Effect of Intravenous Catheter Placement on Venous Pressure Reading and the Risk of Complications in Critically Ill Patients

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Abstract: Central venous cannulation is associated with many complications. The recent literature suggests that there is a close relationship between peripheral and central venous pressure readings. This prospective comparative study is designed to investigate the agreement between central venous pressure (CVP) and peripheral venous pressure (PVP) and investigate the effect of intravenous catheter placement on the risk of complications in critically ill patients. Sixty patients were enrolled in the study as soon as they had a central venous catheter in place. They were cannulated at the antecubital site with a 20- gauge peripheral over- the needle intravenous catheter at the same time of central venous catheter insertion. Assessment of risk of complications of both peripheral and central venous catheters was done using the infiltration scale, observation of exit-site infection, assessment of catheter occlusion as well as bacteriological examination. Peripheral and central venous pressure readings were monitored immediately after insertion of both central and peripheral venous catheters and then every 6 hours for 3 days. Temperature and blood pressure were measured before each measurement. The results showed that PVP was closely correlated to CVP (r = 0.92 to 0.98). Significant relation was found between CVP and PVP at different times of measurement. PVP was consistently greater than CVP by an average of 2 mmHg. (P<0.001). Catheter colonization was significantly higher among patients with central venous catheters (CVCs) (P<0.01). Catheter malfunction was higher in CVCs. Infiltration occurred more often with peripheral venous catheters (PVCs). The findings indicated that peripheral venous catheters can be used instead of central venous catheter for estimation of body volume status and minimize central catheter complications.

[Shaimaa A. Awad; Azza H. El-Soussi; Mohamed A. Sultan; Mohammed El-Farrash and Nayera Tantawy **Effect of Intravenous Catheter Placement on Venous Pressure Reading and the Risk of Complications in Critically Ill Patients.** Journal of American Science 2011; 7(10): 645-655].(ISSN: 1545-1003). http://www.americanscience.org.

Key words: Central venous pressure, Peripheral venous pressure, Hemodynamic monitoring, Catheter related infection.

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1. Introduction

Central venous cannulation is an invasive procedure that is considered as a minor surgery requiring local anesthesia as well as a common long-term intravenous access which leads to life-threatening complications[(1-3)]. Moreover, CVCs represent an economic burden to health care system. The use of CVCs increased morbidity, mortality, length of hospital stay and hospital cost [(4,5)].

In addition, there is a patient population in which the surgical site contraindicates catheter placement, or the anatomy of the patients has been altered by surgery or radiation. Under these conditions, inserting a catheter into the jugular or subclavian veins may be difficult, if not impossible and associated with significant risks [(6)]. Therefore, there is a trend toward using minimally invasive methods for hemodynamic monitoring to decrease the risk of complications associated with massive invasion [(7)].

Critical care nurses play a vital role in the care of critically ill patients since they spend more time beside the patients. Nurses are responsible for assessing and preparing the patient before the insertion of intravenous catheters (IV) (either central or peripheral), care and maintenance of IV catheters and preventing the development of complications[(3)]. Therefore, this study was carried out to investigate the effect of intravenous catheter placement on venous pressure readings and the risk of complications in critically ill patients.

Aim of the study:

The aim of the study was to investigate the effect of intravenous catheter placement on venous pressure readings and the risk of complications in critically ill patients.

Research hypotheses:

1. PVP readings are consistent with CVP readings.
2. Complications resulting from PVC are less than those of CVC.

2. Material and Methods

Material:

Research Design:

A prospective comparative research design was utilized in this study.

Setting:

This study was conducted at the Surgical Intensive Care Unit, Emergency Hospital, Mansoura University.

Subjects:

Sixty adult critically ill patients admitted to the previously mentioned setting. All patients had a recently (first day of insertion) central venous catheter, and had acceptable access for peripheral intravenous (IV) placement. Patients with edematous arms were excluded from the study.

