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Effect of Semi Fowler's Positions on Oxygenation and Hemodynamic Status among Critically Ill Patients with Traumatic Brain Injury

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Abstract: **Positioning is one of the most frequently performed nursing activities, however there is lack of knowledge about the relationship between hemodynamic and different body positions among patients with traumatic brain injury (TBI). Aim: to examine the effect of semi-fowler positions on oxygenation and hemodynamic status among critically ill patients with Traumatic Brain Injury. Design: A quasi- experimental (repeated measures) design was utilized. Setting: the study was conducted at neurosurgical ICU of Menoufia University Hospital, Menoufia Governorate, Egypt. Sample: A convenient sample of fifty patients who were admitted to the neurosurgical ICU with TBI. Tools: Semi structured demographic Questionnaire, Cardiorespiratory parameters Questionnaire, Glasgow Coma Scale (GCS), APACHE II scale. Results: there was a statistically significant increase in MAP from 93.02 ± 1.69 to 96.50 ± 1.33, p<.05 after 30 minutes of positioning the patients at 45° HOB Elevation while there was no significant difference in RR, systolic/diastolic BP, CVP, Partial Pressure of Arterial Oxygen, Partial Pressure of Carbon Dioxide (P> 0.05). While after 30 minutes of the 30° HOB Elevation there was a highly statistically significant decrease in HR, SBP, Partial Pressure of Arterial Oxygen, Partial Pressure of Carbon Dioxide, RR (87.94 ± 1.34; 122.5±1.7, 27; 36 ± 2.19; 18.54 ± 1.58) (P< 0.001). Conclusion: semi-fowler position of the 30° HOB Elevation has a positive effect on hemodynamic and oxygenation. Recommendation: Development of practice guidelines for critical care nurses to position mechanically ventilated patients at 30 degree HOB elevation after TBI to improve oxygenation and hemodynamic status.**

Keywords: **Semi-Fowler Position, Hemodynamic, Oxygenation, Traumatic Brain Injury.**

1. INTRODUCTION

Traumatic Brain Injury (TBI) is a growing epidemic throughout the world and may present as a major global burden in 2020**.** Traumatic Brain Injury not only increases the overall morbidity and mortality, but also imposes substantial impact on quality of life [1]. The global incidence rate of TBI was estimated at 200 per 100 000 people per year [2].The Prevalence rate of TBI in adults over 18 is 8.5% [3].In Egypt, the overall incidence of TBI in 2016 was 2124 patients. 62.1% of the patients had a mild head injury, 17.5% had moderate head injury and 20.3% had a severe head injury [4].

Patients with TBI at a great risk for secondary head injury due to concurrently occurring multisystem challenges, including cardiovascular vulnerability, fluid and electrolyte alterations, acute mechanical ventilation dependency, pulmonary pathology, and cerebrovascular compromise [5] This complex combination of multisystem physiologic processes makes TBI patients most exposed to random body position changes. Hemodynamic changes occur with postural change [6; 7]. These changes can be classified as immediate (within 30 seconds after repositioning), stabilized (within 20 minutes after repositioning), and prolonged (20 minutes to several hours after repositioning). An upright position results in blood volume shifts. About 10 % of the total blood volume and 25% to 30% of the thoracic blood volume is shunted to the lower body [8]. This shift results in blood decreases.

Hemodynamic changes arising after primary brain injury lead to the secondary brain injury and cerebral ischemia. Numerous secondary brain insults, both intracranial and extra cranial or systemic, may complicate the primarily injured brain and result in secondary brain injury [9, 10]. Systemic brain insults are mainly ischemic in nature and cause hemodynamic changes as hypotension, or hypertension; hypoxemia, and acid-base disorders, hypomania , hypercapnia and change of body temperature as fever or, hypothermia, [6]. It has been evident that early episodes of hypotension and hypoxia significantly increase morbidity and mortality in TBI patients [11].

