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The Effect of Safety Guidelines during Different Measuring Techniques on Central Venous Pressure Reading in Mechanically Ventilated Patients

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Abstract: **The central venous pressure remains the most frequently used variable to guide fluid resuscitation in critically ill patients which may be influenced by several elements such as intra-thoracic pressure and cardiac function. Aim: The current study aimed to investigate the effect of safety guidelines during different measuring techniques on central venous pressure readings in mechanically ventilated patients. Method: A prospective comparative study design was utilized in the current study. This study was conducted at the Internal Anesthetic Intensive Care Unit (IAICU), Emergency Hospital, Tanta University Hospitals. A purposive sample of 50 adult mechanically ventilated patients admitted to the previously mentioned setting. Two tools were used in data collection; central venous catheter assessment tool and central venous pressure monitoring schedule. Results: Safety guidelines were more effective in declining the percentage of central venous catheter complications such as infection and occlusion. Also, statistically significant differences were observed at three techniques of measuring central venous pressure (p< 0.05). The mean differences of central venous pressure were (2.03, 2.23, 2.47 and 2.01cm H2O) between positive end expiratory pressure =5 at supine position and baseline positive end expiratory pressure = 0. Also, they were (0.98, 1.24, 1.12 and 1.00 cm H2O) between reverse trendelenburg position and baseline positive end expiratory pressure = 0 at supine position for four consecutive readings. Conclusion: The results of the current study concluded that there was a direct good relationship between implementing safety guidelines and central venous pressure monitoring which reflected on readings. Also, central venous pressure was affected significantly during an increase in positive end expiratory pressure and changing position. Both supine and reverse trendelenburg position with positive end expiratory pressure =5 are suitable for the estimation of central venous pressure. Approximately, an increase in positive end expiratory pressure to 5 cm H2O was associated with about 2.0 cm H2O elevation in central venous pressure value at the supine position. Additionally, an increase in positive end expiratory pressure to 5 cm H2O was associated with about 1.0 cm H2O elevation in central venous pressure value reverse trendelenburg position (2.00 versus 1.00).**

Keywords: **Safety Guidelines, Different Measuring Techniques, Central Venous Pressure and Mechanically Ventilated Patients.**

1. INTRODUCTION

Measurement of central venous pressure (CVP) is a critical parameter of the complete hemodynamic assessment that reflects the critically ill patient's overall fluid volume status as it reflects the pressure within the right atrium. Additionally, CVP reading facilitates the diagnosis and treatment of the abnormal circulatory function of a critically ill patient [(1-3)].

Central venous catheter (CVC) is frequently used in Intensive Care Units (ICUs) and is the gold standard of CVP measurement. It is an invasive technique that plays a crucial role in estimating CVP in clinical practice. In addition, it enables the administration of total parenteral fluid and life-supporting medications and therapies [4,5].

The CVP can be measured intermittently using a water column manometer or continuously using a microprocessor-based pressure transducer. The normal CVP values range from 2-6mmHg or 5-10 cmH20. Any condition that alters circulating volume or the venous return may affect CVP reading. CVP may be raised, if the circulating volumes increase. On the other hand, it may be declined, if the circulating volumes decrease [6].

Positive end expiratory pressure (PEEP) in mechanically ventilated patients increases the intrathoracic pressure during expiration compresses the thoracic vena cava and decreases venous return. Therefore, reduction in the intrathoracic pumps leads to decrease CVP as a result of declining blood returns to the right atrium. Also, high PEEP level reflects high CVP more than usual [7,8].

Moreover, body position such as trendlenburg position compromises the respiratory function. The use of head of the bed elevation 45 degrees will raise intra-abdominal pressure 5-15 mmHg. Therefore, in mechanically ventilated patients trendlenburg position worse gas exchange and cardiac function. On the other hand, reverse trendlenburg position is preferred to allow ventilation, oxygenation, respiratory system mechanics and lung recruitment [9-11].

Central venous catheters can lead to mechanical injury, air embolism, catheter occlusion and infection to mechanically ventilated patients. Therefore, safety guidelines must be used during measuring CVP, CVC care and maintenance such as hand hygiene, clean the insertion site with an antiseptic solution, dressing changes every 48 hours, disinfection of the hubs and injection ports, replacement of administration sets and fluids and daily assessment of the insertion site [12,13].