Tools:

Two tools were used for data collection in the current study based on reviewing the related literature [8-13]:

Tool (I): Intravenous access risk assessment sheet:

It was used to assess the risk of complications that occurred in both central and peripheral venous lines. It consists of 3 parts: part I, II and part III that was adapted from the **Infusion Nurses Society** [9].

Part I:

Patient's characteristics: include demographic as well as clinical data, such as age, gender, and diagnosis.

Part II:

Catheter characteristics: include site, uses of the catheter and the reason for removal of the device.

Part III:

Catheter- related complications: consist of the delayed complications arising post catheter insertion that was detected through:

- Infiltration scale.
- Exit-site infection: as tenderness, erythema, pain and purulence.
- Catheter occlusion: diagnosed by the presence of any change in the ability to infuse or withdraw blood or intravenous fluids or presence of visible clots in the external portion of the catheter.
- Bacteriological examination: obtained from both the tip of the central and peripheral venous catheters immediately after their removal.

Tool (II):

Central and peripheral venous pressure monitoring sheet: was developed by the researcher for recording the readings of central and peripheral venous pressure. It consists of 5 partitions; the first and the second are for recording temperature and blood pressure before every measurement of CVP and PVP, the third is the time at which CVP and PVP measurements were done, the fourth and the fifth partitions are for recording CVP and PVP respectively.

Methods:

Approval to conduct the study was obtained from the hospital administrative authority after explanation of the study aim. The tools were tested for content validity by Jury of 5 members in the field and necessary modifications were done. An informed consent was obtained from patients or significant others before conducting the study. A pilot study was conducted on 6 critically ill patients to test the feasibility and applicability of the tools and the appropriate modifications were done prior to data collection for the actual study. Data collection took approximately 6 months from 28/4/2009 to 1/11/2009.

A representative sample of 60 patients who fulfilled the inclusion criteria were included in the study. Patients were enrolled in the study as soon as they had a central venous catheter in place. They were cannulated at the antecubital site, at the same time of central venous catheter insertion, with a 20-gauge peripheral over- the needle intravenous catheter (Ultraflon IV cannula with luer lock and injection port, MFD by Ultra MP. Ind. Area, Assiut).

Data Collection

Each catheter was inserted under aseptic technique. Patient and catheter characteristics were assessed using part (I) and (II) of tool (I). The following nursing care was implemented by the researcher before catheter insertion and upon catheter removal

Protocol for catheter insertion and subsequent care

Before central and peripheral venous catheter insertion:

Patients and equipment were **prepared** as follows:

- Equipment preparation such as: catheter set, syringe, antiseptic solution, and gloves…etc.
- Patient's preparation includes: explanation of the procedure before catheter insertion, assessment of the patient to select the vein.
- Positioning the patient in the trendlenberg position with the head turned to the opposite side of insertion for central venous catheter insertion, while the patient was positioned in

the supine position with the arm extended for peripheral catheter insertion.
- Aseptic technique and universal precautions were used before and during insertion.
- The insertion site was prepared with povidone-iodine for 30 seconds for peripheral catheter insertion and for two minutes for central venous catheter insertion and allowed to dry before insertion.

Post catheter insertion:
- Central venous catheter was checked for accurate location by using x-ray.
- CVP and PVP were measured immediately after insertion of both central and peripheral venous catheters and then every 6 hours for 3 days.

Technique of pressure measurement:

The proximal lumen of the triple lumen central venous catheter was connected to the standard hospital pressure transducer system. The central line was flushed with 20 ml of normal saline solution and the transducer was zeroed at the phlebostatic axis, defined as the horizontal line extending from the mid-axillary line and the fourth intercostal space and the CVP reading was obtained.

The transducer was then disconnected from the central line and was connected to the peripheral line through a low compliance extension tubing and a three way stopcock. Continuity of the PVP catheter with the downstream venous system was demonstrated by observing pressure changes in the PVP waveform during circumferential proximal arm occlusion. The peripheral line was then flushed with 20 ml of normal saline solution to ensure its patency.