Therapeutic positioning is a core component of critical care nursing to optimize ventilation and perfusion and to promote effective pulmonary gas exchange [12]. Semi Fowler's position cause significant changes in the cardiovascular system [13]. Rising from the supine to upright position results in changes on the cardiovascular system such as decreased Mean Arterial Pressure (MAP) and every 2.5 cm change of vertical height from the reference point at the heart level leads to a change of MAP by 2 mmHg either decrease or increase in the opposite direction, decreased Central Venous Pressure (CVP) slightly (3 mm Hg) , impaired venous return from reduced stroke volume by 40% with massive venous pooling in the lower extremities leading to decreased cardiac output by 25% and increased total peripheral resistance by 25%, heart rate is increased by 25% , Systolic blood pressure is slightly reduced due to fall in stroke volume, diastolic blood pressure is slightly increased due to increased total peripheral resistance [14]

The semi fowler's position (30, 45°) also affect oxygenation and arterial blood gases parameters by increasing SpO_2, pao_2 and decreasing paco2 [15]. Also, tidal volume increase due to lowering of diaphragm and increase alveolar expansion. The semi-fowler position maximizes lung volumes, flow rate and capacities increases spontaneous tidal volumes, and decreases the pressure on the diaphragm exerted by abdominal contents, increase in respiratory system compliance so oxygenation increased and $PaCo_2$ decreased [16].

Nurses based their clinical judgment on physiological and scientific evidence to position critically ill patients to prevent complications of immobility and to achieve optimal patient outcomes. Therapeutic positioning in immobile patients is done to improve ventilation and perfusion and to promote effective pulmonary gas exchange. It is well established that the way in which the patient positioned may prevent unnecessary changes in hemodynamic and oxygenation for patients with traumatic head injuries. Findings about the effect of body position on hemodynamic and oxygenation of patients with brain-injury are conflicting which suggest that the effectiveness of an elevated backrest position for brain- injured patients is not clear. Lack of clarity about this aspect is a problem that hinders the delivering of effective care of brain-injured patients. Therefore, the aim of the current study was to examine the effect of semi-fowler positions on oxygenation and hemodynamic status among critically ill patients with Traumatic brain injury.

Research Hypotheses:

- There will be a change in patient's hemodynamic parameters after receiving semi-fowler positions of 30, 45 degree among critically ill Patients with Traumatic Brain Injury.
- There will be a change in patient's oxygenation parameters after receiving semi-fowler positions of 30, 45 degree among critically ill Patients with traumatic brain injury.

2. METHODS

Research Design: Quasi-expermental (repeated measure) research design was utilized.

Sample: A convenient sample of 50 patients who were admitted to the neurosurgical ICU of the university and teaching hospital of Menoufia University who were approached over a year from the beginning of January 2016 to the end of December 2016. These patients met the study inclusion criteria included: (a) adult patient, aged from 19 - 65years old, (b) GCS < 8, (c) Patient diagnosed with traumatic brain injury. Subjects were excluded if they had (a) Spinal cord injury because this injury will impose limitations when changing positions as it is contraindicated for those patients to move to avoid further deformity [18], (b) Patients under 19 or above 65years old will be excluded because the study focus is adults persons, (c) Patients with fever (temperature > 38°C) because fever affect patient hemodynamic parameters.

Sample Size Calculation: In the present study, sample size was calculated based on power analysis performed in previous study which indicated that 33 patients would yield sufficient statistical power of 0 .80 to detect a treatment effect with body positioning on hemodynamic, medium treatment effect size = 0 .5, and alpha = 0 .05, two-tailed [18].

Setting: The study was conducted at neurosurgical ICU of the Menoufia University and teaching hospital of Shebin El-Kom city, Menoufia Governorate, Egypt.

Data Collection Tools:

Tool I: A Semi Structured Demographic Questionnaire: It included data about age, gender, ICU length of stay, medical history and medications. Data were extracted from the patient's medical records by the researcher at the initial data collection point.