1.1 Significance of the study:

The progress of safety guidelines during different central venous pressure measuring techniques indicates significant evidence that critical care nurse is responsible for patient's safety and the first line of caring for mechanically ventilated patients to enhance patient' care outcomes [14]. Moreover, during central venous pressure monitoring by the nurse in Intensive Care Unit we found that the critical care nurse measures the central venous pressure for mechanically ventilated patient then subtract the whole value of PEEP or separate the patient connection to mechanical ventilation and it pays attention to weaknesses and constraints that exist in both central venous pressure reading and patient safety.

1.2 Aim of the study:

The current study aimed to investigate the effect of safety guidelines during different measuring techniques on central venous pressure readings in mechanically ventilated patients.

1.3 Operational definition:

Different measuring techniques: means putting the mechanically ventilated patient in two different positions with three different PEEP value to ensure the CVP reading and maintain patient safety. These positions include; reverse trendelenburg position with PEEP = 5 cm H2O, supine position with PEEP = 5 cm H2O and supine position with PEEP = 0 cm H2O.

1.4 Research hypothesis:

H1. Mechanically ventilated patients who are exposed to safety guidelines during measuring CVP will exhibit minimal or no complications such as catheter-related bloodstream infections (CRBSIs), air embolism, and catheter occlusion.

H2. Reverse trendelenburg position with PEEP = 5 cm H_2O is safer technique for measuring CVP than supine position with PEEP = 0 cm H_2O.

H3. Central venous pressure readings during reverse trendelenburg position with PEEP = 5 cm H_2O are relatively consistent with the supine position with PEEP = 0 cm H_2O.

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2. SUBJECTS AND METHODS

2.1 Research design:

A prospective comparative study design was utilized in the current study.

2.2 Study Setting:

This study was conducted at the Internal Anesthetic Intensive Care Unit (IAICU) , Emergency Hospital at Tanta University Hospitals. It is prepared and equipped well for caring patients with life-threatening problems that transferred from all hospital departments which include surgical, medical and post-operative Intensive Care Units.

2.3 Subjects

A purposive sample of 50 adult mechanically ventilated patients was admitted to the previously mentioned setting and was selected based on Epi info program. They were undergoing safety guidelines, during which the patient put in the supine position with PEEP = 0 cm H_2O and 5 cm H_2O and after 15 minutes the CVP should be taken for another time while the patient put in reverse trendelenburg position with PEEP = 5 cm H_2O. also, after another 15 min CVP was taken for the third time while the patient put in supine position with PEEP =5 cm H_2O.

Patients' inclusion criteria, included adult patients aged from 18- 60 years with both sex, patient with central venous catheter insertion at the first 48 hours and PEEP equal to 5 cm H_2O.

2.4 Tools of the study:

Two tools were used for data collection

Tool I: Central Venous Catheter Assessment Tool:

This tool was developed by the researchers after reviewing the relevant literature. It composed of three parts as follows:

Part A: **Patients' Socio-demographic Data,** to assess data related to patient's age, sex and diagnosis.

Part B: **Central Venous Catheter Characteristics** [2,6,15], to assess patients for the indication of CVC insertion, size, types, number of catheter lumen, side of catheter insertion in the body.

Part C: **Catheter Related Complications:**

In this part, the catheter was inspected to assess signs of infection such as redness, hotness, swelling, and tenderness, assess any changes in the ability of the central line to withdraw blood, infuses intravenous fluids and presence of visible clots in the external portion of the catheter. Also, it was used to assess the presence of catheter disconnection or stopcock placed in the wrong position or a crack in the hub of the catheter [15,16,17].

Tool II: Central Venous Pressure Monitoring [18]:

This tool was developed by the researchers based on a relevant literature review to record CVP reading. It composed of three partitions; the first for recording CVP when the patient in the supine position with PEEP = 0 cm H2O and the second when PEEP = 5 cm H2O, while the third for recording CVP for patients in reverse trendelenburg position with PEEP = 5 cm H2O.

2.5 Methods

Ethical consideration: Official permission to carry out the study was obtained from the director of Emergency Hospital, Tanta University Hospitals through official letters from the faculty of nursing explaining the purpose of the study before data collection. The relatives of mechanically ventilated patients gave informed oral consent before their patients' participation in this study. The participation was voluntary. The confidentiality of each patient was obtained through the coding of all data.

All tools of the study were developed by the researchers after reviewing relevant literature and used to collect the data.

All tools were tested for content validity by five experts in the field of critical care nursing specialists, anesthesiologists and medical biostatistics to ensure their validity.

All tools of the study were tested for reliability and Cronbach alpha test was used and fond to be 0.819 for tool I and 0.787 for tool II which represent highly reliable tools.

