Effect of Different Backrest Positions' Degrees on Hemodynamic Stability for Mechanically Ventilated Patients

Rehab Zakaria Lutfy Yassien [1], Manal Hessein Nassr [2], Dalia Abdallah Abdelatief [3], Arzak Mohammed Khalifa Ewees [3]

[1] B.Sc. in Nursing.[2] Professor of Medical Surgical Nursing, Faculty of Nursing, Ain Shams University.[3] Assistnat Professor of Medical Surgical Nursing, Faculty of Nursing, Ain Shams University.

Abstract

Background: Backrest elevation is one of the important performed nursing activities in Intensive Care Unit (ICU) and often providing an essential focus for planning other nursing activities. Hemodynamic changes occur with positioning which is a core component of critical care nursing to optimize ventilation on mechanically ventilated patients. **Aim:** This study aims to assess the effect of different backrest positions' degrees on hemodynamic stability of mechanically ventilated patients through the following : assess hemodynamic status among mechanically ventilated patients pre implementation of different backrest positions degrees,implement different backrest positions degrees in 0-30-45 for patients on mechanical ventilation , assess hemodynamic status among mechanically ventilated patients post implementation of different backrest positions degrees.**Design**: A quasi experimental design was conducted to achieve the aim of the present study. **Setting:** The study was conducted in the general intensive care unit at Blebies Central Hospital Elsharqia. **Study subject:** A purposive sample of 40 patients on mechanical ventilators who admitted to ICU in the previous mentioned setting. **Tools of data collection:** were consisted of patient's assessment tool, mechanically ventilated patients' parameters assessment tool**. Results:** Revealed that 40.0% of studied patients were 60 years old or more with the mean age 54.9 ± 12.86 as well, 70.0% of them were males, there was highly statistically significant difference was found as regard blood pressure diastolic and central venous pressure, there was a highly statistically significant difference between the studied patients' respiratory assessment at post 0^o, 30^o and 45^o degrees of backrest positions. **Conclusion:** Implementation of 45 degree backrest position is associated with improvement of hemodynamic status of mechanically ventilated patients. **Recommendations:** Encourage nurses in intensive care units settings to apply 45 degree head of bed elevation to improve oxygenation and hemodynamic status that involved in nursing guidelines for mechanically ventilated patients.

Keywords: Backrest Positions, Mechanically Ventilated Patients' Hemodynamic Stability, ICU.

Introduction:

Mechanical ventilation is a therapeutic intervention that supports or replaces spontaneous breathing and thereby supports adequate oxygenation of body tissues in critically ill patients **(Güner & Kutlutürkan, 2022).** The patients on mechanical ventilators in intensive care unit are required close observation including by examining blood gas analyzes, specifically pH, PO2, PCO2, HCO3, and oxygen saturation ***(Yudistirawati, 2021).***

Changing the patient's position is considered as the main care measures, especially in the intensive care unit (ICU), which is done routinely at regular intervals ***(Jalali et al., 2022).*** Critical care patients are given different positions during the hospitalization due to several reasons including clearing the respiratory tract secretions, increasing oxygenation, improving blood circulation, prevention of the compression wound, and avoiding infections, Respiratory and hemodynamic changes may be seen during position changes ***(Değişikliklerinin, 2021).***

The correct positioning of patients can affect the oxygen saturation level by increasing lung volume, reducing the heart rate, helping mucociliary clearance, and improving ventilation/ perfusion matching ***(Elamoudy et al., 2022).*** Additionally, there are significant circulatory and respiratory changes with changes in body position in both awake and sedated patients. These changes may affect the blood-gas exchange and hemodynamic stability ***(Elzohry et al., 2020).***

The hemodynamic condition of patients during treatment in the ICU was always changing (unstable), so serial monitoring of central venous pressure is needed and in the patient's position, it must be constant and must use the same reference point ***(Lesmana et al., 2019).*** Based on the mechanism of human body homeostasis, repositioning the patient's body every 2 hours can maintain hemodynamic stability ***(Oktorina & Nuraeni, 2018).***

Hemodynamic monitoring plays an important and central role in the management of critically ill patients, It aims to guide medical management,to prevent and /or treat organ failure,and to improve the outcomes of patients ***(Setiyawan et al., 2019).*** Hemodynamic monitoring itself includes several different techniques In spite of the availability of several monitoring techniques, central venous pressure (CVP) monitoring remains in common use as index of circulatory filling and cardiac preload. CVP measurement is the most widely and frequently used variable in the intensive care ***(Senmar et al., 2017).***

Care of mechanically ventilated patients requires a professional critical care nurse. The critical care nurse has an important role, particularly in fulfilling patients' oxygenation needs and hemodynamic monitoring, in addition to assess and monitor factors affecting them ***(Ibrahim et al., 2022).***

When planning positioning maneuvers, critical care nurses should consider these effects in relation to the specific needs of each patient. Hemodynamic and cardiopulmonary responses to positioning should be evaluated in conjunction with other therapeutic modalities such as those designed to preserve skin integrity and improve comfort ***(Di Mascio et al)***

The head of bed elevation is elevation of the head of the bed at degrees(0-30-45). The effect of adopting these position degrees in critically ill patients have been extensively investigated as apotential means of preventing ventilator-associated pneumonia (VAP). VAP of ventilated patients which is associated with rolonged duration of mechanical ventilation, hospital stay, and increased morbidity and mortality, The incidence of VAP is independently associated with a supine (0) degree head of bed position during the first 24 hrs of mechanical ventilation ***(Mir et al., 2015).***

Adopting backrest positions in mechanically ventilated critically ill patients is recommended, as it has been shown to reduce incidence of ventilator-associated pneumonia. Although the benefits to the respiratory system are clear,it isnot known whether elevating the head of the bed result in hemodynamic instability ***(Katz et al., 2018).*** Nursing patients in the semirecumbent position substantially decreases the aspiration of gastric content, and a randomized trial has confirmed that this significantly reduces the incidence of VAP. The backrest position is an upright position of the head of the bed at degrees (0-30-45). It is well established that the way in which the patient positioned may prevent unnecessary changes in hemodynamic and oxygenation for mechanically ventilated patients (Mokadem et al., 2020). Hemodynamic changes occur with postural Therapeutic positioning is a core component of critical care nursing to optimize ventilation and perfusion and to promote effective pulmonary gas exchange ***(Mezidi & Guérin, 2018).***

Significance of the study:

