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Effectiveness of Passive Range of Motion Exercises on Hemodynamic parameters and Behavioral pain Intensity among Adult Mechanically Ventilated Patients

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Abstract: *Mechanically ventilated critically ill patients are often given strict bed rest and sometimes completely immobilized because of the severity of their illness and administration of drugs such as sedatives and neuromuscular blocking agents. Mobilization can improve outcomes for these patients including significantly shorter lengths of stay and improved functional outcomes.* ***This study aimed to*** *evaluate the effect of passive range of motion exercises on hemodynamic parameters and behavioral pain intensity among adult mechanically ventilated patients. The study was carried out in Anesthesia Care Unit at Tanta Emergency Hospital. A quasi-experimental research design was utilized. Convenient sample of 40 adult ventilated patients meet the inclusion criteria were exposed to the program of passive range of motion exercises. Three tools were used for data collection.* ***Tool I:*** *Critically ill patient's assessment sheet. This tool divided into two parts.* ***Part one:*** *Bio-Socio demographic assessment sheet. It includes patient's age, sex, level of consciousness, medical history, diagnosis, and co morbidity conditions.* ***Part two****: ventilator assessment sheet.* ***Tool II:*** *Hemodynamic parameters assessment sheet that assesses physiological and hemodynamic measures.* ***Tool III:*** *Behavioral pain scale for unconscious patients to assess intensity of behavioral pain among ventilated patients.* ***Research hypothesis: H1:*** *Mean scores of physiological parameters for ventilated patients will be within normal variation throughout three phases of the study.* ***H2:*** *The intensity of behavioral pain scale will be improved throughout three phases of intervention.* ***Results:*** *a significant decrease in systolic, diastolic blood pressure and oxygen saturation mean scores were observed after 5 and 20 min minutes of intervention (119.45±7.06, 116.88±5.75), (81.80±4.23, 79.68±3.05) and (93.50±2.44, 93.02±2.08) respectively compared to the mean scores before intervention (Time 0) 122.95±8.13, 84.75±5.17 and 94.60±2.71 respectively .While after 60 min (T3) the mean scores were nearly equal to before intervention (Time 0). On the other hand, significant increase in mean scores of heart and respiratory rate were observed after 5 and 20 min minutes of intervention (89.58±5.51, 93.92±4.96) and (20.28±2.34, 21.28±1.95) compared to the mean scores before intervention (Time 0) (86.05±6.25, 18.92±2.36). While after 60 min (T3) the mean scores were nearly equal to the mean scores before intervention (Time 0). Although these changes was observed but it was within normal ranges of physiological variables and no need for discontinuation of passive leg exercises Also, this result showed that 50% of ventilated patients had severe pain before starting the program of passive range of motion exercises. However after 60 minutes from intervention about two third (60%) of critically ill patients had no pain.* ***Conclusion:*** *slight changes in the mean scores of physiological parameters after 5 and 20 minutes after intervention compared to the mean scores before intervention were observed. After 60 minutes of intervention these mean scores returned to their base line. Also, the intensity of behavioral pain decreased after 60 minutes compared to before intervention. Based on findings of this study, it is recommended to carry out early passive range of motion exercise for ventilated patients within the context of a mobilization protocol.*

Keywords: *Passive Range of motion exercises, Hemodynamic parameters, Behavioral pain Intensity.*

I. Introduction

Critically ill and mechanically ventilated patients are often given strict bed rest and they are sometimes completely immobilized because of the severity of their illness and administration of drugs such as sedatives and neuromuscular blocking agents (1). The physiological consequences of bed rest and inactivity are many and they detrimentally affect the functioning of many body systems and physical functioning (2). The impact of immobility on the patient may encompass functional decline and associated neuromuscular, musculoskeletal weakness, impaired coordination, delayed weaning from mechanical ventilation, prolonged hospital stay and delayed recovery after hospital discharge. These complications can significantly affect the quality of life both of patients and their family. Mobilization of these patients, particularly those who are receiving mechanical ventilation, presents challenges to healthcare professionals (3, 4). The challenges to mobilize critically ill patients are numerous factors including the safety of tubes and lines, hemodynamic instability, personnel and equipment resources, sedation practices, the patient's size, the patient's pain, the time and the priority of mobilization. All of these factors may persist for days to weeks and delaying the use of active mobility. With respect to the activity event and the patient's ability to hemodynamically tolerate the movement, safety may be the most significant factor (5-7).

Passive exercise as a routine nursing procedure may be the most appropriate activity for these patients in the early phase of illness (8, 9). Passive limb exercises (PLEs) are defined as repeated movements of a joint within available limits, performed without volitional control, and could be considered as a an early form of mobilization for ICU patients who are sedated or unconscious (10,11).

Passive activity can be delivered manually by therapists or nurses, or via machines such as cycle ergometers or continuous passive motion machines. Studies have reported manual passive exercise repetitions for 5, 7 and 10 time for each joint, but no rationales were provided for these choices (12-14). Also, there is a study showing that continuous passive exercise in one leg three times a day for seven days improved muscle blood flow and prevented myopathy (15-17). It can be employed until a patient is ready to progress to more active interventions. Tolerance of passive activity may be one signal that institution and progression are appropriate (8).