A pilot study was carried out on 10 critically ill ventilated patients in order to test the clarity, feasibility and the applicability of the different items of the developed tools. Modifications on tools were done and the 10 patients were excluded from the study sample.

Data collection: Each studied patient who participated in this study and met the inclusive criteria was observed by the researchers. Data collection was conducted in the period from the end of April 2018 to the beginning of November 2019.

The study was carried out on four phases: Assessment, planning, implementation, and evaluation phases.

I. Assessment Phase:

During this phase, a purposive sample of 50 adult critically ill ventilated patients who fulfilled the inclusion criteria was selected. They were undergoing safety guidelines and positions during measuring CVP. The patients were assessed as follows:

- Patient and CVC characteristics were assessed using a tool I part A and B.
- Assessment of catheter related complications such as CVC site for infection, CVC occlusion and air embolism using a tool I part C.
- Central venous pressure readings were measured three times at three different positions with 15 minutes interval for each. Then CVP was measured four times; within the first 48 hours after CVC insertion, post 24 hours from the first reading, post 48 hours from the first reading and post 72 hours from the first reading using tool II.
- Safety guidelines during different central venous pressure measuring techniques of mechanically ventilated patients were assessed four times: Immediately before safety guidelines, post 24 hours of implementing safety guidelines, post 48 hours from implementing safety guidelines and post 72 hours from implementing safety guidelines using two developed tools.

II. Planning Phase:

This phase was articulated based on the assessment phase and the literature review. Priorities and expected outcome criteria were put into consideration when planning patients care.

The expected clinical outcome included: 1) the patients had no or minimal complications during CVP. 2) The patients had accurate CVP reading. 3) Using the best and safer position for the patient during CVP monitoring.

III.Implementation Phase:

In this phase, safety guidelines for CVP monitoring and subsequent care during different measuring techniques and CVP reading were implemented by the researcher as follows:

1) Central venous catheter care before CVP measurement:

A. preparation of the equipment:

Use aseptic techniques such as hand washing and maximal personal protective barriers such as gloves, gown, caps and masks, antiseptic solution preferably chlorhexidine gluconate 2% with alcohol, 2 or 3 x 10 ml sterile syringes to check for patency, 2 or 3 x 20 ml syringes filled with normal saline for flush, 2or 3 caps one per lumen and sterile gauzes [1,19].

B. Patient's preparation:

Put the patient in a supine position with the head turned to the opposite side of CVC before flushing the central line to prevent mechanical trauma.

C. Flush central venous pressure ports through:

1. Decontaminate the ports, clamps and lumens of CVC: Cleanse each port, clamp and limb using friction scrub for 30 seconds and use a new piece of gauze for each time for each port.

2.Assess blood flow: With the attachment of a new 10 ml syringe, then open the arterial port clamp and check for adequate blood flow using a "withdraw and instill" motion to ensure catheter patency. Finally, clamp the lumen immediately to prevent air embolism.

3. Flush lumens with normal saline: Attach a 20 ml sterile saline syringe to the arterial port. Flush lumen using a "push/pause" method which includes a short repetitive push on the syringe plunger to prevent CVC occlusion, and then clamp the lumen immediately to prevent air embolism**.**

4. Instill locking solution: Instill locking solution and immediately close clamp while continuing to apply pressure on the syringe plunger, then remove the syringe from the arterial port and attach cap to the lumen.

5. Label and wrap: Wrap the lumens together with a 4x4 gauze and secure with tape outer of the dressing. Attach a label with the volume of solution to the gauze wrap [5,20].

2) The central venous pressure monitoring technique:

After the central line was flushed, CVP must be 'zeroed' before the measurement and after every change of position to ambient pressure at the level of the right atrium. This is usually taken at the level of the fourth intercostal space in the mid-axillary line while the patient was in supine position and disconnected from PEEP. After 15 minutes the CVP should be taken for another time while the patient put in reverse trendelenburg position with PEEP. Also, CVP was taken for the third time after 15 min while the patient is in supine position with PEEP = 5 mmHg. Each measurement was taken at the same zero position.

A 3-way stopcock was used to connect the manometer to an intravenous drip set on one side and via the extension set to the patient on the other side to remove any air bubbles.

The 3-way stopcock was then turned and opened to the fluid bag and the manometer and closed to the patient to fill the manometer column adequately with fluid. Once the manometer has filled adequately then the 3-way stopcock was turned again to allow open to the patient and the manometer, but closed to the fluid bag. The fluid level within the manometer column was fall to the level of the CVP, the value of which was read on the manometer scale. The CVC should be flushed every 12 hours to maintain the patency of the catheters before CVP measurement [21].