Tool II: Cardiorespiratory Parameters Questionnaire: It was developed by Holzheimer (2001) [19] to assess physiological parameters: such as; Hart Rate (HR), Respiratory Rate (RR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP), Central Venous Pressure (CVP) via the monitor (Nihon Kohden Life Scope Bsm-3500) which was calibrated automatically. The reliability of bed side monitor (NIHON KOHDEN, life scope, BSM 3000 series) was tested by Cronbach's Co efficiency Alpha (a=.0.87) . The validity of bed side monitor (NIHON KOHDEN, life scope, BSM 3000 series) had a Respiratory Rate accuracy of 93.1% and a Heart Rate accuracy of 94.4% among ICU patients [20]. Oxygenation was measured through Arterial Blood Gases values (SaO_2, PaO_2 and $PaCo_2$) via RAPID Point 500 Blood Gas analyzer which equipped with fully automated calibration mechanism and was calibrated every 2 hours. The reliability of RapidPoint 500(®) was reported in a sample of One hundred sixty five adult hospitalized patients in ICU. The Intra-and inter- assay coefficients was higher than 0.91[21]. The validity of RapidPoint 500(®) was assessed through two types of evaluation. The first was an analysis of paired- sample measurements on a 114 randomly selected patient blood samples using the RapidPoint 500(®) and standard analyzer. The second analysis consisted of using standard reference material to assess reproducibility (precision) of the analyzer over a 20 day period. In the paired-sample analysis, the correlation coefficients for the values determined by the two systems showed a significant relationship (r = 0.962 for pH, r = 0.9955 for PaCO2), and r = 0.9829 for PaO2). RapidPoint 500(®) has adequate accuracy and precision for use in the clinical arena [22].

The validity of the Cardiorespiratory Parameters Questionnaire was tested in the present study by using Pearson Product Moment Correlations. Based on the significant value obtained by the Sig (2-tailed) <0.05 and the internal consistency (r^2=0.61, p-value = <0.05).The reliability of the Cardiorespiratory Parameters Questionnaire was tested in the present study using the Internal consistency and the Crombach Co-effeciency alpha was.77.

Tool III: Glasgow Coma Scale (GCS): A neurological scale developed by Graham and Bryan, (1974) [23] used to give a reliable and objective way of recording the conscious status of a person for initial as well as subsequent assessment. A patient is assessed against the criteria of the scale, and the resulting points give a patient score. The maximal total score for a fully awake and alert person is 15. A minimal score of 3 is consistent with complete lack of responsiveness. A total score of 3 to 8 suggests severe impairment, 9 to 12 suggests moderate impairment, and 13 to 15 suggest mild impairment.

The validity of GCS scale was shown to be high when used in patients with TBI (r^2=0.233, p<0.0001) [24].The reliability of GCS scale was reported in a study of 50 adult patients who had TBI. Internal consistency was evaluated using Crombach Co-efficiency alpha and was 0.81 for the total scale [25]. Also, the reliability of GCS scale was reported in a study of 100 adult patients who had neurologic condition including TBI. Internal consistency was evaluated using Crombach Co-efficiency alpha and was 0.87 for both the first and the second rater. Spearman correlation coefficients was high (P = 0.98 for the first rater; P= 0.92 for the second rater) [26].

III- Acute Physiology and Chronic Health Evaluation II (APACHE II) Scale was developed by Knaus, Draper, Wagner & Zimmerman (1985) [27]. APACHE II was designed to measure the severity of disease for adult patients admitted to ICU. It is applied within 24 hours of patient admission to the ICU; an integer score from 0 to 71 is computed based on several measurements such as patient's age and 12 routine physiological measurements (PaO2 (depending on FiO2), Body temperature, Mean Arterial Pressure (MAP), arterial pH, Heart Rate, Respiratory Rate, Serum Sodium, Serum Potassium, Creatinine, Hematocrit, White Blood Cell Count (WBC), Glasgow Coma Scale). The validity of APACHE II scale was shown to be high when used in patients with TBI with Bravais-Pearson correlation coefficient, 0.86, P<0.01) [28]. The reliability of APACHE II scale was reported in a study of 37 adult patients who had TBI. Internal consistency was evaluated using Crombach Co-efficiency alpha and was 0.91 (P < .001) for the total scale [29].