Physiological measures such as heart, respiratory rate, blood pressure, oxygen saturation, central venous pressure and behavioral pain response have been suggested as approaches to identify patient's tolerance, and preliminary research has demonstrated a physiologic stability in mechanically ventilated and critically ill patients who were mobilized five days or longer after intubation (12, 18, 19).

Passive activity, if demonstrated safely, may provide early benefit for those critically ill patients who are not yet able to tolerate progressive activity. It increased venous return, stroke volume, oxygen consumption, maintain joint range, decreased contracture, facilitated weaning, shortened hospitals stays, and improved quality of life for mechanically ventilated and critically ill patients (20-25). Another benefit of passive exercises is decreasing pain behaviors indicating that mobilization may serve as a novel approach to pain management in the critically ill patients. Behavioral Pain Scale score is decreased during and after the intervention in a study about physiologic responses to a passive exercise intervention in mechanically ventilated critically ill adults (20).

Finally, mechanical stress from limb mobilization may alter hemodynamic responses such as heart rate (HR), blood pressure (BP) and myocardial oxygen consumption (mVO_2) (25). So the monitoring of physiological responses of critically ill patients during mobilization determines not only when the patient is ready to begin the activity, but also when the activity should be halted (26). Therefore, the aim of this study was to evaluate the effect of passive range of motion exercises on hemodynamic parameters and behavioral pain intensity among adult mechanically ventilated patients.

II. Aim of the study

To evaluate the effect of passive range of motion exercise on hemodynamic parameters and behavioral pain intensity among adult mechanically ventilated patients.

III. Sitting

Intensive Care Unit at Emergency Hospital. Tanta University.

IV. Study Design

The study was a quasi experimental design.

V. Subject

A convenient sample of 40 adult mechanically ventilated patients meeting the inclusion criteria will be exposed to the program of passive range of motion exercise carried out by the researchers.

Inclusion Criteria:

- Age of 18 or older
- Patient with mechanical ventilation started within 48 hours
- Stability of hemodynamic parameters
- Absence of an orthopedic and vascular problems limiting range of motion (ROM) such as extremity fracture, joint dislocation, subluxation amputation, missing or injured limbs, suspected or actual deep venous thrombosis and spinal, pelvic, or lower extremity instability are excluded from the study.

Research Hypothesis:

1. Mean scores of physiological parameters of mechanically ventilated patients will be within normal variation throughout the four periods of the study.
2. The intensity of behavioral pain scale will be improved through the four phases of intervention

VI. Tools

Three tools were developed by the researchers based on the review of recent related literature to collect the necessary data required for this study:

Tool I: Critically ill patient assessment sheet:

This tool was developed by the researches and divided into two parts to assess adult mechanically ventilated patients.

Part one: Bio -Sociodemographic assessment sheet:

This part includes patient age, sex, level of consciousness, medical history, diagnosis and co-morbidity condition.

Part two: ventilator parameters assessment sheet:

This part includes the mode of ventilator, sedation and narcotics during intubation, and vasopressor medication.

Tool II: Hemodynamic parameters assessment sheet [18]

This tool includes assessment of physiological and hemodynamic measures such as heart rate, systolic and diastolic blood pressure, oxygen saturation, respiratory rate, and central venous pressure and O_2 saturation.

Tool III: Behavioral pain scale for unconscious patients: [27]

This tool is used to assess the level of patient's comfort, and intensity of pain among critically ill mechanically ventilated patients. Behavioral pain scale (BPS) is a valid tool used in assessing pain in unconscious critically ill patients. It composed of 3 observational items (facial expressions, upper limbs, and compliance with ventilation) that are scored from 1 to 4, with higher numbers indicating higher levels of discomfort. The total BPS score can range from 3 (no pain) to 12 (the most pain).

VII. Methods

- An official permission to carry out the study was obtained from the responsible authorities.
- Critically ill patient's assessment tools were developed by the researchers after reviewing the recent literature.
- The tools were revised by 9 experts who are specialized in the field of nursing and medicine in Tanta University for their validity and modifications were done accordingly.
- The content validity of behavioral pain Scale has been used and reported in different patient populations [27].
- Reliability testing of behavioral pain Scale has been reported as 0.94% and had been tested using Cronbach's Alpha test [28].
- An informed consent was obtained from patents guardian after explaining the purpose of the study.
- Confidentiality of critically ill ventilated patients was ascertained.

Pilot study: A pilot study was carried out on 5 critically ill ventilated patients to test the feasibility and applicability of the developed tools, and the modifications were done. The five patients of the pilot study were excluded from the study.

- Data were collected through 5months, starting from September 2014 to January 2015.
- The study was implemented through four phases:

Assessment Phase: Assessment phase was done for all patients to collect baseline data (Tool I). This phase began with a 30-minute rest period. Before starting the rest period, care activities such as repositioning, suctioning, examination, and hygiene measures were performed by the critical care nurse to limit the influence of other activity on study outcomes.
- At the end of the rest period, baseline measures were recorded by the researchers for each patient as heart rate, systolic and diastolic blood pressure, oxygen saturation, central venous pressure, and BPS score using tool II and III.

Planning phase: The program was developed by the researchers based on the review of current literature and based on the results of patients 'assessment [1].