3) Central venous catheter care after central venous pressure measurement:

A. Site of central venous pressure inspection:

The CVC site was inspected for signs of infection such as redness, hotness, tenderness and irritation.

B. Central venous catheter dressing:

Change CVC dressing every 2 days and more frequently if soiled, damp, or loose. Catheter site care is performed with chlorhexidine 2% at dressing changes. In the absence of chlorhexidine, povidone iodine 10% may be used to prevent CRBSIs.

IV.Evaluation Phase:

Evaluation of safety guidelines during different central venous pressure measuring techniques of mechanically ventilated patients were done four times immediately before safety guideline, post 24 hours of implementing safety guideline, post 48 hours from implementing safety guideline and post 72 hours from implementing safety guideline using two developed tools.

Additionally, evaluation of central venous pressure value of mechanically ventilated patients were done four times within the first 48 hours after CVC insertion, post 24 hours from the first reading, post 48 hours from the first reading and post 72 hours from the first reading using two developed tools.

2.6 Statistical analysis:

The analysis was performed using statistical software SPSS version 23. For quantitative data: mean and standard deviation were calculated. For qualitative data: A comparison between groups was done by using Chi-square test. For a comparison between means of two variables, the t- test was used. A significance was adopted at $P<0.05$ for interpretation of results of tests of significance.

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3. RESULTS

Table (1): Percent distribution of the studied patients according to their socio–demographic characteristics.

Socio–demographic characteristics	The studied patients (n=50)	
	n	%
Age (in years)		
- (20-< 30) years	6	12.0
- (30-<40) years	18	36.0
- (40-< 50) year	18	36.0
- (≥ 50) year	8	16.0
Range	**(22-55)**	
Mean ± SD	**39.46±8.662**	
Sex		
- Male	34	68.0
- Female	16	32.0
Diagnosis		
- Medical disease	11	22.0
- Trauma	12	24.0
- Multiple organ failure	14	28.0
- Post-operative	7	14.0
- COPD	6	12.0

COPD: Chronic obstructive pulmonary disease

Table (1) shows the percent distribution of the studied patients according to their socio-demographic characteristics. It was observed that more than one third (36.0%) of the studied patients were in the age group of (30 - <50 years) and more than two-thirds (68.0 %) was male.

Regarding diagnosis, more than one-fifth (22%) and (24%) of studied patients had medical diseases and trauma respectively while more than one-fourth (28%) had multiple organ failure.

Table (2): Percent distribution of the studied patients regarding central catheter characteristics.

Central catheter characteristics.	The studied patients (n=50)	
	N	%
Indication of CVP		
- Total parentral nutrition	15	30.0
- Hemodynamic monitoring	19	38.0
- Rapid infusion of fluids	16	32.0
Types of central venous catheter		
- Non-tunneled	24	48.0
- Tunneled	26	52.0
Numbers of catheter lumens		
- Triple	50	100.0
Site of central venous catheter insertion		
- Internal jugular vein	40	80.0
- Subclavian vein	10	20.0
Side of catheter insertion in the body		
- Left	16	32.0
- Right	34	68.0

Table (2) shows percent distribution of the studied patients regarding central catheter characteristics. It was observed that more than one third (38%) of the studied patients reported hemodynamic monitoring as an indication of central venous catheter insertion. As for types of CVC, more than half (52.0%) of studied patients had tunneled catheters. Also, all studied patients had triple catheter lumens. Furthermore, the majority (80%) of studied patients had central venous catheter insertion in the internal jugular vein and more than two-third of them (68%) had the catheter at the right side.

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Table (3): Percent distribution of the studied patients according to central venous catheter related complications throughout periods of study.

`complications of central venous catheter	Periods of study							
	Immediately before safety guideline		Post 24hrs of safety guideline		Post 48 hrs of safety guideline		Post 72 hrs of safety guideline	
	N	%	N	%	N	%	N	%
1. CVC infection								
1. Redness	33	66.0	23	46.0	9	18.0	0	0.0
2. Hotness	33	66.0	20	40.0	7	14.0	0	0.0
3. Tenderness	19	38.0	17	34.0	2	4.0	0	0.0
4. Swelling	10	20.0	10	20.0	4	8.0	0	0.0
2. CVC occlusion								
1. Inability to withdraw blood	15	30.0	9	18.0	3	6.0	1	2.0
2. Inability to infuse intravenous fluids	12	24.0	4	8.0	1	2.0	1	2.0

Table 3 reveals percent distribution of the studied patients regarding central venous catheter complications throughout the periods of study. It was observed that two thirds (66.0%) of studied patients had redness and hotness. Also, (38.0%) and (20.0%) had tenderness and swelling before implementing safety guidelines respectively. The percentage of redness and hotness, tenderness and swelling decreased to (18.0%, 14.0%, 4.0%, and 8.0%) post 48 hours of implementing safety guidelines respectively then these signs disappear post 72 hours of implementing safety guideline.

