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Comparison between Peripheral and Central Venous Catheters Regarding Venous Pressure and Complications among Critically ILL Patients

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Abstract

Venous pressure is a vital assessment parameter amongst critically ill patients venous pressure is monitored by inserting the central or peripheral venous catheter. The literature recommends using a peripheral venous catheter to assess venous pressure as an alternative for the central venous catheter.

Aim: To compare peripheral and central venous catheters regarding venous pressure and complications among critically ill patients.

Methods: Quantitative, conducted one comparative group design on a purposive sample of 60 critically ill patients admitted in intensive care units at King Saud Medical City in Riyadh. They developed the venous catheter assessment sheet to document central and peripheral venous pressure and complications on the first 3 days of catheter insertion.

Results: The mean peripheral venous pressure during the three days was observed consistently higher than central venous pressure (11.5 ± 2.5, 11.3 ± 2.2, 10.8 ± 4 *vs.* 10.5 ± 2.1, 10.6 ± 2.04, 9.9 ± 3.70, respectively). Late complications findings demonstrate catheter occlusion for peripheral venous catheter (33%), followed by extravasation and infiltration grade 4 (28.4%). In comparison, the most common late complications from central venous catheters were catheter-related infections (5%).

Conclusion: The researcher recommends using peripheral venous catheters for fewer complications than central venous catheters in ICU and conducting further clinical trial research.

Keywords: *Central venous catheter; ICU patients; Venous pressure; Peripheral venous catheter; Catheter complications*

Introduction

Central Venous Catheter (CVC) known as standard method for hemodynamic monitoring that plays an essential role in critically ill patient management. After recognizing critical condition, measuring, and evaluating the underlying pathophysiological strategies and receiving suitable therapy [1]. Venous pressure is the pressure present within a blood vessel that can be measured directly *via* an inserted catheter, and it reflects the venous return to the heart [2]. The catheter tip may influence venous pressure measurement [3]. A venous catheter can be inserted either central or peripheral [4].

A qualified healthcare practitioner, an anesthetist, or other medical practitioners, is inserted CVC, but a nurse does preservation and follows up. CVC is placement within the subclavian, internal or external jugular, femoral, basilica, or axillary veins. CVCs contained a single lumen or multiple lumens. Categorized by Central venous catheters are into short-term CVCs and long-term CVCs [5-7]. It has CVCs, which are imported inside the UK every year annually are nearly 200,000 at intensive care units [5].

In contrast, approximately peripheral catheters are 150 million and central venous catheters are used each year within the United Kingdom are five million [8]. CVC it utilized for providing intravenous therapy, medication or vasopressors support drug, total parenteral nutrition, blood& chemotherapy, and treated by hemodialysis, and central venous pressure monitoring [9,10].

CVC procedure has many associated complications that increase morbidity& mortality rate, length of hospital stays, and healthcare cost [1,11,12]. Despite the advent of ultrasound-guided vascular cannulation [13]. Problems related to CVC are classified into two early: Late complications, early complications are also called Mechanical difficulties that happen within the insertion time of the central lines such as arterial puncture leading to a hematoma, pneumothorax, dysrhythmia, and late complications like the infection is it a severe complication that occurs when a central line is *in situ* which can lead to sepsis, shock and death and thrombotic complications that include venous thrombosis and pulmonary embolism [10,14].

Complications associated with CVC occur in nearly 15% of patients, mainly 5%-19% are mechanical complications, 5%-26% are infectious complications, and 2%-26% are thrombotic complications [15,16]. Central Line-Associated Bloodstream

Infection (CLABSI) calculated accounts for one-third o f died patients with an attributable mortality of 12%-25% [8].

Central Venous Pressure (CVP) is an essential monitored medical framework in ICU. Described CVP as the fluid that transmits through pressure calculated within the thoracic close to the right atrium [17]. Central venous pressure is usually measured hour in ICU all over the word [18].

Electronically measure CVP can be expressed at millimeters of mercury or manually methods with centimeters of H20 more than atmospheric pressure. The CVP is influenced by numerous conditions, including technical and physiologic factors. The usual range of CVP at a healthy person is 3-6 mmHg [19]. While the targeted endpoint of CVP is 15 mmHg with the patient had undergone invasive mechanical ventilation.

A Peripheral Venous Catheter (PVC) is a catheter placed in the vascular during therapy. It introduced using a needle, such as that used to draw blood. It is the most used type of catheter in medicine, and in most cases, it is inserted PVC in the hand or arm vein [20]. The nursing staff can insert PVC. Applied PVC for both medication and patients care; this makes it probable to manage intravenous fluid, blood, total parenteral nutrition, Also applied veins access for hemodynamic monitoring [21]. The nurses should help choose and select the right distal vein for PVC [22].