Mechanically ventilated patients are at high risk for many complications; liability for infection, hemodynamic instability that leads to increase hospital stay, morbidity, and mortality rate among mechanically ventilated patients. The prevelance of these complications has increased demand for optimizing medical outcomes, and need to establish evidence-based guidelines for patient's health care needs during their periods on mechanical ventilation, and hospital stay. Nurses have important role in preventing these complications through many actions such as; assessing hemodynamic status with implementing different backrest positions' degrees and evaluate influence of each backrest position on hemodynamic stability of mechanically ventilated patients ***(Göcze et al., 2013).***

However, in Egypt there is no national statistics available about backrest positions degrees and their influence on hemodynamic stability of mechanically ventilated patients, in addition the medical record of ICU at Belbies-Central Hospital revealed that there were 160 patients from 670 patients which represents 23.8% of all patients had developed different complications during their mechanical ventilation period ***(Medical record of CU at Belbies-central hospital, 2019).***

Aim of the study:

This study aims to assess the effect of different backrest positions' degrees on hemodynamic stability of mechanically ventilated patients through the following: assess hemodynamic status among mechanically ventilated patients pre implementation of different backrest positions' degrees, implement different backrest positions' degrees in 0-30-45 for patients on mechanical ventilation, assess hemodynamic status among mechanically ventilated patients post implementation of different backrest positions' degrees.

Research hypothesis:

Implementation of 45 degree backrest position improved hemodynamic stability of mechanically ventilated patients.

Subjects and Methods

1-Technical design:

The technical design included research design, setting, subjects and tools of data collection used in this study.

(A)-Research design:

A quasi experimental design was used for studied patient to assess effect of different backrest position degree (0 – 30 – 45) on hymodynamic status.

A quasi experimental design was used to achieve the aim of the present study. This design aimed to establish a cause and effect relationship between independent and dependent variables did not relay on random assignment. Instead, subjects were assigned to groups based on non – random criteria ***(Borusyak et al., 2022)***.

(B)-Setting:

The study was conducted in ICU at Blebies Central Hospital in Elsharqia Governate. It was a general I.C.U located at 3rd floor contains 20 beds, 10 mechanical ventilators, 20 monitors, 20 syringe pump, 2 Electric shock devices (Defibrillators), and one emergency car, patients were classified into 4 sides. The nursing staffs were 45 nurses, their experience ranging from 1 to 15 years. ICU also contains one room for nurses, and one room for physicians. The qualification of the most of staff nurses is bachelor degree in nursing.

(C)-Subject:

A purposive sample of 40 patients on mechanical ventilators admitted to ICU were selected according to certain inclusion criteria.

Sample size:

Sample size calculated by using open epi according to the following total number of ICU patients in one year and became 160 cases at 2020 and percent reduction Scvo2 by 45 positions was 3. 5 % so ci 95%. The sample size was calculated to be 40 cases ***(Kadam & Bhalerao, 2010).***

n' = (NZ^2 P(1-P))/(d^2 (N-1)+ Z^2 p(1-p)

Where

n'= sample size with finite population correction

Inclusion criteria:

Adults patients, who were connected with mechanical ventilation, from both genders, with central venous catheter, with different levels of consciousness and agree to participate was eligible for inclusion in the study.

Exclusion criteria:

Patients with acute cardiovascular instability, or those with pump –driven circulatory or respiratory support, also all patients in whom the supine position is contraindicated (for example patients with traumatic brain injury), or those who were immobilized due to spinal injuries or unstable pelvic fractures, patients with morbid obesity.

(D)- Tools of data collection:

The tools used in this study were patients' assessment tool, mechanically ventilated patients' parameters and hemodynamic status assessment tool.

Tool 1:-Patients' assessment tool:

It was designed by the investigator and written in English language after reviewing current related literatures ***(Wang et al., 2016; Anchala, 2016; Katz et al., 2018)*** to assess patients' demographic and clinical data**,** It was composed of two parts;

Part 1: Patients' demographic characteristics: It was concerned with assessment of demographic characteristics of the patients under study as patients' age, gender, marital status, educational level, and occupation. It can be collected through patient's file.

Part 2: Patients' clinical assessment: It was concerned with assessment of patients' clinical data such as present medical diagnosis, past medical history, Glasgow coma scale, gastrointestinal assessment,fluid and electrolyte assessment, integumentary assessment, diagnostic tests such as complete blood count, liver function test, renal function test.

The reading of Glasgow coma scale:

This part was used to assess patients clinical outcomes regarding Glasgow coma scale that:

- Severe (3-8)
- Moderate (9-12)
- Mild (13-15)
- Fully conscious (15).

Gastrointestinal assessment:

It involved examination of abdomen and abdomen content; during gastrointestinal nurses' assessment would use the technique of inspection, auscultation, percussion, and palpation which included normal, bowel sounds, hyperactive, hypoactive, diarrhea, constipation and vomiting. ***(Jarvis, 2016).***

Diagnostic tests:

Laboratory investigation	**Reference range**
Red blood cell	Male 4.2 - 5.6 10/ml Female 3.8 - 5.1 10^6 /ml
White blood cell	3.8 – 11.0 10^3 /mm^2
Hemoglobin	Male 14 – 18 g/dl Female 12- 16 gldl
Blood gases measurement	
PH	7.34 – 7.45
$Paco_2$	35 – 45 mmhg
Pao_2	80 – 100 mmhg
Hco_3	22 -26
Liver function tests	
(ALT)	45 U/L or less
(AST)	40 U/L or less
(Albumin)	3.5 -5 gm/dl
(Total protein)	6 – 8.5 g/dL
Renal function test	
(Urea)	8 – 25 mg/dl
(Creatinine)	0.6 – 6 mg/dL
Electrolyte tests (Sodium)	135 – 145 mmol/L
(Potassium)	3.5 – 5.3 mmol/L

Tool 2:- Mechanically ventilated patients' parameters and hemodynamic status assessment tool: It was designed by the investigator and written in English language after reviewing the related literatures ***(Brindle et al., 2013; Anchala et al., 2016; Farsi et al., 2020)*** to assess patients' ventilator parameters, and patients' hemodynamic status, it was composed of two parts as the following:

Part 1: Ventilator's parameters assessment:

It was concerned with the assessment of the ventilator parameters among the studied patients, it included; duration of mechanical ventilation (hours) from the time of intubation to the implementation of backrest positions, mode of mechanical ventilation (pressure controlled ventilation (PCV), Volume controlled ventilation (VCV), synchronized intermittent mandatory ventilation (SIMV)), tidal volume (ml), positive-end expiratory pressure (PEEP), peak airway pressure (p max), Flow. It was obtained from patients' files and mechanical ventilation usesetting.

Part 2: Patient's hemodynamic assessment parameters;

1- Cardiovascular assessment: It was concerned with the assessment of patients' cardiovascular status such as; heart rate, blood pressure, main arterial pressure, central venous pressure, capillary refill, fluid and electrolyte assessment, etc. It was measured by the investigator 30 minutes after each position.