Ethical Consideration:

An offical permission for conducting the study was obtained from the Research Ethics Commity at the Faculty of Nursing and the University hospital director for seeking permission to carry out the study after explaining the nature and the purpose of the study.

A written/ oral consent was obtained from the relatives of the patients who met the study inclusion criteria to participate in the study. At the initial interview, relatives were informed about the purpose, procedure, and benefits of participating in the study. The researcher explained to the relatives that participation in the study is voluntary and they can withdraw from the study at any time without penalty. Confidentiality and anonymity of patients 'information were assured through coding all data and put all collecting data sheets in a secured cabinet. Questionnaires were fulfilled by the investigator.

Data Collection Procedure (Intervation):

At the initial visit, the investigator collected patients' demographic data from the patient's records by using the Semi Structured Demographic questionnaire. Then the investigator assessed conscious level by using Glasgow coma scale (GCS) for every participant and APAHCII scale to detect the severity of the TBI within the first 48hours of ICU admission. Each participant was examined in both positions (30° & 45°). The choice of 30 degree elevation for this study was based on the traditional recommendations prescribed for the head injured patients as well as anatomical and scientific data. Participants served as their own controls. All participants had a 15 minute rest before the positioning so that any previous nursing activities will not affect the studied variables. Every participant was positioned in the 30°semi-fowler position for 15 minutes until stabilization of patients hemodynamic. No nursing activities were done during the 15 minutes of positioning the patient at the30°semi-fowler position in order not to affect patients hemodynamic. The investigator assessed patient's oxygenation and haemodynamic status by using the Cardiorespiratory parameters questionnaire after 15minute, then the patient positioned in the 30°semi-fowler position for another 15 minutes then the investigator assessed patient's oxygenation and haemodynamic status again after 30 minutes. Then the patient positioned in the 45°semi-fowler position and the cardiorespiratory parameters readings were measured after 15 and 30 minutes for each patient.

Statistical Analysis:

Data was coded and transformed into specially designed form to be suitable for computer entry process. Data was statistically analyzed using Statistical Package for Social Science (SPSS) Version 16 for windows. The findings were collected, tabulated, and statistically analyzed by two types of statistics that were: Descriptive statistics (Frequency, Arithmetic Mean (X), Stander Deviation (SD), and Analytic Statistics (Student t-test, Paired t –test, Multivariate analysis of variance (MANOVA). Student t test is used to test the association between two variables. For each test the P value of 0.05 level was used as the cut off value for statistical significance.

3. RESULTS

Characteristics of the Studied Sample:

The mean age of the studied sample was 32.92% ± 14.81 and the majority of the sample was males (94.0%). According to the educational level the majority of the patients were illiterate (82.0%) and 56% of the studied sample were married. About 50% of the participants were smoker and 28.0% of the participants were diagnosed with Subdural Hemorrhage (SDH). See table (1).

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Table (1) The Socio-demographic Characteristics of the Participants

Socio-demographic Variables	No	%
Age X ± SD Range	 32.92 ± 14.81 19.00 - 65.00	
Gender Male Female	 47 3	 94.0% 6.0%
Educational level Illiterate Read and Write	 41 9	 82.0% 18.0%
Marital Status Single Married	 22 28	 44.0% 56.0%
Smoking No Yes	 25 25	 50.0% 50.0%
Diagnosis		
Subdural hemorrhage Subarachnoid hemorrhage Subdural & Subarachnoid hemorrhage Epidural hemorrhage Intraventricular & Subarachnoid hemorrhage	14 11 12 11 2	28.00% 22.00% 24.00% 22.00% 4.00%

Regarding the severity of the disease, 40.0% of the participants have APACHE II score ranged from 10-14 , which indicate 15% mortality risk; 26.0% of the participants have APACHE II score ranged from 20-24 with 40% mortality risk. The mean APACHE score was 17.06 ± 5.6. The Glasgow Coma Scale (GCS) mean score of the participants was 4.82 ±1.90. See table (2).