Regarding central venous catheter occlusion, it was seen that more than one fifth (30.0% and 24.0%) of studied patients had inability to withdraw blood and infuse intravenous fluids before implementing safety guidelines respectively while only 2% of studied patients reported inability to withdraw blood and infuse intravenous post 72 hours of implementing safety guideline.

Table 4: Mean scores of central venous pressure readings with different positioning with different PEEP throughout the periods of study

Positioning and PEEP	Range Mean ± SD				F P
	Within 48 hrs of CVC insertion	Post 24 hrs from the first reading	Post 48 hrs from the first reading	Post 72 hrs from the first reading	
1. Supine position with PEEP=0 cm H2O	(20-22) 21.02±0.82	(17-19) 17.76±0.52	(13-16) 14.64±1.26	(9-11) 9.98±0.82	**1382.97** **0.000***
2. Supine position with PEEP=5 cm H2O	(22-24) 22.92±0.69	(18-22) 20.52±1.05	(15-19) 17.30±1.25	(10-13.5) 11.92±0.75	**2677.24** **0.000***
3. Reverse trendelenburg position with PEEP=5 cm H2O	(21-23) 22.00±0.83	(19-19) 19.00±0.00	(13-17) 15.12±1.79	(10-12) 10.92±0.85	**2571.03** **0.000***

* Significant at level $p < 0.05$.

Table (4) illustrates Mean scores of central venous pressure readings with different positioning with different PEEP throughout periods of study. In this table, the mean score of CVP reading at the supine position with PEEP=0 cm H_2O within 48 hrs. of central venous catheter insertion was 21.02±0.82 compared to 9.98±0.82 post 72 hrs. from the first reading. Also, the mean score was 22.92±0.69 at supine position with PEEP=5 cm H_2O compared to 11.92±0.75 post 72 hrs. from the first reading. Moreover, it was 22.00±0.83 at reverse trendelenburg position with PEEP=5 cm H_2O compared to 10.92±0.85 Post 72 hrs. from the first reading. Significant differences were observed among patients throughout the period of study regarding patients' positions where P= 0.000.

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Table 5: Comparison between mean scores of central venous catheter readings and clinical data of critically ill patients at supine position with PEEP=0 cm H2O throughout period of study.

Characteristics	Baseline supine position with PEEP=0 cm H2O Range Mean ± SD			
	Within 48 hrs of CVC insertion	Post 24 hrs from the first reading	Post 48 hrs from the first reading	Post 72 hrs from the first reading
Age (in years)				
- (20-< 30) years	20.33±0.52	17.33±0.52	14.00±1.55	9.67±1.03
- (30-<40) years	21.39±0.85	17.83±0.38	14.72±1.02	9.94±0.64
- (40-< 50) year	20.94±0.64	17.94±0.54	15.00±1.33	10.28±0.90
- (≥ 50) year	20.88±0.99	17.50±0.54	14.13±1.25	9.63±0.74
t , P	**3.102 , 0.036***	**3.332 , 0.027***	1.530 , 0.219	1.657 , 0.189
Types of central venous catheter				
- Non-tunneled	21.08±0.83	17.79±0.51	14.67±1.27	10.00±0.83
- Tunneled	20.96±0.82	17.73±0.53	14.62±1.27	9.96±0.82
t , P	0.271 , 0.605	0.170 , 0.682	0.020 , 0.887	0.027 , 0.870
Site of central venous catheter insertion				
- Internal jugular vein	21.13±0.82	17.75±0.49	14.65±1.23	9.98±0.80
- Subclavian vein	20.60±0.70	17.80±0.63	14.60±1.43	10.00±0.94
t , P	**3.439 , 0.040***	0.073 , 0.788	0.012 , 0.912	0.007 , 0.932
Side of catheter insertion in the body				
- Left	21.06±0.85	17.88±0.50	14.69±1.25	10.00±0.82
- Right	20.00±0.82	17.71±0.52	14.62±1.28	9.97±0.83
t , P	**4.062 , 0.025***	1.166 , 0.286	0.033 , 0.857	0.014 , 0.907

* Significant at level P < 0.05.