The patient's upper limb from where PVP was measured was straightened and held out so that the antecubital vein and the transducer were placed at the phlebostatic axis and the reading of PVP was obtained. Readings were obtained only if the patient was supine and were taken at the end of expiration. The patient's temperature and blood pressure were recorded before each measurement of venous pressure. PEEP was not used during any of the measurements. Comparison between PVP and CVP was then recorded using tool (II).

Conventional peripheral and central venous catheter care:

Flushing was done with normal saline every twelve hours to maintain catheters patency. After medication administration and TPN (for CVC), the catheters were flushed with normal saline. Both catheters were flushed with 20 ml of normal saline solution before each venous pressure measurement to ensure catheter patency and for equilibration After catheter flushing, the positive pressure was maintained by keeping the thumb on the plunger of the syringe while withdrawing the syringe to prevent blood back flow and clotting in the line.

Dressing was changed routinely every 24 hours on peripheral catheter site and immediately if the integrity of the dressing was compromised. Dressing was changed routinely every 48 hours on central catheter site and immediately if the integrity of the dressing was compromised.

The insertion site was visually inspected daily and palpated for tenderness through the intact dressing and assessed for signs and symptoms of complications. Also, catheter occlusion and the presence of any change in the ability to infuse or withdraw blood or intravenous fluid or presence of visible clots in the external portion of the catheter were assessed using part (III) of tool (I). Care of the catheter site was done using aseptic cleansing of the catheter-skin junction with povidone-iodine solution.

Upon catheter removal (Bacteriological examination):

The peripheral catheter was removed on the third day (after 72 hours) of insertion. The central catheter was removed on 10^{th} to 15^{th} day of insertion.

Culture technique:

1. **Before removal of the catheter**: the catheter entry site was cleansed with povidone-iodine, swabbed with alcohol and allowed to dry to prevent potential complications by bacteria located at the cutaneous exit-site surface. For central line, retaining sutures were cut and removed with sterile scissors and forceps.
2. **During removal of catheter**: Care was taken to avoid contact between the emerging catheter and the skin to minimize contamination with commensal bacteria.
3. **Following removal of catheter:** a 2-cm segment of the distal catheter tip was cut aseptically and placed in a sterile container and sent immediately to the laboratory at the Microbiology Diagnostic and Infection Control Unit in Medical Microbiology and Immunology Department for microbial evaluation. Both qualitative and semi quantitative methods were used for all samples. The tip was vortexing in broth for one minute followed by surface plating on a blood agar plate then incubated at 37°c, after 24 hours of incubation, the plate was examined and counted for different colonies. Significant catheter tip colonization was defined as the growth of more than or equal to 10^3 CFU.

Statistical analysis

Data entry and analyses were performed using SPSS statistical package version 10 (SPSS, Inc., Chicago, IL, USA). The chi-square (χ^2) was used to find association between columns and rows in qualitative data. Student t-test used to compare means of two groups. The One-Way ANOVA procedure produces a one-way analysis of variance for a quantitative dependent variable by a single factor (independent) variable. Correlation between variables was done using Pearson correlation for parametric data. For all above mentioned statistical tests done, the threshold of significance is fixed at 5% level (P value). P value of < 0.05 indicates a significant result while, P value of < 0.001 indicates a high significant result.

3. Results

This part illustrates the current study findings regarding the effect intravenous catheter placement on venous pressure reading and the risk of complications in critically ill patients.

Table (1): shows the distribution of the study sample according to patient's characteristics: it can be noted that all the study sample were males. Regarding diagnosis, 95% of the patients had trauma and regarding length of hospital stay, it was noted that the mean hospital stay of the patients was 10.23 days. As regards to age, the mean age of the study sample was 35.6 years.

Table (2): Describes the distribution of the study sample according to the uses of the catheters: it can be seen that all the patients receiving medications in both peripheral and central venous catheters and 3.3 % of the patients received blood products. While, 9 patients (15%) received TPN through the central venous catheter this was found to be statistically significant. In addition, all patients with central venous catheters were monitored for central venous pressure.