Implementation Phase: The program of passive range of motion exercises was carried out for each patient as follows:

Passive range of motion exercises protocol:

- The passive-exercise protocol consisted of 20 minutes of flexion-extension movements for both upper and lower limbs simultaneously (one session for one day). After completion of protocol of range of motion exercise, the patient should rest for about 60 minutes without any activities until the researchers obtain the last reading.
- Every Patient received 10 repetitive upper and lower extremity passive ranges of motion by the researchers while being in a supine position.

For the upper extremities, passive ranges of motion exercise included finger flexion and extension, wrist flexion, extension and ulnar and radial deviation; elbow flexion, extension, supination and pronation; and shoulder flexion, extension, abduction, and adduction.

Lower extremity PLEs included toe flexion and extension, ankle plantar flexion, dorsiflexion, inversion and eversion, knee flexion and extension and hip flexion, extension, abduction, adduction, and internal and external rotation.

The time taken for the program was 20 minutes for one day. The researchers obtained hemodynamic parameters and BPS through four phases:

- **Phase 1 (time 0):** involve base line measurement (heart rate, systolic, diastolic, and oxygen saturation, CVP) and BPS score were obtained.
- **Phase 2 (time 1):** the researchers measure physiological parameters (heart rate, systolic, diastolic, and oxygen saturation, CVP) and BPS score after 5 minutes following exercise.
- **Phase 3 (time 2):** the researchers measure the physiological parameters after 20 minutes of intervention (after completion).
- **Phase 4 (time 3):** the researchers measure the physiological parameters after 60 minutes from completion of the intervention.

Evaluation phases: In this phase, the researchers start to measure hemodynamic parameters and BPS during the four phases mentioned above and comparing them to know the improvement in these findings through using (Tools II and III).

Limitations of the study:

- Sedation administration may subside or hide the effect of exercises program in some cases.
- Attempts were made to limit the nurse from initiating the patient's activity before the intervention but some patients had activity during the 60-minute rest period after completion of the intervention.

Statistical analysis: The range, mean and standard deviation were calculated for quantitative data. For qualitative data, a comparison between the four phases in one group was done using Chi-square test (χ^2). For a comparison between more than two means, the F-value of ANOVA was calculated. A significance was adopted at $P<0.05$ for interpretation of the results [29].

VIII. Results

Table (1) shows the distribution of the studied critically ill patients according to their sociodemographic data. Regarding the age, it was observed that 45% of the studied group ranged from 50 - 61 years old and 35% of them were in age between 41-50 years with the mean age of 48.75±9.44. Also, most of the studied group (60 %) was males and 40% of them were females. Concerning the diagnosis, it was found that more than half of the studied group (55%) had head trauma. However, brain tumor, intestinal obstruction postoperative and respiratory failures reported the same proportion (15%) of the sample respectively.

In relation to the past medical history, the results showed that more than one third of the studied group (35%) had past history of neurological disease. Also, one third (30%) of the sample had past history of respiratory disease. while, diabetes mellitus and cardiovascular disease were encountered among 25% and 10% of the sample respectively.

Regarding the mode of mechanical ventilation, majority of the sample (62.5%) were treated with SIMV mode while control volume was (37.5%) and pressure support was (23%). More than one third (37.5% and 32.5%) of critically ill ventilated patients were given sedation and vasopressors at the time of intervention respectively.

Table (2) represents the mean scores of physiological parameters of ventilated patients throughout four phases of passive exercises. In this table, significant decreases in systolic, diastolic blood pressure and oxygen saturation mean scores were observed after 5 and 20 minutes of intervention (119.45±7.06, 116.88±5.75), (81.80±4.23, 79.68±3.05) and (93.50±2.44, 93.02±2.08) respectively compared to the mean scores before intervention (time 0) (122.95±8.13), (84.75±5.17) and (94.60±2.71) respectively while after 60 minutes (Time3), the mean scores were nearly equal to before intervention (Time 0). On the other hand, significant increases in the mean scores of heart and respiratory rate were observed after 5 and 20 minutes of intervention (89.58±5.51, 93.92±4.96) and (20.28±2.34, 21.28±1.95) were compared to the mean scores before intervention (Time 0) (86.05±6.25, 18.92±2.36) respectively while after 60 minutes (Time 3), the mean scores were nearly equal to the mean scores before the intervention (Time 0) Where P= 0.00. Although these changes was observed but it was within normal ranges of physiological variables and no need for discontinuation of passive leg exercises

No clinically and statistically significant changes in the mean scores of central venous pressure and tidal volume were observed throughout four periods of the study where P= 0.107 and 0.726 respectively.

Table (3) shows the distribution of the studied ventilated patients according to their items of behavioral pain score throughout the four phases of passive range of motion exercises. This table showed that there were significant changes in facial expressions, movement of upper limbs and compliance with ventilation throughout the four periods of the study with P = 0.00.

In this table, grimacing facial expressions was encountered among 70% of critically ill ventilated patients before intervention (time 0) while about two third of patients (60%) had relaxed Facial expression after 60 min of intervention (Time 3).

Concerning the movement of upper limbs, it was observed that majority (70%) of the studied patients fully bent with finger flexion before intervention (Time 0) compared to 75% of them didn’t move upper limbs after 60 minutes of intervention (Time 3).