Cardiovascular parameters and fluid and electrolyte assessment:

Cardiovascular parameters	**Reading**
Heart rate	60 – 100 beat/ minute
Tachycardia	More than 100 beat / minute
Bradycardia	Less than 60 beat /minutes
Blood pressure	120 / 80 mmhg
Hypertension	More than 140 / 90 mmhg
Hypotension	Less than 100 / 60 mmhgon
Main arterial pressure	70 – 100 mmhg
Hypertension	More than 100mmhg
Hypertension	Less than 60
Central venous pressure	8 – 12 mmhg
Low	Less than 8
High	More than 12
Capillary refill	3 seconds ≤

It was used to assess patients clinical outcomes regarding cardiovascular system, increased heart rate more than 100 b/m indicated tachycardia, heart rate less than 60 b/m indicate bradycardia, blood pressure more than 140/ 90 mmhg indicated hypertension, blood pressure below 100 /60 mmhg indicated hypotension, central venous pressure within normal 8 – 12 mmhg , less than 8 mmhg indicate low centeral venous pressure , and more than 12 indicated high ce ofnteral venous pressure.

2- Respiratory assessment: It was concerned with the assessment of the patients' respiratory status such as; respiratory rate, rhythm, color, oxygen saturation, chest sound (crackles, strider, rhonchi, and wheezing), hypoxemia, and lung compliance.

Respiratory parameters: it used to assess respiratory outcome as normal respiratory rate (12 – 20 cycle / minute), tachypnea (more than 20 c/ m), bradypnea (Less than 12 c/ m).

Hypoxemia

Hypoxemia was defined as PaO2/FIO2 ratio of 300 mmhg or less. P" represents PaO2 (arterial Po2) from the ABG. "F" represents FIO2 –the fraction (percent) of inspired oxygen the patient (40 % oxygen = FIO2 of 0.40) How to calculate the P/F ratio: PaO2/FIO2 P divided by F = P/F ***(Palanidurai et al., 2021).***

Hypoxemia severity score was classified as:

- 300 – 201 mild hypoxemia
- 200 – 100 moderate hypoxemia
- ≤ 100 severe hypoxemia

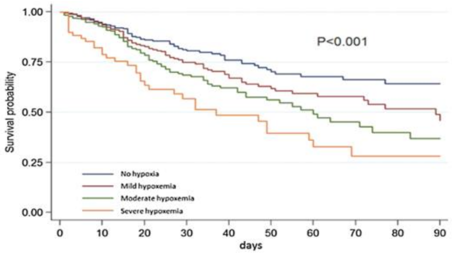

Fig (1) : Survival curve according to hypoxemia severity. Survival curves were drawn according to the severity of hypoxemia using the Kaplan–Meier method and were compared using the log-rank test. Follow-up ended at the ICU leaving or was censored at day 90 ***(Ranieri et al., 2012).***

Lung compliance

Is a measure of the lung' ability to stretch and expand in clinical practice it is separated into two different measurements, static compliance and dynamic compliance static compliance represents pulmonary compliance during periods without gas flow, such as during an inspiratory pause.

It can be calculated with the formula;

C stat = VT / P plat – PEEP

Where

VT = tidal volume, Pplat = plateau pressure, PEEP = positive end – expiratory pressure.

Compliance ≥ 80

60 – 70 ml / cm H2O

40 - 59 ml / cm H2O

20 to 39 ml / cm H2O

≤ 19 ml /cm H2O2

Low compliance indicates astiff lung (one with high elastic recoil) and can be thought of a thick ballon, this case often seen in fibrosis. High compliance indicates a pliable lung (one with low elastic recoil) and can be thought of as a grecery bag, this often seen in emphysema. Compliance is highest at moderate lung volumes and much lower at volumes that are very low or very high ***(Nosek et al., 2016)***.

Operational design:

The operational design included preparatory phase, tools validity and reliability, pilot study & field work.

A- Preparatory phase:

It included reviewing of current and past, national and international related literature, and theoretical knowledge of various aspects of the study using books, articles, internet, periodicals, and magazines to develop tools for data collection and self- care guidelines followed the APA 7th edition citation style 2020 for reference.

b- Ethical Considerations

The ethical research considerations in the study included the following: the research approval of protocol was obtained from the scientific research Ethical Committee in the Faculty of Nursing in Ain Shams University before starting the study, the investigator clarified the objective and aim of the study to patient's family included in the study, the investigator assured maintaining anonymity and confidentiality of the subject's data, patients (families) were informed that they were allowed to choose to participate or not in the study and that they had the right to withdraw from the study at any time.

c- Validity and reliability:

Testing validity of the proposed tools by using face and content validity. Face validity aimed at inspecting the items to determine whether the tools measured what supposed to measure. Content validity was conducted to determine whether the content of the tools covered the aim of the study. This stage developed by a jury of 7 experts, five professors and two assistant professors at Faculty of Nursing, Ain shams University. The experts reviewed the tools for clarity, relevance, comprehensiveness, simplicity and applicability; no modification was done.

Tools reliability;

The reliability of patients' clinical assessment tool was 0.803. The reliability of mechanically ventilated patients' parameters assessment tool was 0. 812. It was measured by Alpha crompach test.

D- Pilot study:

A pilot study was conducted to test feasibility, applicability and clarity of the tools used and time required for application of the study tools. It was carried out on 10% of patients who were hemodynamically stable on mechanical ventilation in ICU at Belbies Hospital. Patients who were included in the pilot study were included into the study sample because no modifications were done after conducting the pilot study.

E- Field Work

Data were collected from patients for this study took about six months, started from the beginning of June 2022 to the end of November 2022. Data were collected three days / week for the studied patients during morning and afternoon shifts. Filling the tools took about (40-60) minutes distributed between the following: patients' demographic characteristics, clinical data, laboratory investigation, integumentary assessment, cardiovascular assessment, respiratory assessment, and mechanical ventilation parameters. Field work included three phases: assessment phase, implementation phase, and evaluation phase.

1- Assessment phase

The assessment was done by the investigator first before the positions were done to the patients at ICU. It involved the assessment of demographic characteristics, clinical data, laboratory investigations, cardiovascular status (blood pressure, mean arterial pressure, pulse, central venous pressure, capillary refill, fluid and electrolyte), and respiratory system (rate, rhythm, color, chest sounds, hypoxemia, and lung compliance) integumentary and gastrointestinal assessment.

2- Implementation phase

The investigator was available 3 days / week during morning and afternoon shifts. First, the investigator greeted the patients' families introduced herself and explained the aim of the study, specific infection control precautions were considered as hand washing, wearing gown, mask, and overhead by the investigator during every visit for hospitalized patients.