Table (2) APACHE II Score & GCS of the Participants

APACHE Score	Mortality Risk	No	%
5-9	8%	2	4.0
10-14	15%	20	40.0
15-19	25%	11	22.0
20-24	40%	13	26.0
25-29	55%	2	4.0
30-34	75%	2	4.0
X ± SD		17.06 ± 5.6	
Range		8.00 - 31.00	
Glasgow Coma Scale X ± SD Range		 4.82 ± 1.90 3.00 - 8.00	

Effect of 30° and 45° Head of Bed Elevation Position on Hemodynamic parameters:

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) compared with the 30° HOBE position. Also, there was a statistically significant decrease in MAP after 30 minutes of the 30° HOBE position (92.19 ± 2.10), (P2< 0.05) compared with the 45° HOBE position.

There was a statistically significant increase in the CVP after 15 minutes of the 30° HOBE position (6.19± 3.52), (P< 0.05) compared with 15, 30 minutes of 45° HOBE position while there was no statistically significant difference in the mean score of the DBP between the 30° and the 45° HOBE position after 15, 30 minutes of patient positioning (P> 0.05). See table (3).

Table (3) the Differences in Hemodynamic Parameters in the 30° and 45° Head of Bed Elevation Position

Hemodynamic parameters	**Position 30°**		**Position 45°**		**P –value**
	After15 minutes	**After30 minutes**	**After15 minutes**	**After30 minutes**	
	X ± SD	X ± SD	X ± SD	X ± SD	
HR	96.70 ± 1.30	87.94± 1.34	102.94 ±2.9	107.04± 2.80	P1<.001** P2< 0.05*
SBP	127.14± 1.97	122.5± 1.7	126.34± 1.66	129.64± 1.93	P1<.001** P2> 0.05 Ns
DBP	75.94 ± 2.51	75.64± 2.07	75.26 ± 2.76	76.10± 2.64	P1> 0.05 Ns P2> 0.05 Ns
MAP	94.53 ± 4.31	92.19± 2.10	93.02 ± 1.69	96.50± 1.33	P1< 0.05* P2< 0.05*
CVP	6.19 ± 3.52	5.42 ± 2.8	4.78 ± 0.7	4.65± 0.84	P1< 0.05* P2> 0.05 Ns

**= Highly significance P1: post 15 min 30°, 45°HOBE

*= Significance P2: post 30 min 30°, 45°HOBE

Ns= No significance

The Effect of 30° and 45° Head of Bed Elevation Position on Oxygenation parameters. There was a statistically significant increase in PaO2, SaO2 (165.9± 5.6, 99.07±1.35) respectively , (P < 0.05) and a statistically significant decrease in PaCO2 after 30 minutes of the 30° HOBE position (27.36± 2.19), (P > 0.05) compared with 15, 30 minutes of the 45° HOBE position. Also, there was a highly statistically significant increase in RR after 30 minutes of 45° HOBE position (22.46± 1.76), (p2> 0.05) compared with 15, 30 minutes 30° HOBE position. See table (4).