Peripheral venous catheters include various curative purposes; however, they have resulted in infectious complications and non-infectious complications. Infectious complications like; pain, hematoma, phlebitis, and infiltration. Non-infectious complications as leakage, extravasation, bleeding, and blockage [23].

the less common bloodstream infection is associated with PVC; it occurs around 0.1% or 0.5 per 1,000 catheter days [24]. PVC complications are predominantly joint to enrollment techniques, neither reflection to the catheter or infusat [23].

Peripheral Venous Pressure (PVP) examination method is reversed from the CVP examination.

PVP is calculated through the joining of PVC with a tube of a transducer with pressure. Measurement of PVP is intrusive in a small amount, puts an impact on price, and has the ability to foretell the CVP [25]. Within the critically ill patients, PVP monitoring and works as an alternative for CVP. So, technical problems related to CVP measurement can be ignored if PVC is used [25].

In critically ill patients, they demand to address the evaluation of fluid volume status in a minimum complex way.

Practicing a modern hemodynamic observation method at the stand of evidence and scientific reasoning will open a new gateway to less complicated yet effective critical care to patients [1]. Some studies were conducted among critically ill patients and found the agreement's degree is a high between CVP and PVP

The Nurses are accountable for an estimate and set the patients before inserting venous catheters (either peripheral or central), nursing care and conservation intravenous catheters, and prohibiting the expansion of complications [26].

Therefore, this study will compare peripheral versus central venous catheter pressure and complications among critically ill patients.

Materials and Methods

This study was a quantitative, one group comparative Quasi-experimental design study.it was carried out on three adult ICUs (trauma, neurosurgery, and medical) at King Saud Medical City (KSMC), a general clinic in Riyadh, Saudi Arabia.

Current research data collection was using a venous assessment sheet from August 2018 to June 2019. Three ethical approval was obtained one from the Faculty of Nursing and another one was from the faculty of medicine, KAU. And last one from the research center at KSMC.

Purposive sampling technique was used, included ICU with central venous catheter (subclavian or jugular vein), male or female patient between 20 years and 60 years of age and willing to participate. While excluded patients with cardiac disorders and elderly, burn patients, patients with a femoral central line, contraindicated patients to place the peripheral intravenous catheter, and skin infection at the intended insertion site. The researchers developed a venous assessment sheet in English language.

It was developed it after reviewing the relevant recent literature. Venous assessment sheet is a series of a developed checklist designed for gathering information about patient demographic and clinical data, venous catheter characteristics evaluation, venous pressure monitoring and venous catheter-related complication observation. After gaining ethical approval the representation of 60 critically ill patients meets the inclusion criteria from that target population recruited from selected ICUs. The Researcher measured venous pressures from central and peripheral catheters three times per day for three days. The researchers observed late complications for CVC from the time of insertion until removal. For PVC, late complications from the time of insertion until difficulties appear.

Data analysis

The data analyzed by using SPSS version 24. ANOVA, t-test and Chi-Square test, inferential statistics, and Bland-Altman plots have been made.

Results

Demographic and clinical data

Demographic data	Descriptive statistics	
	N	%
Age		
20-29	17	28.3
30-39	14	23.3
40-49	13	21.7
50-59	16	26.7
Age (Mean ± SD)	38.8 ± 12	
Gender		
Male	46	76.7
Female	14	23.3
Marital status		
Single	33	55
Married	27	45
Educational level		
Illiterate	3	5
Secondary school	5	8.3
High school	25	41.7
Diploma	13	21.7
Bachelors	14	23.3
Clinical data		
Weight in kg (Mean ± SD)	76.70 ± 21.6	
Height in cm (Mean ± SD)	167.92 ± 9.6	
BMI (Mean ± SD)	26.9 ± 6.1	
Diagnosis-Septic shock	1	
Surgical cases	21	
Respiratory cases	9	
Polytrauma cases	22	
Hematology cases	2	
Drug overdose	3	
Renal cases	2	
Unit - medical ICU	1	
Surgical ICU	31	
Trauma ICU	28	
MV-Yes	57	
No	3	

Table 1: The distribution of the studied sample according to the patient's demographic characteristics and clinical data (No: 60)

Table 1 presents the distribution of patients according to the demographic characteristics and clinical data. As shown in this table study sample consists of 60 patients, most of them were male (77%), and 55% were single. Results represent the mean age from the studied sample (60 patients) was 38.8 ± 1.5 years. Regarding the educational level, results display that less than half of the selection was graduated from high school (41.7%). the sample according to clinical data It recognized that the mean weight value was (76.70 ± 21.6) regarding body weight. It observed that the mean height and the mean body mass index was 26.9 ± 6.1. Additionally, it was shown from the table that the most studied patients admitted to surgical ICU (51.7%), and less than half of them (37%) were diagnosed with polytrauma cases. About the connection with mechanical ventilation, the results show that 95% were mechanically ventilated.