The investigator collected data using different backrest position degrees 0 – 30 – 45 , the mechanically ventilated patient was placed in the first backrest position degree 0 by making patient lying flat on bed for 30 minutes , the investigator stayed with the patient to observe patient during 30 minutes for any complications, then the investigator measured patient cardiovascular parameters (blood pressure, mean arterial pressure, pulse, central venous pressure, capillary refill, fluid and electrolyte), respiratory parameters (rate, rhythm, color, chest sounds (auscultated by the physician), hypoxemia, and lung compliance) , and mechanical ventilator parameters (duration, mode, tidal volume, PEEP, peak air way pressure p max, flow), and later the investigator recorded all these parameters and it took about 15 minutes, the investigator return the patient to the base line and then left the patient for 2 hours interval before doing the second position. Two hours later the patient was placed in 30 degree head of bed elevation and left for 30 minutes with continuous observation from the investigator during 30minutes of patient' status for any changes, then data were collected as the first position, then recorded. The investigator returns the patient to base line and left the patient for 2 hours and took time for recording collected data. Finally the investigator placed the patient in 45 degree position for 30 minutes then hemodynamic data were collected and recorded in the same way as other positions. All mechanically ventilated patients' involved in the study were placed in different backrest positions degrees 0 – 30 – 45 in the same mentioned way.

The investigator collected data form 1 or 2 patients for each visit under supervision and assistant of the physician at ICU.

2- Evaluation phase

This phase included evaluation of the effect of different backrest positions on hemodynamic status for mechanically ventilated patients by comparing between three positions (0, 30,45) and evaluated the most hemodynamic stability among different backrest positions' degrees.

3- Administrative design:

Approval letter to carry out this study was obtained from the Dean of the Faculty of Nursing to Director of Blebies- Hospital.(Patients consent written in ethical consideration and was obtained for data collection after explaining the purpose of the study).

Statistical Analysis;

Data was sorted, classified, and the results were shown in tables. The Statistical Package for the Social Sciences was used to analyze the data on a suitable personal computer (SPSS Inc; version 21; IBM Corp., Armonk, NY, USA). The one-sample Kolmogorov–Smirnov test was used to determine the data's normality. Numbers and percentages were used to describe qualitative data. Continuous variables were presented as means ± standard deviation. An ANOVA test is a type of statistical test used to determine if there is a statistically significant difference between two or more categorical groups by testing for differences of means using variance. Cochran's Q test is used to determine if there are differences on a dichotomous dependent variable between three or more related groups. The results were considered significant when the probability of error is less than 5% (p< 0.05) and highly significant when the probability of error is less than 0.1% (p< 0.01).

Results:

Table (1) :illustrates demographic characteristics of the studied patients, it showed that 40.0% of the patients their ages were 60 years old or more with the mean age 54.9 ± 12.86. As well, 70.0% of patients were males. Also, 75.0% of them were married. In addition, 70.0% of them didn't work. Besides, 50.0 % of them live in urban areas.

Figure (2) :represented that 32.50% of studied patients had secondary level education, and 27.50% of them were illiterate, while 22.50% of them had university education.

Table (2):revealed that the studied patients' duration of mechanical ventilation (hours) from the time of intubation ranged from 24 to less than 96 hours among 67.5% of them with mean S.D= 84.15±14.6. Regarding mode of mechanical ventilation, 72.5% of them were on synchronized intermittent mechanical ventilation. Besides, the mean of tidal volume was 476.4(39.8), the mean of PEEP was 7.9(2.1), the mean of peak airway pressure (p max) was 38.9(6.3), and finally the mean of flow was 49.3(7.1).

Table 3 reflected that there was a highly statistically significant difference (P< 0.01) between the studied patients' Cardio-vascular assessment at post 0º, 30º and 45º degrees of backrest positions as regard Heart rate, Blood pressure systolic, Main arterial pressure and Peripheral pulse. In addition, highly statistically significant difference was found (P< 0.01) as regard Blood pressure diastolic and central venous pressure, while there was no statistically significant difference as regard Fluid and electrolyte assessment.

Table (4 a) :illustrated that there was a highly statistically significant difference (P< 0.01) between the studied patients' Respiratory assessment at post 0º, 30º and 45º degrees of backrest positions as regard Respiratory rate and Oxygen saturation.

Table (4b) :represented that there was no statistically significant difference between respiratory outcome for mechanical ventilated patients at post 0º, 30º and 45º degrees of backrest positions as regard Hypoxemia, and lung compliance.

Table (**5 a**) **:**As shown in, there was statistically significant positive correlation (p< 0.05) between patients' capillary refill and their age at post 30 degree. while, there were statistically significant negative correlations (p< 0.01) between patients' age and their heart rate, systolic and diastolic blood pressure, main arterial pressure at post 30° degree. As well, there was a statistically significant negative correlation (p< 0.05) between patients' central venous pressure and their age at post 30° degree.

Table (5 b) : As shown in, there was a statistically significant positive correlation (p< 0.05) between patients' capillary refill and their age at post 45° degree. While, there were statistically significant negative correlations (p< 0.01) between patients' age and their heart rate, systolic and diastolic blood pressure, main arterial pressure at post 45° degree. As well, there was a statistically significant negative correlation (p< 0.05) between patients' central venous pressure and their age at post 45° degree.

Table (**6 a**) :indicated that, there was a highly statistically significant positive correlation (p< 0.01) between patients' hypoxemia and their age at post 30 degrees. Besides, there were highly statistically significant negative correlations (p< 0.01) between patients' age and their respiratory rate and lung compliance at post 30 degree. Additionally, there was a statistically significant negative correlation (p< 0.05) between patients' oxygen saturation and their age.

Table (6 b) :indicated that, there was statistically significant positive correlation (p< 0.01) between patients' hypoxemia and their age at post 45° degree. Besides, there were statistically significant negative correlations (p< 0.01) between patients' age and their respiratory.

Table (1): Number and percentage distribution of demographic characteristics among studied patients.