Table (4) the Differences in Oxygenation Parameters in the 30° and 45° Head of Bed Elevation Position

Oxygenation parameters	Position 30°		Position 45°		P –value
	After15 minutes	After30 minutes	After15 minutes	After30 minutes	
	X ± SD	X ± SD	X ± SD	X ± SD	
PaO2	163.7± 5.3	165.9± 5.6	151.43± 2.54	151.81± 2.51	P1< 0.05* P2> 0.05 Ns
PaCO2	28.21± 2.96	27.36± 2.19	29.49± 1.04	29.44± 1.06	P1< 0.05** P2> 0.05Ns
SaO2	98.79± 1.78	99.07± 1.35	95.64± 2.77	95.73± 2.59	P1< 0.05* P2> 0.05 Ns
RR	21.12± 2.49	18.54± 1.58	21.24 ± 1.16	22.46± 1.76	P1<.001** P2> 0.05 Ns

**= Highly significance P1: post 15 min 30°, 45°HOBE

*= Significance P2: post 30 min 30°, 45°HOBE

Ns= No significance

4. DISCUSSION

Effect of 30° and 45° Head of Bed Elevation Position on Hemodynamic Parameters:

Head position may potentially influence intracranial hemodynamic after severe brain injury. An intact cerebral autoregulation system normally maintained a constant Cerebral Blood Flow (CBF). However, compensatory mechanisms for sustaining CBF may be affected when the brain is injured. Elevated Intra Cranial Pressure (ICP) in excess of 40 mmHg, mean blood pressures that exceed 60 to 150 mmHg, local or diffuse injury from ischemia, or inflammation all are factors that can affect these protective mechanisms. An important component of nursing care is identifying the most optimal body position that enhances adequate CBF while controlling ICP, CPP, and brain oxygenation [30].

The present study hypothesized that there will be a change in patient's hemodynamic parameters after receiving Semi-fowler positions of 30, 45 degree among critically ill patients with Traumatic Brain Injury .The findings of the present study supported the study hypothesis and revealed that there was a statistically significant reduction in MAP after 30 minutes of the 30°position. Similar findings have been reported by Göcze et al., (2013) [31] who studied the effect of the semi recumbent position on the hemodynamic status in mechanically ventilated patients in sequence of HBE positions (0°, 30°, and 45°) adopted in random order allowing 3 minutes for hemodynamic parameters to be recorded and found that increasing the angle of HBE to 30° was associated with significant decreases in MAP. However, the findings of the current study are different from what was reported by Okasha et al., (2013) [18] who studied the effect of supine and semi-fowler position on cerebral perfusion pressure among patients with acute traumatic brain injuries and found that after 15 minute of semi-Fowler position 30° there was a significant increase in pulse rate, SBP & MAP and found no statistically significant difference in the diastolic blood pressure. Also, the findings of the current study are different from what was reported by Agbeko, (2012) [32] who examined the effect of head of bed elevation on ICP, CPP, MAP, cerebral oxygenation in 38 brain injured patients and found that there was no significant change in MAP after 15 minutes of 30° position.

There was a statistically significant increase in the CVP after 15 minutes of the 30° HOBE position (6.19± 3.52), ($P < 0.05$) compared with 15, 30 minutes of 45° HOBE position while there was no statistically significant difference in the mean score of the DBP between the 30° and the 45° HOBE position after 15, 30 minutes of patient positioning ($P > 0.05$). Different findings have been reported by Kim & Sohng (2016) [33] who studied the effects of backrest position **(**30°) on CVP and ICP in 64 patients after brain surgery and found that there was no significant change in CVP after 5 minutes of 30° position. A possible explanation of the current study findings may be Hypovolemia. Hypovolemia is one explanation for the hemodynamic changes associated with head of bed elevation. Hypovolemia can lead to decreased perfusion of the brain and other organ systems resulting in less desirable outcomes [34].

Effect of 30° and 45° Head of Bed Elevation Position on Oxygenation Status:

There is a conflicting result about the relationship between backrest elevation and gas exchange among different patient populations. Partial pressure of arterial oxygen seems to decrease in the sitting position immediately after surgical procedures, but this change may decrease over time. [33] The findings from additional studies, however, contradict these results.[34, 35]. While, other studies have reported no statistically significant differences in mixed venous oxygen saturation during 0, 20, 30, 40, and 45 degrees of backrest elevation in mechanically ventilated postoperative cardiac surgical patients. [36, 37].

