 2020) [44] 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.

Regarding to percentage distribution of the studied groups regarding pulmonary complications occurrence post nursing intervention protocol, the present study findings demonstrated that very low percentage of the study group post-nursing intervention protocol, compared with high percentage of the control group who received routine hospital care had ventilator-associated pneumonia and barotrauma complications. Finally, there was a high statistical significant difference between both groups related to ventilator associated pneumonia (VAP) and barotrauma occurrence.

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 (Shaban *et al*., 2021) [6] 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 less than one third of the participants have VAP while more than two thirds 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 (Amin *et al*., 2023) [45] whose study results showed that there was a statistically significance difference in the occurrence of VAP between both groups on the seventh days and ninth day (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.

Regarding incidence of barotrauma (pneumothorax), the current study was in an agreement by (Abdelaziz, 2020) [39] 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) [46] who concluded that ventilator bundles had a great effect on reducing VAE and pulmonary complication among mechanically ventilated patients.

Also, (Hammouda *et al*., 2022) [32] stated that less than two thirds of the intervention 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.

Regarding relation between selected pulmonary complications occurrence of the studied groups and nursing intervention protocol, it was noticed that implementing oral care with the chlorhexidine, head of bed elevation 30º-45º (Independent factor) decreased the occurrence of ventilator associated pneumonia (dependent factor) as documented by p value (0.008, 0.032) respectively, on the other hand chest physiotherapy had low effect on reducing pulmonary complication.

Regarding the impact of implementing oral care with the chlorhexidine on reducing incidence of VAP, the current study finding was augmented by (Abd-alraheem *et al*., 2020) [44] who demonstrated that poor oral alteration and the incidence of ventilator-associated pneumonia were very statistically significantly correlated. Additionally, they noted that the existing oral care practices in intensive care units (ICUs) without chlorhexidine may not be sufficient to remove respiratory pathogens and dental plaque from ventilated patients' oropharynx, which exacerbates the incidence of VAP and deteriorates oral health.

.Regarding the effect of implementing head of bed elevation 30º-45º on reducing incidence of VAP and barotrauma, the current study finding was similar to (Shadis, 2022) [47] whose study results displayed that a relationship exists between head of bed (HOB) elevation and reduced incidences of VAP, the higher the elevation (>30˚) → higher reduction in VAP incidences, implementation of a VAP bundle reduced rates of VAP in mechanically-ventilated patients.

In relation to chest physiotherapy, that had low effect on reducing pulmonary complication. The present study finding was contradicted to (Meawad *et al*., 2018) [48] their study's findings affirm the value of a chest physical therapy program for early MV patients as it raises PAO2 and SAO2, reduces MV patient problems, shortens ICU stays, lessens psychological disorders associated with ICU stays, and lowers medical expenses.

Conclusion

Based on the findings of the present study, it can be concluded that the findings of this study underscore the significant impact of implementing a nursing intervention protocol on minimizing pulmonary complication among mechanically ventilated patients. By reducing the occurrence of pulmonary complications such as ventilator-associated pneumonia (VAP) and barotrauma, the protocol demonstrated its effectiveness in promoting patient safety and improving recovery. The highly significant differences between both groups highlight the value of standardized, evidence-based nursing care in critical care settings. Ultimately, the study advocates for the broader adoption of nursing intervention protocols to improve care quality for critically ill patients.

Recommendation

Recommendations related to nurses

1. Creation of in-service training programs for intensive care unit nurses to enhance their expertise and proficiency in enhancing the outcomes of patients on mechanical ventilation.
2. Development of a concise and thorough guide that covers the fundamentals of ventilator-associated pneumonia (VAP), such as its description, contributing factors, nursing's role in prevention, and the components of the ventilator bundle and their significance.
3. Continuous professional development programs should be provided to nurses, emphasizing critical care skills, ventilator management, infection prevention, and the application of intervention protocols.
4. Nurses should perform regular and systematic monitoring of patients' hemodynamic parameters and ventilator settings to identify and address potential complications early.

Recommendations for more researches

1. Replicating the study on a bigger random sample from other parts of Egypt to ensure the study's generalizability.
2. Evaluate the effectiveness of training programs and workshops in improving nurses' adherence to protocols and their impact on patient care.

Conflict of Interest

Not available

Financial Support

Not available

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