Items	N	%
Age		
• 18 ≤ 30	10	25.0
• 30 ≤ 40	6	15.0
• 40 ≤ 60	8	20
• 60 and more	16	40
Mean ± S.D	54.9 ± 12.86	
Gender		
• Male	28	70.0
• Female	12	30.0
Marital Status		
• Single	10	25.0
• Married	30	75.0
Occupation		
• Working	12	30.0
• Not working	28	70.0
Residence		
• Urban	20	50.0
• Rural	20	50.0

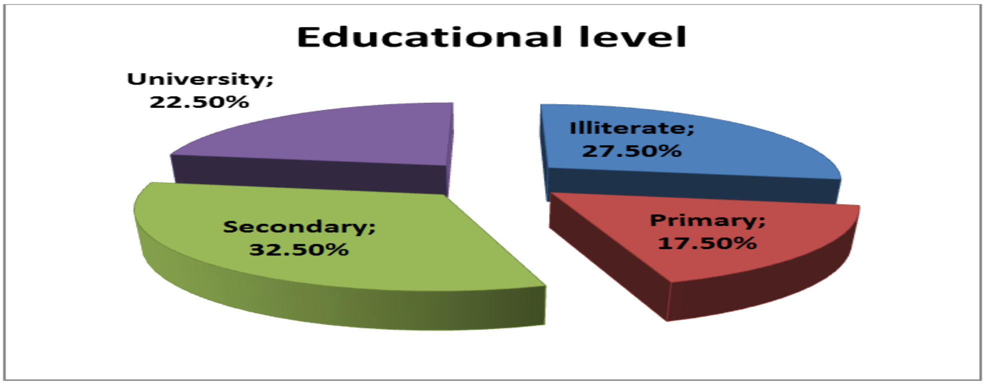

Figure (2): Percentage distribution of educational level among studied patients (n=40).

Table (2): Ventilator parameters among studied patients (n=40).

Items	N	%
Duration of mechanical ventilation (hours) from the time of intubation		
• 24 -<96hours	27	67.5
• 96- 192 hours	8	20
• >192 hours	5	12.5
Mean ± S.D		
84.15±14.6		
Mode of mechanical ventilation		
• Pressure controlled ventilation	5	12.5
• Volume controlled ventilation	4	10
• Pressure support	2	5
• Synchronized intermittent mechanical ventilation	29	72.5
	Mean (SD)	
• Tidal volume (ml)	476.4(39.8)	
• Positive-end expiratory pressure (PEEP)	7.9(2.1)	
• Peak airway pressure (p max)	38.9(6.3)	
• Flow	49.3(7.1)	

Table (3): Comparison between studied mechanically ventilated patients cardiovascular assessment for post different backrest positions' degrees (n =40).

Items	0°		30°		45°		ANOVA test (P value)
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
Cardiovascular assessment							
Heart rate	117	14.8	85	10.1	86	6.4	8.932 (<0.01**)
Blood pressure systolic	138	20.7	124	10.9	119	10.3	9.012 (<0.01**)
Blood pressure diastolic	91	6.4	88	5.1	78	3.7	4.352 (<0.05*)
Main arterial pressure	93	2.8	82	5.7	79	5.5	8.001 (<0.01**)
Central venous pressure	11.3	2.2	10.9	2.1	11.0	2.0	3.998 (<0.05*)
Capillary refill	2.05	0.3	2.10	0.28	2.02	0.18	0.827 (>0.05)

Table (4 a): Comparison between studied mechanical ventilated patients respiratory assessment post different backrest positions' degrees (n=40).

Items	0°	30°	45°	ANOVA test P value
Respiratory assessment				
• Respiratory rate				8.932
• Mean (SD)	39.1(5.9)	30.7(4.5)	28.2(3.7)	<0.01**
Rhythm				
• Regular. n (%)	40(100)	40(100)	40(100)	
• Irregular. n (%)	0(0)	0(0)	0(0)	--------
Cough				
• Present. n (%)	0(0)	0(0)	0(0)	
• Not present. n (%)	40(100)	40(100)	40(100)	-------
Color				
• Clear n (%)	10(25)	10(25)	10(25)	
• White n (%)	12(30)	12(30)	12(30)	
• None n (%)	18(45)	18(45)	18(45)	-------
Oxygen saturation				8.932
• Mean (SD)	89.4(4.7)	95.2(6.9)	97.6(5.3)	<0.01**

Table (4 b): Comparison between the studied mechanical ventilated patients' respiratory outcomes post different backrest positions' degrees (n=40).

Items	0°		30°		45°		Cochran's Q Test
	No	%	No	%	No	%	P. value
Hypoxemia							--------
• $PaO_2/FIO_2 \geq 300$	28	70	28	70	28	70	
• PaO_2/FIO_2 225 to 299	6	15	6	15	6	15	
• PaO_2/FIO_2 175 to 224	4	10	4	10	4	10	
• PaO_2/FIO_2 100 to 174	2	5	2	5	2	5	
• $PaO_2/FIO_2 < 100$	0	0	0	0	0	0	
Lung compliance							----------
• Compliance ≥ 80 ml/cm H_2O	12	30	12	30	12	30	
• Compliance 60 to 79 ml/cm H_2O	9	22.5	9	22.5	9	22.5	
• Compliance 40 to 59 ml/cm H_2O	13	32.5	13	32.5	13	32.5	
• Compliance 20 to 39 ml/cm H_2O	6	15	6	15	6	15	
• Compliance ≤ 19 ml/cm H_2O	0	0	0	0	0	0	

Table (5 a): Correlation between patients' age and cardiovascular status in 30 ° backrest position.

Items	Age	
	r	P
• Heart rate	-0.643	<0.01**
• Bl. pressure systolic	-0.599	<0.01**
• Bl. Pressure diastolic	-0.622	<0.01**
• Mean arterial pressure	-0.583	<0.01**
• Central venous pressure	-0.364	<0.05*
• Capillary refill	0.600	<0.05*

Table (5b): Correlation between patients' age and cardiovascular status in 45 ° backrest position.

Items	Age	
	r	P
• Heart rate	-0.672	<0.01**
• Bl.pressure systolic	-0.586	<0.01**
• Bl.pressurediastolic	-0.618	<0.01**
• Mean arterial pressure	-0.530	<0.01**
• Central venous pressure	-0.377	<0.05*
• Capillary refill	0389	<0.05*

Table (6 a): Correlation between patients' age and respiratory status in 30° backrest position.

Items	Age	
	r	P
• Respiratory rate	-0.562	<0.01**
• Hypoxemia	0.467	<0.01**
• Lung compliance	-0.597	<0.01**
• Oxygen saturation	-0.362	<0.01**

Table 6(b): Correlation between patients' age and respiratory status in 45° backrest position.