According to the compliance with ventilation, it was observed that half of the sample (50%) were fighting ventilator before intervention (Time 0) while majority (90%) of the patients had a tolerating movement after 60 minutes of intervention (Time 3). Also, significant changes in facial expressions, the movement of upper limbs and compliance with ventilator throughout the four periods of the study were observed with P=0.00.

Table (4) shows the percentage distribution of the studied patients according to the severity of behavioral pain score throughout the four phases of passive exercises. In this table, a significant decrease in behavioral pain score was observed from Time 0 (before intervention) to Time 1(after 5 min) and from Time 0 to Time 2 (after 20 min). No pain was found at Time 2 and Time 3 (after 60 min. from intervention). Also, half of the sample (50%) had a severe pain before the intervention while none of the studied patients had pain after 20 and 60 min of intervention.

Table (5) represents the effect of age on the severity of the total behavioral pain score among the studied patients throughout the four phases of passive range of motion exercises. In this table, it was observed that more than two thirds (62.5%) of ventilated patients with age more than 40 years had a severe pain before starting the exercises.

On the other hand, majority of the patients with age ≤ 40 years had a moderate pain. A significant and statistical difference was observed regarding the age among critically ill ventilated patients at the base line (Time 0), where P =0.00.

Also, the total behavioral pain Score (BPS) decreased after 5 minutes of the intervention (time 1) and more than half of ventilated patients (56.25%) aged > 40 years had a moderate pain compared to the baseline (time 0). Also, half of the studied patients (50%) with age ≤ 40 years reported a moderate pain at time 1. A significant and statistical difference was observed regarding the age among critically ill patients after 5 minutes from intervention (Time1), where P =0.011.

A significant improvement in BPS was observed after 20 minutes of exercises (Time 2) among all ventilated patients with P=0.000. In addition, the majority (75%) of ventilated patients with age > 40 years reported no pain after 60 minutes of intervention (Time 3) compared to only 25% of patients with age≤ 40 years. A significant and statistical difference was observed in this phase (Time 3) with P= 0.00.

Table (6) shows the effect of sex on the severity of the total behavioral pain score among studied patients throughout the four periods of the study. This table showed that more than two thirds (62.5%) of female ventilated patients had a severe pain before starting the passive range of motion exercise program compared to more than half (58.33%) of male ventilated patients. No statistical significant difference was observed at the base line regarding the sex and BPS.

After 5 minutes from starting exercises program (Time 1), the BPS was improved among ventilated patients with both sex and about one third (33.33) of male patients reported severe pain compared to only 12.5% of the female ones. Regarding Time 2, it was observed that more than two thirds (66.67%) of male ventilated patients had no pain and the percentage improved to 70.83% after 60 minutes from intervention (Time 3).

Also, one quarter (25%) of female patients reported no pain and the percentage improved to 62.5 % after 60 minutes (Time 3). A significant and statistical difference was observed among ventilated patients regarding the sex at time 2 with P= 0.001.

Table (7) shows the effect of sedation administration on the severity of the total behavioral pain score (BPS) among the studied patients throughout the four phases of passive range of motion exercises. In this table, a significant and statistical difference was observed among the studied patients regarding the administration of sedation and BPS at the base line before the application of exercise program (Time0) with P=0.00. Also, about half of ventilated and non sedated patients (52%) had a severe pain compared to none of sedated and ventilated ones.

On the other hand, the severity of BPS decreased after 5 minutes from starting exercises among all the ventilated patients. A significant and statistical difference was observed where P= 0.010. Also, majority (66.67%) of the sedated ventilated patients reported no pain after 20 minutes of intervention (Time2) compared to 40% of non sedated patients. No significant difference was observed at this phase.

After 60 minutes from intervention (Time 3), it was observed that majority (80%) of the sedated patients reported no pain compared to 40 % of none sedated ones. A significant and statistical difference was observed at this phase with P = 0.039.

IX. Tables

Table (1): Distribution of the studied critically ill patients according to their sociodemographic data:

Personal characteristics		Studied sample (n = 40)	
		N	%
Age (years)	From 28-40	8	20
	From 41-50	14	35
	From 51-65	18	45
Mean ± SD		**48.75±9.44**	
Sex	Male	24	60
	Female	16	40
Diagnosis.	brain tumor	6	15
	head trauma	22	55
	Intestinal obstruction post operative	6	15
	Respiratory failure	6	15
Co morbidity Conditions.	DM	10	25
	Cardiovascular diseases	4	10
	Respiratory diseases	12	30
	Neurological disease	14	35
Mode of ventilation.	C.V. mode	15	37.5
	SIMV mode	25	62.5
Pressure support.	No	30	75
	Yes	10	25
Sedation.	No	25	62.5
	Yes	15	37.5
Vasopressors.	No	27	67.5
	Yes	13	32.5