The current study hypothesized that there will be a change in patient's oxygenation status after receiving the semi-fowler positions of 30°, 45° among critically ill Patients with traumatic brain injury. The findings of the present study revealed that there was a statistically significant increase in SaO_2 and PaO_2 of the 30° HBE position after 30 minute. Similar findings were reported by Okasha et al., (2013) [18] who studied the effects of supine and semi-fowler position on cerebral perfusion pressure among patients with acute traumatic brain injuries and found that after 15 minute of semi-Fowler 30° position there was a significant increase in SpO_2, PaO_2, SaO_2 and significant decrease in the $PaCO_2$. Also, similar findings have been reported by Prato et al., (2015) [38] who examined the influence of different degrees of head of bed elevation on respiratory mechanics in 35 mechanically ventilated patients and found that after 5 minutes of Semi Fowler's 30° position there was increase in oxygen saturation.

In addition, the present study findings revealed that on 45° position there was no statistically significant difference in oxygenation parameters (PaO_2, $PaCO_2$, SaO_2, RR) after 15 and 30 minute of 45° position . The current study findings are similar to what was reported by Thomas, Paratz, Lipman, (2013) [39] who examined the effect of seated and semi-recumbent positioning on gas exchange, respiratory mechanics and hemodynamic of 34 ventilated intensive care patients and revealed that putting patients in semi-fowler's position with the head of the bed elevated 45° for 30 minute showed no statistically significant difference of RR and Arterial blood gas values (PaO_2, SaO_2, $PaCO_2$). However, the findings of the current study are different from what was reported by Deye et al., (2013) [40] who assessed the physiologic effects of the body position on the work of breathing in patients with weaning difficulties in 24 intubated patients breathing with pressure support who had already failed a spontaneous breathing trial or an extubation episode. Deye findings reported that the semi-seated position at 45 degree decreases the inspiratory effort and is found to be at least as comfortable as other positions for difficult-to-wean patients.

5. LIMITATION OF THE STUDY

1. The findings of the current study are limited in their generalizability because of the convenience sample. The lack of random sampling may contribute to sample selection bias and limits the generalization of the findings.

2. The current study included patients within the first 24 hours after TBI, therefore, our findings can only be generalizable for patients in the early acute phase after admission to the ICU rather than long-term mechanically ventilated patients. During this period we could detect all acute hemodynamic changes associated with altering the angle of the backrest elevation, but cannot determine whether these changes would be maintained over time and what the longer-term consequences of these changes are.

3. Participants were recruited from a single hospital, thus, findings should be interpreted cautiously.

4. Another limitation is related to the small sample size.

6. CONCLUSION

Semi-fowler position 30° has a positive effect on hemodynamic parameters as pulse rate, respiratory rate, blood pressure, CVP, mean arterial blood pressure (MAP) and arterial blood gas values (SaO_2, PaO_2 and $PaCo_2$).

7. RECOMMENDATIONS

Nursing is a practice discipline concerned with patient responses (ANA, 1990). The findings of this study are important to the nursing discipline and have implications for both clinical practice and future research. Understanding similarities and differences in patterns of response experienced by brain-injured patients can help critical care nurses to tailor individualized intervention.

1) Backrest elevation should be decided individually for each patient according to patient’s responses, including cardiovascular and hemodynamic parameters, and systemic oxygenation.

2) Development of practice guidelines for critical care nurses to position mechanically ventilated patients at 30 degree head of bed elevation after traumatic brain injury to improve oxygenation and hemodynamic status.

3) Replication of the study is recommended with several design changes such as, using large sample size; using a randomized selection and different sites.

Implication for Future Research:

Future studies are needed to examine hydration with additional measures such as serum Sodium, Blood Urea Nitrogen (BUN), and hematocrit values to determine the role of hydration in promoting optimal hemodynamic status.

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