Table (5) shows the relation between mean scores of central venous catheter reading and clinical data of critically ill patients at the supine position with PEEP=0 cm H2O throughout period of study. Significant differences were observed regarding the mean score of CVP readings in relation to age within 48 hrs. of CVC insertion and Post 24 hrs. from the first reading where p= 0.036 and 0.027 respectively. Also, significant differences were observed regarding the mean scores of CVP readings concerning the site of central venous catheter insertion and side of catheter insertion in the body within 24 hrs. of CVC insertion where P= 0.040 and 0.025 respectively. On the other hand, no significant differences were observed regarding the mean score of CVP reading in relation to types of CVC.

Table 6: Relation between mean scores of central venous catheter reading and clinical data of critically ill patients at the supine position with PEEP=5 cm H2O throughout the period of study.

Characteristics	Supine position with PEEP=5 cm H2O Range Mean ± SD			
	Within 48 hrs of CVC insertion	Post 24 hrs from the first reading	Post 48 hrs from the first reading	Post 72 hrs from the first reading
Age (in years)				
- (20-< 30) years	21.33±0.52	19.00±0.00	14.00±1.55	9.67±0.52
- (30-<40) years	22.39±0.85	19.00±0.00	14.11±0.96	9.83±0.38
- (40-< 50) year	21.89±0.68	19.00±0.00	14.83±1.38	9.44±0.51
- (≥ 50) year	21.88±0.99	19.00±0.00	13.75±1.04	9.88±0.35
t , P	**3.112 , 0.035***	-	1.973 , 0.131	**2.894, 0.045***

Types of central venous catheter				
- Non-tunneled	22.00±0.83	19.00±0.00	14.33±1.27	9.67±0.48
- Tunneled	22.00±0.85	19.00±0.00	14.27±1.25	9.69±0.47
t , P	0.00 , 1.00	-	0.032 , 0.858	0.036 , 0.850
Site of central venous catheter insertion				
- Internal jugular vein	22.05±0.85	19.00±0.00	14.28±1.22	9.70±0.46
- Subclavian vein	21.80±0.79	19.00±0.00	14.40±1.43	9.60±0.52
t , P	0.716 , 0.402	-	0.079 , 0.780	0.356 , 0.554
Side of catheter insertion in the body				
- Left	22.06±0.85	19.00±0.00	14.31±1.25	9.69±0.48
- Right	21.97±0.83	19.00±0.00	14.29±1.27	9.68±0.48
t , P	0.130 , 0.720	-	0.002 , 0.962	0.006 , 0.939

* Significant at level P < 0.05 .

Table (6) reveals the relation between mean scores of central venous catheter reading and clinical data of critically ill patients at the supine position with PEEP=5 cm H2O throughout the period of study. Significant differences were observed regarding the mean score of CVP reading in relation to age within 48 hrs. of CVC insertion and post 72 hrs. from the first reading where p= 0.035 and 0.045 respectively. On the other hand, no significant differences were observed regarding the mean scores of CVP readings in relation to site of central venous catheter insertion, side of catheter insertion in the body and types of central venous catheter.

Table 7: Relation between mean scores of central venous catheter readings and clinical data of critically ill patients at reverse trendelenburg position with PEEP=5 cm H2O throughout the period of study

Characteristics	**Reverse trendelenburg position with PEEP=5 cm H2O**			
	Range Mean ± SD			
	Within 48 hrs of CVC insertion	**Post 24 hrs from the first reading**	**Post 48 hrs from the first reading**	**Post 72 hrs from the first reading**
Age (in years)				
- (20-< 30) years	20.67±2.07	19.00±0.00	13.67±0.52	13.67±1.03
- (30-<40) years	21.89±0.47	18.39±0.50	12.61±0.85	13.89±0.58
- (40-< 50) year	20.56±4.03	18.44±1.65	13.44±1.54	14.17±1.04
- (≥ 50) year	19.75±4.06	18.63±0.52	13.13±0.99	13.63±0.74
t , P	1.126 , 0.348	0.549 , 0.651	2.101 , 0.113	1.005 , 0.399
Types of central venous catheter				
- Non-tunneled	20.58±3.55	18.38±1.44	13.25±1.48	13.88±0.90
- Tunneled	21.23±2.47	18.65±0.49	13.00±0.85	13.96±0.82
t , P	0.568 , 0.455	0.870 , 0.355	0.547 , 0.463	0.126 , 0.724
Site of central venous catheter insertion				
- Internal jugular vein	21.63±1.01	18.63±0.49	12.95±0.85	13.90±0.84
- Subclavian vein	18.10±5.86	18.10±2.18	13.80±1.99	14.00±0.94
t , P	**13.70 , 0.001***	2.025 , 0.161	**4.369, 0.042***	0.108 , 0.744
Side of catheter insertion in the body				
- Left	21.56±1.09	18.63±0.50	12.94±0.85	13.81±0.91
- Right	20.62±3.57	18.47±1.24	13.21±1.32	13.97±0.83
t , P	1.065 , 0.307	0.230 , 0.634	0.549 , 0.462	0.369 , 0.547