Table (2): Mean scores of physiological parameters of ventilated patients throughout four phases of passive range of motion exercises

items	Mean ± SD				F	P
	Base line	Time 1	Time 2	Time 3		
1. Systolic blood pressure	122.95±8.13	119.45±7.06	116.88±5.75	122.72±6.797	**6.88**	**0.00***
2. Diastolic blood pressure	84.75±5.17	81.80±4.23	79.68±3.05	84.08±5.076	**10.71**	**0.00***
3. Heart rate	86.05±6.25	89.58±5.51	93.92±4.96	85.95±5.688	**17.94**	**0.00***
4. Respiratory rate	18.92±2.36	20.28±2.34	21.28±1.95	18.82±2.308	**10.88**	**0.00***
5. Oxygen saturation	94.60±2.71	93.50±2.44	93.02±2.08	94.15±2.293	**3.39**	**0.02***
6. CVP	11.35±2.01	11.12±2.02	11.25±2.15	12.15±1.98	**2.07**	**0.107**
7. TV	512.90±37.92	505.30±34.72	512.80±31.08	510.60±32.004	**0.438**	**0.726**

Base line: Time 0, Time 1: after 5 min, Time 2: after 20 min, Time 3: after 60 min

Table (3): Distribution of the studied ventilated patients according to their items of behavioral pain score throughout four phases of passive range of motion exercises.

Items		Base line (n=40)		Time 1 (n=40)		Time 2 (n=40)		Time 3 (n=40)		χ^2 P
		N	%	N	%	N	%	N	%	
1. Facial expression.	Relaxed	0	0	0	0	20	50	24	60	**97.209 0.00***
	Partially tightened	6	15	8	20	16	40	10	25	
	Fully tighted	6	15	10	25	2	5	4	10	
	Grimacing	28	70	22	55	2	5	2	5	
2. movement of upper limbs	No movement	2	5	2	5	26	65	30	75	**89.20 0.00***
	Partially bent	2	5	2	5	4	10	2	5	
	Fully bent with finger flexion	28	70	34	85	10	25	8	20	
	Permanently retracted	8	20	2	5	0	0	0	0	
3. Compliance with ventilation.	Tolerating movement	14	35	24	60	32	80	36	90	**48.679 0.00***
	Coughing but tolerating	6	15	6	15	8	20	4	10	
	Fighting ventilator	20	50	10	25	0	0	0	0	

Table (4): Percentage distribution of the studied patients according to severity of total behavioral pain score throughout four phases of passive exercises

Intensity of behavioral pain		The studied patient throughout four phases of exercises								χ^2 P
		Base line (n=40)		Time 1 (n=40)		Time 2 (n=40)		Time 3 (n=40)		
		N	%	N	%	N	%	N	%	
Total behavior pain score	No pain	0	0	0	0	20	50	24	60	**1.046 0.00***
	Mild	6	15	8	20	16	40	10	25	
	Moderate	14	35	22	55	4	10	6	15	
	sever	20	50	10	25	0	0	0	0	

Table (5): Effect of age on severity of total behavioral pain score among studied patients throughout four phases of passive range of motion exercises.

Age throughout four phases of exercise		Total behavioral pain intensity								χ^2 P
		No pain		Mild		Moderate		Sever		
		N	%	N	%	N	%	N	%	
Base line	≤ 40 (n=8)	0	0	2	25	6	75	0	0	22.52 0.000*
	> 40 (n=32)	0	0	4	12.5	8	25	20	62.5	
Time 1	≤ 40 (n=8)	0	0	4	50	4	50	0	0	13.13 0.011*
	> 40(n=32)	0	0	4	12.5	18	56.25	10	31.25	
Time 2	≤ 40 (n=8)	0	0	8	100	0	0	0	0	29.14 0.000*
	> 40 (n=32)	20	62.5	8	25	4	12.5	0	0	
Time 3	≤ 40 (n=8)	2	25	6	75	0	0	0	0	23.74 0.000*
	> 40 (n=32)	25	75	4	12.5	3	12.5	0	0	

Table (6): Effect of sex on the severity of total behavioral pain score (BPS) among studied patients throughout four phases of passive range of motion exercises.

Sex throughout four phases of exercise		Total behavioral pain intensity								χ^2 P
		No pain		Mild		Moderate		Sever		
		N	%	N	%	N	%	N	%	
Base Line	Male (n=24)	0	0	4	16.67	6	25	14	58.33	**2.659 0.265**
	Female (n=16)	0	0	2	12.5	4	25	10	62.5	
Time 1	Male (n=24)	0	0	6	25	10	41.67	8	33.33	**4.356 0.113**
	Female (n=16)	0	0	2	12.5	12	75	2	12.5	
Time 2	Male (n=24)	16	66.67	4	16.67	4	16.67	0	0	**14.167 0.001***
	Female (n=16)	4	25	12	75	0	0	0	0	
Time 3	Male (n=24)	17	70.83	4	66.67	3	12.5	0	0	**3.765 0.152**
	Female (n=16)	10	62.5	6	37.5	0	0	0	0	

Table (7): The effect of sedation administration on the severity of total behavioral pain score (BPS) among studied patients throughout four phases of passive range of motion exercises.