Day	CVP (Mean ± SD)	PVP (Mean ± SD)	t-value (P-value)
Day 1			
1st time	10.36 ± 2.61	11.51 ± 3.36	0.039 (.039)
2nd time	10.56 ± 2.58	11.33 ± 2.67	0.113 (.113)
3rd time	10.75 ± 2.62	11.90 ± 2.89	0.025 (.025)
Total	10.5 ± 2.1	11.5 ± 2.5	2.390(0.018)*
Day 2			
1st time	10.68 ± 2.38	11.40 ± 2.69	.125 (.125)
2nd time	10.71 ± 2.21	11.36 ± 2.59	0.142 (0.143)
3rd time	10.53 ± 2.46	11.41 ± 2.66	0.062 (0.062)
Total	10.6 ± 2.04	11.3 ± 2.2	1.925 (0.057)
Day 3			
1st time	10.35 ± 3.77	11.06 ± 4.36	0.338 (0.338)
2ndtime	10.10 ± 4.13	11.15 ± 4.68	0.195 (0.195)
3rdtime	9.41 ± 4.07	10.36 ± 4.63	0.236 (0.236)
Total	9.9 ± 3.70	10.8 ± 4	1.283 (0.202)

Table 2: Comparison between the mean central venous pressure and peripheral venous pressure measurements throughout three consecutive days (N: 60). CVP: Central Venous Pressure, PVP: Peripheral Venous Pressure. Statistically significant at **: P ≤ 0.05

Table 2 illustrates a comparison between mean CVP and PVP three times daily for three consecutive days. I statistically significant difference was observed among the mean CVP and PVP on the first day (p=0.018) but no significant differences in the second and third days (p=0.057, 0.202, respectively). It was observed that the mean PVP during the three days were higher than CVP (11.5 ± 2.5, 11.3 ± 2.2, 10.8 ± 4 vs. 10.5 ± 2.1, 10.6 ± 2.04, 9.9 ± 3.70, respectively).

Complications	Group		z test	P
	PVC	CVC		
	N (%)	N (%)		
Late complications				
Venous spasm	2(3.3)	0 (0.0)	1.431	0.152
Extravasation and infiltration grade 4 (leakage)	17(28.4)	0 (0.0)	4.592	0
Catheter occlusion	33(55)	0 (0.0)	8.563	0.000*
Accidental removal	7(11.7)	0 (0.0)	2.779	0.005
Catheter-related infection (Micro organism) Yes	0 (0.0)	3(5)	1.777	0.075
No	60 (100)	57 (95)		
Bacteriological examination: Gram-positive bacilli	0 (0.0)	2 (3.3)	1.431	0.152

Table 3: Comparison between the central venous catheter and peripheral venous catheter-related complications (N: 60)

Table 3 Demonstrate a comparison between CVC and PVC related early and late complications. The results show that there were no early complications from both CVC and PVC. Regarding late complications, the findings demonstrate that catheter occlusion was the latest complications for PVC (33%), followed by extravasation and in iltration grade 4 (28.4%). In comparison, the most common late complications from CVC were catheter-related infection (5%). The bacteriological

examination showed that the three CVC had a positive outcome, with two of them being gram-positive bacilli, and one had gram-negative bacilli. At the same time, the bacteriological examination for PVC was negative **(Table 4)**.

	CVP Total	
PVP Total	**Pearson correlation**	**0.896****
	Sig. (2-tailed)	0
	N	60

Table 4: Revels that the correlation between PVP and CVP (P<0.05) was significant a correlation coefficient of (r=0.896) indicates a strong positive correlation.

Discussion

Demographic and medical data

The recent study performed 60 adult patients of both genders. The results show that the total age of the researched required sample was 38.8 ± 1.5 years. Most participants were males and single. Lower than half of patients graduated from high school. The results present that most patients admitted to surgical ICU were diagnosed with polytrauma and connected to a mechanical ventilator.

Venous catheter characteristics

In the present investigation, the mean duration of patients on PVC was 4.1 ± 0.1 days. This result is supported by who report that the average PVC days for the routine replacement group were (4.29 days SD 2.47) [27]. Moreover, Randomized control trial demonstrated by PVC was introduced without complications for a common of (3.73 ± 2.25) and a more than 10 days in the empirical collection however the catheter of the monitoring team was recorded for 3.28 ± 1.66) and extreme of week [28].