* Significant at level P < 0.05 .

Table (7) shows the relation between mean scores of central venous catheter reading and clinical data of critically ill patients at reverse trendelenburg position with PEEP=5 cm H2O throughout the period of study. Significant differences were observed regarding the mean score of CVP reading in relation to the site of central venous catheter insertion within 48 hrs. of CVC insertion and post 48hrs. from the first reading where p= 0.001and 0.042 respectively.

Table 8: Comparison of central venous pressure value during Supine position with PEEP=0 cm H2O and selected positions with PEEP =5 cm H2O throughout periods of measurement

	Mean difference Supine position with PEEP=0 cm H2O			
	Within 24 hrs of CVC insertion	**Post 24 hrs from the first reading**	**Post 48 hrs from the first reading**	**Post 72 hrs from the first reading**
1. Supine position with PEEP=5 cm H2O	2.03	2.23	2.470	2.01
t	**19.80**	**19.95**	**20.05**	**19.79**
P	**0.000***	**0.000***	**0.000***	**0.000***
2. Reverse trendelenburg position with PEEP=5 cm H2O	0.980	1.240	1.120	1.00
t	**16.19**	**16.95**	**17.85**	**15.75**
P	**0.000***	**0.000***	**0.000***	**0.000***

* Significant at level P < 0.05

Table (8) reveals comparison of central venous pressure value during the supine position with PEEP= 0 cm H2O and selected positions with PEEP= 5 cm H2O throughout periods of measurement. In this table, it was observed that CVP rise (2.03, 2.23, 2.47 and 2.01cm H2O) when PEEP =5 at the supine position and it was (0.98, 1.24, 1.12 and 1.00 cm H2O) at reverse trendelenburg position in relation to baseline PEEP = 0 at the supine position for four consecutive days.

Table 9: Percent comparison of central venous catheter infection inspected at the site of insertion of the studied patients within 24 hours of catheter insertion

Central catheter insertion	**The studied patients (n=33) CVC infection inspect at the site of insertion**								
	Redness		**Hotness**		**Tenderness**		**Swelling**		χ^2
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**P**
Types of central venous catheter									
- Non-tunneled	16	48.5	16	48.5	16	48.5	16	48.5	-
- Tunneled	17	51.5	17	51.5	17	51.5	17	51.5	
Site of central venous catheter insertion									
- Internal jugular vein	30	90.9	30	90.9	30	90.9	30	90.9	-
- Subclavian vein	3	9.1	3	9.1	3	9.1	3	9.1	
Side of catheter insertion in the body									
- Left	10	30.3	10	30.3	10	30.3	10	30.3	-
- Right	23	69.7	23	69.7	23	69.7	23	69.7	

Table (9) illustrates the percent comparison of central venous catheter infection inspected at the site of the insertion of the studied patients within 24 hours of catheter insertion. In this table, it was observed that more than one half (51.5%) of studied patients that had redness, hotness, tenderness, and swelling had tunneled catheters. On the other hand, the majority (90.0%) of studied patients that had signs of catheter infection had internal jugular vein insertion. Also, more than two-thirds (69.7%) of studied patients that had catheter-related bloodstream infections had a catheter on the right side.

4. DISCUSSION

Central venous pressure measurement remains widely used in the Intensive Care Unit, especially for guiding fluid management in patients with hemodynamic instability [22]. CVP measurement is a reliable technique for estimating cardiac function and resuscitative status of critically ill patients, but it is an invasive process that results in many complications such as central line-related bloodstream infection, catheter occlusion pneumothorax [23]. In this study we compare between different methods of measuring CVP.