Sedation administration		Total behavioral pain intensity								χ^2 P
		No pain		Mild		Moderate		Sever		
		N	%	N	%	N	%	N	%	
Base line	No (n=25)	0	0	3	12	9	36	13	52	**16.440**
	Yes (n=15)	0	0	10	66.67	5	33.33	0	0	**0.000***
Time 1	No (n=25)	0	0	8	32	12	48	5	20	**9.280**
	Yes (n=15)	0	0	12	80	3	20	0	0	**0.010***
Time 2	No (n=25)	10	40	11	44	4	16	0	0	**4.00**
	Yes (n=15)	10	66.6	5	33.33	0	0	0	0	**0.135**
Time 3	No (n=25)	10	40	12	48	3	12	0	0	**6.487**
	Yes (n=15)	12	80	3	20	0	0	0	0	**0.039***

X. Discussion

Hemodynamic parameters instability in mechanically ventilated and critically ill patients may persist for days to weeks, delaying active mobility interventions, which may integrate to disability [30, 31]. It may be due to that passive exercise is the most congruous activity for critically ill patients in the early form of illness and it can be employed until a patient is yard to onward motion to more active interventions [9]. However, Patient's tolerance to exercises appears to be the limiting factor in application of mobilization. Commonly used bedside physiologic measures, such as heart rate, respiratory rate and blood pressure, oxygen saturation and behavioral pain response have been suggested as approaches in identifying patient' tolerance to exercise [12, 18].

It is clinically relevant that early mobilization should not cause hemodynamic instability as critically ill patients may have marked limitations in their cardiovascular and/or respiratory reserve [7, 32]. Therefore, the aim of this study was to evaluate the effect of passive range of motion exercises on hemodynamic parameters and behavioral pain intensity among adult ventilated patients.

In the present study, it was found that nearly half of the total studied patients were in age between 50-61 years with the mean age of 48.75±9.44 and most of the studied groups were males. This may be contributing that most of the critically ill patients admitted to the Intensive Care Unit are old. These findings were in the same line with **Zamzam** et al (2015) [33] in a study about " assessing the characteristics and outcomes of patients on mechanical ventilation in the Intensive Care Unit of EL-Mahalla Chest Hospital" who mentioned that the mean age of all the studied patients was 58.47±8.2 years and majority of the sample were males. Also, **Ghoneim** et al (2013) [34] in a study about "Patterns of admitted cases to Respiratory Intensive Care Unit at Zagazig University Hospitals, Egypt," reported that most mechanically ventilated patients were of an old age and the higher percentage of cases admitted to ICU had malignancy, post cardio-respiratory arrest and neurological disorders.

Concerning diagnosis and co-morbidity conditions, it was found that more than half of the studied group had head trauma and one third of them had past history of neurological disease and respiratory disease. This may be due to that most of Patients with head injury require mechanical ventilation to maintain an arterial blood gases and old age is associated with increasing chance of serious coexisting disease. This finding was in agreement with **Fuchs** et al (2012) [35] in a study about "ICU admission characteristics and mortality rates among elderly and very elderly patients", reported that the prevalence of some preexisting conditions are increased, with increasing age. Similarly, **Ebirim** and **Ojum** (2012) [36] in a study about "outcome of trauma admissions in Intensive Care Unit in The Niger Delta Region Of Nigeria" stated that most of patients who had head injuries has been found to be the leading cause of admissions in an Intensive Care Unit (ICU) in Nigeria.

Also, **Gélinas** et al (2004) [37] in a study about "Pain assessment and management in critically ill intubated patients" reported that nearly one third of the sample had been hospitalized after head injury and cerebral hemorrhage.

Regarding the mode of mechanical ventilation, majority of the sample were treated with synchronized intermittent mandatory ventilation mode, while more than one third of sample received control volume and nearly one quarter of the sample received pressure support mode .This may be due to that most of the sample had head injury which may require placing the patient on mechanical ventilation. This finding was in accordance with **Amidei** and **Lou Sole** (2013) [38] in a study about "physiological responses to passive exercise in adults receiving mechanical ventilation", found that more than half of the sample was treated with synchronized intermittent mandatory ventilation and pressure support mode.

Also, **Burtin** et al (2009) [19] in a study about "Early exercise in critically ill patients enhances short-term functional recovery" found that most of the sample received (assisted) pressure-support ventilation, and 16% were weaned recently from mechanical ventilation and received supplemental oxygen therapy.

Also, the current study showed that majority of the studied sample did not give sedated and vasopressor drugs and adjusted on SIMV mode of mechanical ventilation. This may contributed that the effect of excessive sedation may create prolonged alteration of consciousness and increased duration of mechanical ventilation. This result was similar to **Naithani** et al (2008) [39] who stated in a study about "Assessment of Sedation and Analgesia in Mechanically Ventilated Patients in Intensive Care Unit" that no patient was given sedative, analgesic or neuromuscular blocking agent in their treatment chart and no sedation was in use for monitoring in ICU. Also, **Winkelman** et al (2013) [40] examining the positive effects of exercise in intubated adults in ICU found that the majority of enrollees in both control and intervention periods received continuous sedation during their participation in the study.

On contrary, a study conducted by **Samuelso** et al (2003) [41] reported that mechanically ventilated patients were routinely sedated in 91% of ICUs. In addition, **Gunten** et al (2003) [42] were not in line with the present study, who reported that sedation should be provided to all patients even those who are comatose. The dose needed to control symptoms will depend on some degrees on the neurological status of the patient and the amount of similar medication used up to the time of extubation. Also, **Amidei** and **Lou Sole** (2013) [38] found that majority of the sample was sedated at the time of the intervention.