Table (3): shows the relationship between the site of catheter and occurrence of complications: the table reveals that catheter colonization was significantly higher among patients with CVC (65%) compared to (43.3%) in PVC. In addition, catheter malfunction occurred in 13.3% of CVC compared to 6.6% in PVC. This table also reveals that exit-site infection occurred in 41.7% of PVC compared to 40% of CVC. While, infiltration occurred in only 4 patients (6.7%) with PVC.

Figures (1, 2): shows the percent distribution of microorganisms isolated from catheter tip culture classified by catheter type: it can be noted that in CVC, the commonest organism was *Staph. epidermidis* (28.3%), followed by Pseudomonas (15%). However the most common organism isolated from PVC was Pseudomonas (11.7%) followed by *Staph. epidermidis* (10%). Candida , *Staph. aureus* and Enterobacter infection had the same percent in CVC and PVC 5%, 8.3%, 3.3% respectively. While, 5% of PVC was infected with *E. coli* and 5% of CVC was infected with Gram +ve diplococci (Pneumococci).

Table (4): shows the relationship between duration of CVC placement and catheter colonization: there was a significant relation between the duration of catheter placement and occurrence of catheter colonization. It can be noted that, 94.9% of catheter colonization occurred when the catheter placement was ≥ 11 days compared to 5.1% when the catheter placement was less than 10 days.

Table (5): illustrates the comparison between central and peripheral venous catheter tip culture: there was a significant relation between catheter site and positive culture. It can be noted that 65% of CVC had positive tip culture compared to 43.3% of CVC and 56% of PVC had negative tip culture (no growth) compared to 35% of CVC.

Table (6), figure (3): shows relation between CVP and PVP measurements at different times: it can be noted that a significant relation was found between CVP and PVP at different times of measurement. PVP was consistently greater than CVP by an average of 2 mmHg.

Table (1): Distribution of the study sample according to patient's characteristics

Characteristics	Study sample N=60 N	% %
Gender		
• Male	60	100
• Female	0	0
Diagnosis		
• Trauma	57	95
• Muscular impairment	3	5
Hospital stay Mean ± SD	10.23 ±	2.89
Age Mean ± SD	35.6 ±	1.58

Table (2): Distribution of the study sample according to the uses of the catheters

Uses of the catheter	CVC N#	CVC %	PVC N#	PVC %	X^2	P
Parenteral administration of:						
• Nutrition	9	15	0	0	7.69	0.005*
• Medications	60	100	60	100	-	1.00
• Blood and blood products	2	3.3	2	3.3	0.26	1.00
Pressure monitoring	60	100	0	0	-	-

Data were not mutually exclusive - CVC=Central Venous Catheter, PVC=Peripheral Venous Catheter
*P<0.05, X^2=Chi-square test

Table (3): The relationship between the site of catheter and occurrence of complications

complication	CVC N	CVC %	PVC N	PVC %	X^2	P
Catheter colonization	39	65	26	43.3	5.67	0.01*
Catheter malfunction	8	13.3	4	6.6	0.83	0.36
Exit-site infection	24	40	25	41.7	0.03	0.85
Infiltration	0	0	4	6.7	FET 4.13	0.119

- Data were not mutually exclusive - CVC=Central Venous Catheter, PVC=Peripheral Venous Catheter
*P<0.05 - X^2=Chi-square test, FET= fisher's exact test