Items	Age	
	r	P
• Respiratory rate	-0.603	<0.01**
• Hypoxemia	0.467	<0.01**
• Lung compliance	-0.597	<0.01**
• Oxygen saturation	-0.371	<0.05*

Discussion:

Mechanical ventilation (MV) is a therapeutic intervention that supports or replaces spontaneous breathing and thereby supports adequate oxygenation of body tissues **(Güner & Kutlutürkan, 2022).**

Positioning is one of the most common nursing activities performed in the critical care unit. It is often providing a central focus that directs other nursing activities. Recently, the concept of therapeutic positioning is emerging in trauma and critical care with the adaptation of research-based positioning strategies designed to enhance or promote physiologic stability and tolerance of nursing and medical treatments **(Ismail et al., 2021).**

Backrest elevation is an important component of the semi recumbent position that must be considered for patients to optimize ventilation and perfusion, promote effective pulmonary gas exchange, and promote lung expansion maneuvers that increases functional residual capacity, enhances quality of respiration, improves alveolar ventilation, decreases work of breathing, and establishes diaphragmatic excursion. The level of Backrest elevation determines the gravitational gradient that act on the cardiovascular and cardiopulmonary systems, from moment to moment, and affects distribution of optimal blood flow and pulmonary venous and arterial system **(Ebrahim et al., 2017).**

Therefore, this study was conducted to assess the effect of different backrest positions' degrees on hemodynamic stability of mechanically ventilated patients.

The results of the present study revealed that more than one third of the studied patients were 60 years old or more with the mean age 54.9±12.86. This result is similar to the result of a study performed by **Elamoudy et al. (2022)** which entitled "Effect of positioning on oxygenation and hemodynamics among patients on mechanical ventilation" and stated that more than third of the patients' ages ranged between 45-<65 years old. This result might be due to this age group is considered one of the most age groups of exposure to critical conditions due to chronic diseases.

Regarding gender of the studied patients, the current study revealed that more than two thirds of the studied patients were males. This result is in accordance with **Elzohry et al. (2020)** in their study which entitled" Airway pressure and respiratory mechanics variability with different body positions in mechanically ventilated critical care patients: a prospective comparative clinical study" who revealed that more than half of the studied patients were male. This result may be due to that males are more risk to exposure to medical conditions due to their life work conditions.

Concerning marital status of the studied patients, the finding of the current study revealed that three quarters of the studied patients were married. This result is supported with a study done by **Ebrahim et al. (2017)** which entitled "Effectiveness of backrest elevation on oxygenation and hemodynamic status among mechanically ventilated patient after coronary artery bypass graft surgery " and found that more than half of the studied patients were married. This finding may be explained by more than one third of the studied patients were 60 years old or more and this age is normally to be married.

Related to the educational level of the studied patients, the current results clarified that less than one third of studied patients had secondary level education, more than three quarters of them were illiterate, nearly less than one quarter of them had university education. The present study result is consistent with **Ismail et al., (2021)** who studied "Effect of body position on oxygenation and hemodynamic status among patients with traumatic brain injury" and reported that more than one third of the studied sample had either secondary or university education.

In relation to ventilator parameters among the studied patients, the findings of the current study revealed that the studied patients' Duration of mechanical ventilation (hours) from the time of intubation ranged from 24 to less than 96 hours among less than two third of them with mean S.D= 84.15±14.6. Regarding mode of mechanical ventilation, near to three quarters of them were on synchronized intermittent mechanical ventilation. Besides, the mean of tidal volume was 476.4(39.8).

These results are consistent with **Elamoudy et al., (2022)** who demonstrated that the mean of Vt was 490.0±119.2 ml, PEEP10.7±1.2 (cm H2 O), FIO2 0.5, and I/E ratio was 1:2. Regarding the mode of the ventilation, the table also illustrates that 61.3% of the studied patients were on SIMV mode with mean static compliance of 15.4±1.4, respiratory rate was 16.2±3.1, resistive pressure 10.9 ± 3.8 (cmH2 O), and the mean of PaO2 /FiO2 ratio was 102.4 ± 45.4.

Concerning comparison between studied mechanical ventilated patients cardiovascular assessment for post-different backrest positions' degrees, the findings of the current study reflected that there was a highly statistically significant difference between the studied patients' cardio-vascular assessment at post 0^o, 30^o and 45^o degrees of backrest positions as regard heart rate, blood pressure systolic, main arterial pressure and peripheral pulse. In addition, highly statistically significant difference was found as regard blood pressure diastolic and central venous pressure, while there was no statistically significant difference as regard fluid and electrolyte assessment.

This result is in the same line with a study done by **Abd El-Moaty et al., (2017)** who clarified that there was a statistically significant increase in HR, RR, and SBP after 30 minutes of the 45° HOBE position (107.04 ± 2.80; 22.46± 1.76; 129.64 ± 1.93), (P2 <0.001) 30° HOBE position (92.19 ± 2.10), (P2< 0.05) after 30 minutes compared to 15 minutes.

Additionally, the current results agree with **Ibrahim et al., (2022)** at a study entitled "Effect of semi-fowler position during suctioning on oxygenation among patient with truma" who clarified that the 30C HOBE (semi-fowler position) has a positive significant effect on total oxygenation in the form of arterial blood gas values (PaO2, and PaCo2) and oxygen saturation (SaO2), in addition to hemodynamic parameters in the form of respiratory rate, systolic and diastolic blood pressure, and MAP, in addition to CVP.

On the contrast, this finding is in difference with **Ebrahim et al., (2017)** who illustrated that there was no significant difference in the heart rate or mean arterial pressure values at the various backrest angle and measurement point (20°, 30°, 60°).

From the investigator point of view, this result may be due to different backrest positions optimize ventilation and perfusion, promote effective pulmonary gas exchange, and promote lung expansion maneuvers that increases functional residual capacity, enhances quality of respiration, improves alveolar ventilation, decreases work of breathing and establishes diaphragmatic excursion. In addition, it improves cardiac output, myocardial contractility, resting heart rate, improves venous return and strengthens cardiac muscles.

For comparison between studied mechanical ventilated patients respiratory assessment post different backrest positions' degrees, the results of the current study clarified that there was a highly statistically significant difference between the studied patients' respiratory assessment at post 0^o, 30^o and 45^o degrees of backrest positions as regard respiratory rate and oxygen saturation. But, there was no statistically significant difference as regard rhythm, cough and color.

These results are consistent with a study done by **Elzohry et al., (2021)** who represented that the semi-sitting position (with thorax angulation=30° &45° from the horizontal plane) is associated with improvement of PO2/FIO2, oxygenation and tidal volume, and the effects of prone position on respiratory mechanics is very beneficial and this reflected on patient outcome and short ICU length of stay. Also in the current study a highly statistically significant difference means improvement of respiratory parameters for mechanically ventilated patients at 45 degree head of bed elevation.

Also, this result is in congruent with **Alan & Khorshid (2021)** a study entitled "The effects of different positions on saturation and vital signs in patients." They concluded that lying on the right side of the body at 45 degree in bed can effectively improve oxygenation in all patients with lung disease.