Additionally, Katiuska and colleagues 'feedback displays that a period's >4 days was related to diminishing the danger of PVC failed [29], which concurs with our feedback. A research by explained that from the first 24 to 30 hours in all problems were involved (P=0.0001) [30].

The present research demonstrates that the average timing of patients on CVC was 9.5 ± 0.8. This result has contradicted [31] and the Infusion Nurses Society [32]. They found that the catheter site is expected in each subclavian or the internal jugular site and needed for greater than two weeks. Furthermore, the present finding illustrates that the CVC removal's most common reason was no massive fluid resuscitation requirement or no indication for the catheter. This result is similar to result [33]. They reported that CVC was removed once there was no demand for a massive volume of fluids and damaging intravenous devices (62%). Two central lines were eliminated because of consistent hematoma and thrombosis in the vein. While stated, the direct elimination of working of CVC is not recommended by gaining temperature [32].

Venous pressure monitoring

The present study compared the mean PVP and CVP for three consecutive days. The results found a significant comparison within CVP and PVP on the first day but an insignificant difference on the second and third days. It also shows that the mean CVP value was higher than the mean PVP among three days on all readings [1]. In this process the CVP and PVP recorded complicatedly by combination of CVP manometer to the central venous catheter as well as peripheral venous catheter of critically ill patients through the reading of pressure at exact time, three times in four hours of interval. The present investigation observed that the grand mean of PVP for three days is higher than CVP (11.28 ± 2.19 *vs.*10.38 ± 2.10, respectively). Furthermore, the present finding illustrates that the CVC removal's most common reason was no massive fluid resuscitation requirement or no indication for the catheter.

In comparison, a last research reported by stated that the PVP and CVP were registered to the closest 1 mmHg at 5 minutes' interval [34]. These similarly conducted a study by Radhakrishna et al. [35]. They are stated that different patients' positions may lead to the elbow's flexion and result in an erroneous value in PVP. Also, Ravindran et al. [34] reported the external compression *via* the factor or blood pressure cuff and stretching too much in the arm of the catheterized site can obtain the peripheral vein and elevated PVP.

Venous catheter complications

The resulting complications arise from the venous catheter, including early complications and late complications. Regarding early complications, the recent study demonstrated the absence of complications from CVC and PVC. Morano et al., demonstrated that CVC's early complications occur because of variations in numerous factors such as medical expertise, sort of device, and type of method or vessel use [36] showed that Nurses work in essential way to inhibit the CVC difficulties or catheter-related bloodstream infection; by using standard guidelines like arrangement of an aseptic environment in CVC introduction.

A current study detected that few patients have PVC developed venous spasm and absence of venous spasm from CVC. This result consistent with **Piper**et al. and Kaur et al. who stated that PVCs usually lead to infiltration, occlusion, phlebitis or thrombophlebitis, dislodgement and venous spasm [37,38].

The findings identified that extravasation and infiltration occur for one-third of patients with PVC while not observed at

the CVC site. Makafi et al. [39] stated that extravasation's incidence and infiltration of PVC, was 3.5% and 7%, respectively. The PVC complication rate accretion with various things that act as danger like person's age and gender as well as the imbalance veins related to infection maximize the chances of it. Kaur et.al; announced that extravasation and infiltration caused by inappropriate placement of PVC, dislodgement, distal puncture, or erosion linked to relative movement of the patient and the catheter.

In the present result, the main reason for PVC removal was catheter occlusion. Kaur et. al; stated that occlusion can come from mechanical blockage of the PVC's or fibrin deposition on the catheter's tip. It may also phlebitis veins swollen or insertion at a point of flexion, both of which may collapse the catheter and prevent flow.

A recent study found accidental removal happened to a few patients with PVC while it did not occur to CVC. The results from the same point of view as Dougherty and Lister. They reported that some peripheral cannulas have wings that help secure the skin device to prevent a piston-like movement of the vein and accidental removal [40].

Conclusion

The current study constructs those differences statistically significant between the mean CVP and PVP on the first day. Still, there were no significant differences found on the second and third days. The mean PVP during the three days was higher than CVP was observed. The findings demonstrate that catheter occlusion was the most common late complication for PVC, followed by extravasation and infiltration grade 4. While the most common late complication from CVC was a catheter-related infection. Based on this study's results, the researcher suggests involving PVC as a method for measuring venous pressure in clinical practice and develops educational programs for healthcare professionals about the care and prevention for PVCs complications.

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