Regarding socio-demographic characteristics, the present study revealed that two-thirds of the sample aged between 30 - <50 years with the mean age of 39.46±8.662. Regarding sex, the study showed that the majority of the studied patients were male this may be interpreted that male was admitted to the Intensive Care Unit due to the nature of their work and massive accident. Also, near one-third of the sample diagnosed as multiple organ failure and trauma. This may be due to the effect of immobilization and invasive procedure that present in the Intensive Care Unit. This result was online with **Shojaee1 M et al (2017)**[24], they reported that the mean age group of their sample was 73.95 ± 11.58 years and more than two third of them were male.

In relation to central catheter characteristics, this study revealed that hemodynamic monitoring is the most common indication for a central venous catheter. Regarding the site of central venous catheter insertion, the majority of studied patients had a catheter in an internal jugular vein more than two-thirds of studied patients had catheter insertion on the right side. It may be due to internal jugular is a superficial vein characterized by a straight insertion line at the right side which enables the anesthesiologist to support the catheter tip at the correct position. This result was on the contrary with **Radhakrishna1 N et al (2019)**[25], they stated that CVP was measured from subclavian vein in most of their sample.

As for central venous catheter infection, this study represented that about one-third of studied patients had redness and hotness and about one-third of them reported an inability to withdraw blood. Also, the majority of the sample that had signs of catheter-related infections had a tunneled type of catheter and had a catheter inserted in an internal jugular vein at the right side. It may be due to the internal jugular vein is near the skin and the possibility of infection may be high. These findings were congruent with **Elfassy S et al (2016)**[15], they reported that tunneled CVC was accompanied with many complications especially catheter-related bacteremia.

Regarding mean scores of central venous pressure readings with different positioning and PEEP value, this study showed that an increase in positive end expiratory pressure to 5 cm H_2O was associated with about 2.0 cm H_2O elevation in central venous pressure value at the supine position. Additionally, an increase in positive end expiratory pressure to 5 cm H_2O was associated with about 1.0 cm H_2O elevation in central venous pressure value reverse trendelenburg position. This result was supported by **Shojaee1 M et al (2017)** [24], they that an increase in PEEP has a direct relationship with CVP increase. Approximately, a 5 cmH2O increase in PEEP will be associated with about 2.5 cmH_2O raise in CVP. In addition, **Yang et al (2012)**[26] reported that 1 cmH_2O increase in PEEP, led to 0.38 cmH2O increase in CVP. Additionally, study on the effect of PEEP in patients under mechanical ventilation by **Cao F et al (2008)**[18], and **Cao F et al (2009)**[27], showed a significant direct relationship between 0, 5, and 10 cmH_2O PEEPs with CVP and the CVP increase was related to mean PEEP during mechanical ventilation when PEEP was set 10 or less.

Regarding mean scores of central venous catheter reading and clinical data of critically ill patients at supine position with PEEP=0 cm H_2O and 5 cm H_2O throughout period of measurement, this result showed that the mean score of central venous pressure was increased between patient with age group of (30-<40) with PEEP 0 cmH_2O and with PEEP 5 cmH_2O within 48hrs of insertion. Also, the mean score of CVP was increased among patients with internal jugular vein insertion with PEEP is 0 cmH_2O within 48 hrs. of CVC insertion. This may be due to the depth of the internal jugular vein. Moreover, the mean score was increased among patients with left-sided catheter within 48 hrs. of CVC insertion. This may be interpreted that the catheter in the left side is nearest to the heart than the right side. This result was on contrary with**Shojaee1 M et al (2017)**[24], they reported that clinical data of patients as sex and medical diagnosis do not significantly affect CVP increase.

Limitation of the study

This study was based on a single clinical area which compromises the extrapolation of data.

5. CONCLUSION

The results of the current study concluded that there was a direct good relationship between implementing safety guidelines and central venous pressure monitoring which reflected on the reading. Also, central venous pressure was affected significantly during an increase in positive end expiratory pressure and changing position. Both of supine and reverse trendelenburg position with Positive end expiratory pressure =5 were suitable for the estimation of central venous pressure. Approximately, increase in positive end expiratory pressure to 5 cm H_2O was associated with about 2.0 cm H_2O elevation in central venous pressure value at the supine position. Additionally, an increase in positive end expiratory

pressure to 5 cm H_2O was associated with about 1.0 cm H_2O elevation in central venous pressure value reverse trendelenburg position.

6. RECOMMENDATION

Rechecking of central venous pressure for mechanically ventilated patients during rising in positive end expiratory pressure value is essential to reach the accurate reading.

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