Additionally, this finding agree with a study carried out by **Mezidi & Guérin, (2018)** and entitled "Effects of patient positioning on respiratory mechanics in mechanically ventilated ICU patients" which reported that the sitting position (with thorax angulation >30° from the horizontal plane) is associated with improvement of oxygenation (SPo2) and reduction of work of breathing with statistically significant improvement SPo2.

This result may be attributed to that owing to the fact that this position leads to diaphragm lowering and alveolar expansion increasing, which maximizes lung volumes by decreasing the pressure relied on the diaphragm caused by the pressure from the abdominal contents. This intensifies the respiratory system obedience, causing PaO2 increase and PaCo2 decrease.

As regarding to the studied mechanical ventilated patients' respiratory outcomes post different backrest positions' degrees, the current study found that there was no statistically significant difference between respiratory outcome for mechanical ventilated patients at post 0^{o}, 30^{o} and 45^{o} degrees of backrest positions as regard hypoxemia, and lung compliance.

Similarly, these findings are consistent with **Malhotra & Kacmarek (2020)** who carried out a study entitled "Prone ventilation for adult patients with acute respiratory distress syndrome" and demonstrated that there is no evidence that prone ventilation prevents organ system dysfunction or reduces the intensive care unit length of stay shorten the duration of mechanical ventilation and improve lung compliance.

These results are in difference with the results of **Martinez et al., (2015)** who studied " Influence of different degrees of head elevation on respiratory mechanics in mechanically ventilated patient" and concluded that head angle affected the respiratory mechanics of mechanically ventilated patients and lung compliance. The highest dynamic compliance value was observed at the 30º position relative to the other angles, and the driving pressure was increased at head angles of 45º and 60º.

From the investigator point of view, these results could be due to it is very difficult to maintain an elevation angle of more than 30° or 45° for long time to patients which cause lack of sufficient comfort and leading to overload in patients physical tolerance which causing negative influence on their lung function.

For correlation between patients' age and hemodynamic stability among the studied patients, the present study results illustrated that there was a statistically significant positive correlation between patients' capillary refill and their age at post 30^{o} and 45^{o} degrees. In addition, there were highly statistically significant negative correlations between patients' age and their heart rate, systolic and diastolic blood pressure, main arterial pressure and peripheral pulse at post 30^{o} and 45^{o} degrees. As well, there was a statistically significant negative correlation between patients' central venous pressure and their age at post 30^{o} and 45^{o} degrees.

On the same line, these results like with the results of **Taha et al., (2021)** who demonstrated that there were highly statistically significant relations between the studied patients' age and physiologic and hemodynamic functions after intervention with semi fowlers' position.

From the investigator point of view, this result could be due to the age of patients is one of the most important factors that determine degree of response and improvement with any type of intervention.

Regarding correlation between patients' age and hemodynamic stability, the results of the present study indicated that, there was a highly statistically significant positive correlation between patients' hypoxemia and their age at post 30^{o} degrees. Besides, there were highly statistically significant negative correlations between patients' age and their respiratory rate and lung compliance at post 30^{o} and 45^{o} degrees and so hypoxemia at post 45^{o} degrees. Additionally, there was a statistically significant negative correlation between patients' oxygen saturation and their age at post 30^{o} and 45^{o} degrees.

This finding is in accordance with **Kandil et al., (2017)** who studied "Traumatic brain injury predictive value of common intensive care severity scores" and found that there were highly statistically significant relation between the studied patients' age and their physiological stability. This finding may be explained by the health outcome of patients is usually affected by age as the younger patients usually recovers early to the absence of most of the chronic disease.

Conclusion:

In light of the current study, it can be concluded that, implementation of 45 degree backrest position is associated with improvement of hemodynamic stability of mechanically ventilated patients.

Recommendations:

Based on the findings of the present study, the following item:

- Encourage nurses in intensive care settings to apply 45 degree head of bed elevation for mechanically ventilated patients' and involved in practice guideline for critical care nurses.
- Posters, and simple illustrations about importance of 45degree head of bed elevation for mechanically ventilated patients.
- Develop simplified and comprehensive booklet for critical care nurses including basic knowledge and practices regarding homodynamic stability for mechanically ventilated patients during head of bed elevation 45 degree.
- Further studies should be suggested to evaluate other factors affecting homodynamic stability for mechanically ventilated patients

References:

Abd El-Moaty, A. M., EL-Mokadem, N. M., & Abd-Elhy, A. H. (2017). Effect of Semi Fowler's Positions on Oxygenation and Hemodynamic Status among Critically Ill Patients with Traumatic Brain Injury. International Journal of Novel Research in Healthcare and Nursing, 4(2), 227-236.

Alan, N., & Khorshid, L. (2021). The effects of different positions on saturation and vital signs in patients. Nursing in critical care, 26(1), 28-34.

Anchala, A. (2016). A Study to Assess the Effect of Therapeutic Positions on Hemodynamic Parameters among Critically III Patients in the Intensive Care Unit at Sri Ramachandra Medical Centre. Journal of Nursing Care, 5(348), 2167-1168.

Borusyak, K., Hull, P., & Jaravel, X. (2022). Quasi-experimental shift-share research designs. The Review of Economic Studies, 89(1), 181-213.

Brindle, C.T., Malhotra, R., O'rourke, S., Currie, L., Chadwik, D., Falls, P., Watson, S. (2013). Turning and repositioning the critically ill patient with hemodynamic instability: A literature review and consensus recommendations. Journal of Wound Ostomy & Continence Nursing, 40(3), 254-267.

Değişikliklerinin, Y. B. H. P. (2021). The Effects of the Position Changes of Critical Care Patients on Respiratory and Cardiac Parameters. Turk J Intensive Care, 19, 167-73.

Di Mascio, N., Clarke, S., de Loughry, G., & Altaf, W. (2022). Prone positioning for mechanically ventilated patients with coronavirus disease 2019: the experience of an Irish regional hospital intensive care unit. Irish Journal of Medical Science (1971-), 1-6.

Ebrahim, A. A., El Mokadem, N. M., & Alizm, S. E. A. (2017). Effectiveness of Backrest Elevation on Oxygenation and Hemodynamic Status among Mechanically Ventilated Patient after Coronary Artery Bypass Graft Surgery.

Elamoudy, H. G., Mohammad, S. Y., Abdellatif, G. A., & Dessowky, S. M. (2022). Effect of Positioning on Oxygenation and Hemodynamics among Patients on Mechanical Ventilation. Evidence-Based Nursing Research, 4(1), 7-7.