As regards the mean scores of changes of physiological parameters of ventilated patients during passive exercises throughout the four phases of the study, the findings revealed that a significant decrease of oxygen saturation, systolic and diastolic blood pressure, the mean scores after 5 and 20 minutes of intervention compared to Time 0 (before intervention), while after 60 min of exercises (Time 3), the mean scores were nearly equal to Time 0 (before intervention). Although there was a significant change in the mean scores of blood pressure, these changes were within the normal ranges of physiological variables. In a similar study by **Burtin** et al (2009) [19] it was showed that no changes in HR, SBP, diastolic blood pressure, or respiratory rate were observed whereas SpO_2 decreased during cycling exercises.

In addition, **Stiller** et al (2004) [18] in a study about "the safety of mobilization and its effect on hemodynamic and respiratory status of intensive care patients", found that mobilization was associated with statistically significant changes for HR and BP but the magnitude of the changes was of a minor clinical importance. Also, this study showed that a transient decrease in oxygen saturation that responded to an increase in supplemental oxygen.

Versusly **Zafiropoulos** et al (2004) [43] implemented a mobilization protocol to the patient's underwent upper abdominal surgery and indicated significant increases in systolic, diastolic and MBP during sitting on the edge of the bed. HR and MBP decreased significantly to baseline values when the subjects sat out of bed for 20 minutes.

Concerning heart and respiratory rate, there was a significant increase in the mean score of heart and respiratory rate after 5 and 20 min. of intervention compared with Time 0 (before intervention) and a return to near baseline levels at the completion of the mobilization treatment. Although these changes were observed but it was within normal ranges of physiological variables and no need for disconsolation of passive exercises. This may be due to that the patients responded to the effort of physical activity by increasing their RR and HR. **Bourdin** et al (2010) [44] investigated the feasibility of early physical activity in ICU patients via measuring physiological parameters before and after each intervention. The authors reported a significant increase in heart and respiratory rate after tilting-up indicating the patient effort with this activity whereas the parameters reduced after chair-sitting which might be the result of improved oxygenation.

Similarly, **Şenduran** et al (2012) [45] investigated the effects of early mobilization on hemodynamic and respiratory responses in critically ill patients and they found significant differences between respiratory rates before, after and five minutes after mobilization.

Also, **Senduran** et al (2010) [46] investigated the hemodynamic effects of physiotherapy program including gradual mobilization in Intensive Care Unit in liver transplant recipients and revealed a significant increase in HR after all mobilization tasks. However, after a five-minute recovery, HR returned to pre-treatment values indicating the safety of mobilization in these patients group during the early post-operative period. On the other hand, **Afify** et al (2008) [47] showed a significant decrease in the resting heart rate and peak diastolic blood pressure that in cardiac patients undergoing high intensity exercise training.

Furthermore, the findings of the present study showed that no clinically significant change in the mean score of central venous pressure and tidal volume throughout the phases of the study. This finding agreed with the results of **Camargo** et al (2013) [48] in a study about "Very early passive cycling exercise in mechanically ventilated critically ill patients", they revealed that a very early cycling exercise is feasible and can be performed safely for mechanically ventilated patients in the ICU. There were no clinically relevant changes during the exercise in any of the hemodynamic variables such as heart rate, MAP, CVP and $SatO_2$ value compared with the rest values. Similar results were reported by **Adler** and **Malone** (2012) [49] who investigated a study "about early mobilization in the Intensive Care Unit", found that overall activity-induced increases in heart rate, blood pressure, respiratory rate (RR), tidal volume, and minute ventilation were within acceptable ranges.

On the other hand, **Genc** et al (2014) [50] in a study about "the hemodynamic and respiratory effects of passive limb exercise for mechanically ventilated patients receiving low-dose vasopressor/ inotropic support" emphasized that CVP and SpO_2 increased significantly after passive leg exercises. Similarly, **Azab** et al (2015)[45] reported that there was an increase in tidal volume (VT), respiratory rate (RR), minute ventilation and fractional inspiratory time during exercise and they decreased significantly during the recovery period.

In relation to the items of behavioral pain score throughout the phases of the study, the current study revealed that majority of critically ill patients had grimacing facial expressions at time (0) before intervention while the majority of them had relaxed facial expressions after 60 min of intervention (time 3). This might be attributed that passive exercise decrease sensation of tension and pain. This result was supported by **Rahu et al** (2013) [52] in a study that aimed to describe facial behaviors during endotracheal suctioning, pointed out grimace facial behaviors were the most observed pain behavioral responses during endotracheal suctioning. Also, **Prkachin** (2009) [53] added that the experience of pain is often represented by changes in facial expressions of patients who have a difficulty in using language to communicate about pain.

Concerning movement of upper limbs, it was observed that majority of the studied patients fully bent with finger flexion before intervention (time 0). On the other hand, the majority of them didn't move upper limbs after 60 min of intervention (time 3). This may be interpreted that passive exercise lead to relaxation and decreased tension of muscle. In this respect, **Choi** (2008) [54] and **Bailey** (2009) [55] concluded that physical activity is also thought to reduce pain, decrease anxiety, promote sleep, and improve mood, all of which are beneficial in reducing effects of illness on muscle.