Elzohry, A. A. M., Abd El Khalik, E. F., & Ismael Roushdy, A. S. (2020). Airway Pressure and Respiratory Mechanics Variability with Different Body Positions in Mechanically Ventilated Critical Care Patients: A Prospective Comparative Clinical Study. J Clin Anesthes Res, 1(1), 1-6.

Elzohry, A. A. M., Abd El Khalik, E. F., & Ismael Roushdy, A. S. (2021). Airway Pressure and Respiratory Mechanics Variability with Different Body Positions in Mechanically Ventilated Critical Care Patients: A Prospective Comparative Clinical Study. J Clin Anesthes Res, 1(1), 1-6.

Farsi, Z., Butler, S., & Zareiyan, A. (2020). The effect of semirecumbent and right lateral positions on the gastric residual volume of mechanically ventilated, critically ill patients. Journal of Nursing Research, 28(4), e108.

Göcze, I., Strenge, F., Zeman, F., Creutzenberg, M., Graf, B. M., Schlitt, H. J ., & Bein, T. (2013). The effects of the semirecumdent position on hemodynamic status in patients on invasive mechanical ventilation: Prospective randomized multivariable analysis. Critical care, 17(2): 80.

Güner, C. K., & Kutlutürkan, S. (2022). Role of head-of-bed elevation in preventing ventilator-associated pneumonia bed elevation and pneumonia. Nursing in Critical Care, 27(5), 635-645.

Ibrahim, N., Ahmed, S. A. E. M., & Shereif, W. I. (2022). Effect of semi-fowler position during suctioning on oxygenation among patients with brain trauma. Port Said Scientific Journal of Nursing, 9(2), 26-43.

Ismail, A. S., Mohammad, S. Y., & Mourad, A. H. (2021). Effect of Body Position on Oxygenation and Hemodynamic Status among Patients with Traumatic Brain Injury. Evidence-Based Nursing Research, 3(2), 15-15.

Jalali, A., Maleki, Z., & Dinmohammadi, M. (2022). The Effect of Different Body Positions on Endotracheal Tube Cuff Pressure in Patients under Mechanical Ventilation. Journal of Caring Sciences, 11(1), 15.

Jarvis, C, (2016). Physical examination and health assessment (7th ed.).ST.Louis, MO: W.B.Saunders

Kadam, P. and Bhalerao, S. (2010): Sample size calculation. International journal of Ayurveda research; 1(1):55.

Kandil, A., Kenawi, M., Samir, A., & Hussein, K. (2017). Traumatic brain injury predictive value of common intensive care severity scores. Research and Opinion in Anesthesia and Intensive Care, 4(3), 124.

Katz, S., Arish, N., Rokach, A., Zaltzman, Y., & Marcus, E. L. (2018). The effect of body position on pulmonary function: a systematic review. BMC pulmonary medicine, 18(1), 1-16.

Lesmana, H., Ose, M. I., Zulfia, R., & Tobing, K. I. S. (2019). The Effect of Changes in Postural Position Angle Degree on Central Venous Pressure Measurement. Indonesian Journal of Medicine, 4(3), 192-200.

Malhotra, A., & Kacmarek, R. M. (2020). Prone ventilation for adult patients with acute respiratory distress syndrome. and Finlay G, deputy editor: UpToDate®. Wolters Kluwers.

Martinez, B. P., Marques, T. I., Santos, D. R., Silva, V. S., Nepomuceno Júnior, B. R., Alves, G. A. D. A.,.. . & Forgiarini Junior, L. A. (2015). Influence of different degrees of head elevation on respiratory mechanics in mechanically ventilated patients. Revista Brasileira de terapia intensiva, 27, 347-352.

Medical record of CU at Belbies-central hospital, (2019).

Mezidi, M., & Guérin, C. (2018). Effects of patient positioning on respiratory mechanics in mechanically ventilated ICU patients. Annals of translational medicine, 6(19).

Mir, M.A., Al Otaibi, A.A., Albaradie, R.S., & El-Razkey, J.Y. (2015). Effect of supine versus semifowler's positions on hemodynamic stability of patients with head injury. World journal of pharmaceutical research, 4(4), 1559-1569.

Mokadem, N. E., & Shimaa, E. S. (2020). Effect of positioning during suctioning o n cerebral perfusion pressure among patients with traumatic brain injury. American Journal of Nursing, 8(4), 435-441.

Nosek, T.M. (2016). Essentials of Human Physiology: An Interactive Multimedia Learning & Teaching Resource on Human Physiology & Functional Anatomy. Gold Standard Multimedia Incorporated; 2016.

Oktorina, V. S., & Nuraeni, A. (2018). The effect of body repositioning on hemodynamic status in patients with vasopressor therapy in intensive care unit. Belitung Nursing Journal, 4(6), 572-580.

Palanidurai, S., Phua, J., Chan, Y. H., & Mukhopadhyay, A. (2021). P/FP ratio: incorporation of PEEP into the PaO2/FiO2 ratio for prognostication and classification of acute respiratory distress syndrome. Annals of intensive care, 11(1), 1-9.

Ranieri, V.M., Rubenfeld, G.D., Thompson, B.T., Ferguson, N.D., Caldwell, E., Fan, E., Camporota, L., Slutsky, A.S. (2012). Acute respira-tory distress syndrome: the Berlin definition. JAMA; 307(23).

Senmar, M., Azimian, J., & Rafiei, H. (2017). Hemodynamic status and its relationship with the risk of pressure ulcers development in patients after open heart surgery. Journal of Nursing and Health Science. 6(1): 100-105.

Setiyawan, S., Ibrahim, K., & Mulyati, T. (2019). Comparison of Central Venous Pressure (Cvp) Score Among Patients on Mechanical Ventilator With Head of Bed (Hob) Elevation 30O; Neutral, Right, and Left Side Positions. Jurnal Keperawatan Padjadjaran, 7(1), 20-28.

Taha, A. S., Omran, E. S., & Mahmoud, E. A. (2021). Effectiveness of Semi-fowler's Position on Hemodynamic Function among Patients with Traumatic Head Injury. Journal of Nursing Science Benha University, 2(1), 89-108.

Wang, L., Li, X., Yang, Z., Tang, X., Yuan, Q., Deng, L., & Sun, X. (2016). Semi-recumbent position versus supine position for the prevention of ventilator-associated pneumonia in adults requiring mechanical ventilation. Cochrane Database of Systematic Reviews, (1).

Yudistirawati, N. (2021). Comparison of positioning between semi-fowler's and left lateral to oxygen saturation in ventilated patients: a quasi-experimental study: comparison of positioning between semi-fowler's and left lateral to oxygen saturation in ventilated patients: a quasi-experimental study. Quality: Jurnal Kesehatan, 15(2), 142-152.