According to compliance with ventilation, it was observed that half of the sample fight ventilator before intervention (time 0), while majority of the studied patients had been tolerating movement after 60 min of intervention (time 3). This finding was in contrast with **Payen** et al (2001) [56] who found in a study about "Assessing pain in critically ill sedated patients by using a behavioral pain scale", that an intubated patient's response to a nociceptive stimulus is associated with a change in compliance with ventilator (cough, fight) prompted us to include this item on the BPS during mobilization.

Regarding the severity of behavioral pain score throughout four phases of the study, the present finding revealed that most of the sample had severe pain before the intervention (time 0) while none of the studied patients had pain after 20 and 60 min. of the intervention (time 2 and time 3). The same finding was indicated by **Amidei** and **Lou Sole** (2012) [38] who showed a significant decrease in pain scores from baseline to 5 minutes after the start of exercise and from baseline to 10 minutes after the start of exercise; the decrease was sustained at the time of completion and 60 minutes after completion.

Similarly, **Besely** and **Abd elMowla** (2014) [57] in a study about "Effect of standardized nursing interventions on the recovery outcomes of patients undergoing thoracic surgeries", found that the percentage of patients who suffer from pain in chest decreased from 15% to 10% after performing exercise. In contrast, **Young** et al (2006) [28] used a behavioral pain scale to assess pain in ventilated, unconscious and/or sedated patients, reported that the mean BPS score of patients receiving mechanical ventilation increased significantly after the repositioning procedure.

Concerning the effect of age on total behavioral pain scale, the present study revealed that most of critically ill ventilated patients who aged over 40 had severe pain before starting the intervention. On the other hand, the majority of critically ill ventilated patients with age less than 40 years had a moderate pain through using behavioral pain scale at the base line. This may be interpreted that most of ventilated patients were adjusted on SIMV mode of ventilation and not sedated. On the other hand, a significant improvement in BPS was observed after 20 minutes of the program (time 2) among all ventilated patients regardless their age. Also, after completion of the program, the majority of ventilated patients with age more than 40 years had no pain. This result was in accordance with **Houston**'s study (1999) [58], who concluded that aging might affect the perception of pain because pain thresholds increased with age.

These results were in contradiction with **Al Sutari** et al (2014) [59] who reported in a study entitled "Pain among mechanically ventilated patients in critical care units" that age was negatively correlated with pain level during rest, indicating that younger patients had a higher level of pain than older ones. On the other hand, **Stotts** et al (2007)[60] in a study entitled "Does age make a difference in procedural pain perceptions and responses in hospitalized adults?" concluded that no difference in pain intensity existed between younger and older patients before and after routine procedures.

Regarding the effect of sex on total behavioral pain score (BPS), the results of this study showed that more than two thirds of female ventilated patients had severe pain before starting the passive range of motion exercise program. This finding may be due that the differences in the background characteristics of the subjects. Also, females were more sensitive to pain than males.

This result may be in line with **Gabyzon** et al (2012) [(61)] who reported in a study about "Gender Differences in Pain Perception and Functional Ability in Subjects with Knee Osteoarthritis" that the female subjects reported a higher intensity of pain in comparison with the male subjects. Also, **Alaa** et al (2008) [(62)] in a study about "Effectiveness of Relaxation Technique on Minimizing Postoperative pain on Banha University Hospital" were consistent with the present study and they stated that females are accepted to express emotional feelings more than males.

Similarly, **Meehan** et al (2000) [(63)] in a study entitled "Analgesic administration, pain intensity, and patient satisfaction in cardiac surgical patients" found a higher pain sensation in female patients. Furthermore, **Robinson** et al (2003) [(64)] and **Keefe** et al (2000) [(65)] were in accordance with this present finding.

As regards sedation and total behavioral pain score, the present study revealed that half of ventilated and non sedated patients adjusted to SIMV mode of ventilation had severe pain. On the other hand, none of ventilated and sedated patients adjusted to control mode of ventilation had a severe pain before application of range of motion exercise. This may be interpreted that all intubated patients with control mode take analgesics to reduce the intensity of behavioral pain.

The present study agreed with **Carrasco G**, et al (2000) [(66)] who stated in a study about "Instrument for monitoring ICU sedation" that sedation must be adjusted in an individualized way according to diagnosis, and consciousness level of patients. As well, **Payen** et al (2001) [(56)] in a study entitled "Assessing pain in critically ill sedated patients by using a behavioral pain scale" concluded that sedation should be better administered according to an individual's need

XI. Conclusion and Recommendations:

CONCLUSION:

Based on the findings of the current study, it can be concluded that a passive exercise protocol was well tolerated in a sample of critically ill and mechanically ventilated patients; although there was a significant change in mean scores of blood pressure, heart, respiratory rate, central venous pressure and oxygen saturation but the change was within the normal ranges of physiological variables. The severity of BPS was decreased after 5 minutes of exercises among all ventilated patients. The majority (66.67 %) of sedated ventilated patients didn't had pain after 20 minutes of intervention compared to 40 % of non sedated patients

RECOMMENDATIONS:

- Early passive exercise protocol should be started early as possible for mechanically ill ventilated patients.
- Future studies should investigate whether mobilization decreases need for narcotics in the critical care setting.
- Continued researches on other pain assessment tools for critically ill ventilated patients for proper pain management.

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