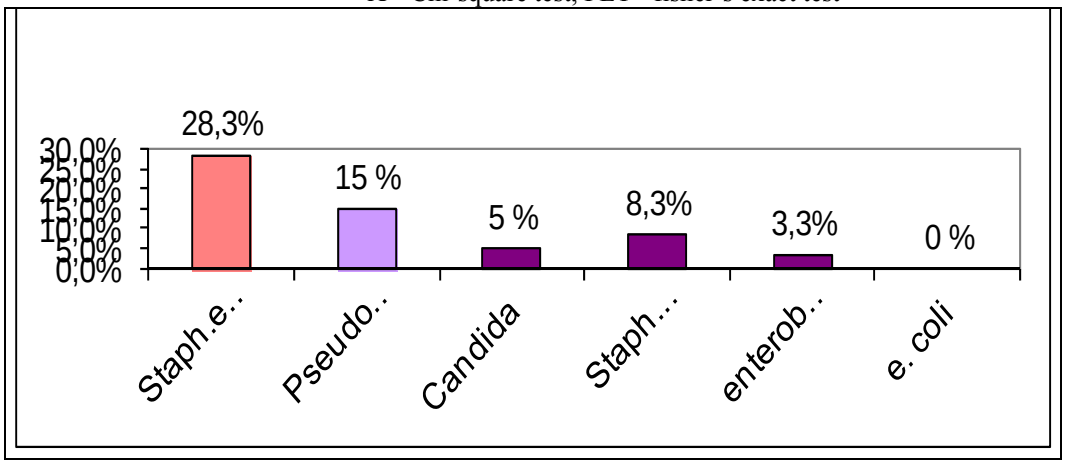

Figure (1): percent distribution of microorganisms isolated from central catheter tip

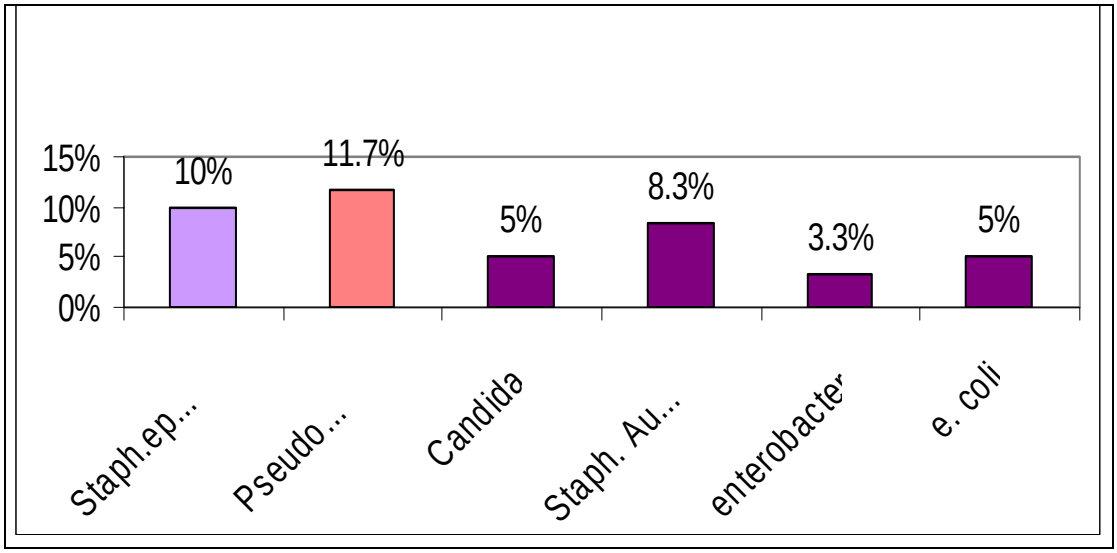

Figure (2): percent distribution of microorganisms isolated from peripheral catheter tip

Table (4): Relationship between duration of central venous catheter placement and catheter colonization:

Duration of CVC placement	Catheter colonization				X^2	P
	No		Yes			
	N	%	N	%		
< 10 days	19	90.5	2	5.1	43.7	0.001*
≥ 11 days	2	9.5	37	94.9		

- CVC=Central Venous Catheter

Table (5) Comparison between central and peripheral venous catheter tip culture

Catheter tip culture	CVC		PVC		X^2	P
	N	%	N	%		
Positive culture	39	65	26	43.3	5.67	0.01*
Negative culture	21	35	34	56		

- CVC=Central Venous Catheter, PVC=Peripheral Venous Catheter
*P<0.05

Table (6): Relation between CVP and PVP measurements at different times:

VP / time	CVP Mean± SD	PVP Mean± SD	t	P
VP immediate.	4.316 ± 2.452	6.633 ± 2.232	5.41	0.001*
VP 6	4.316 ± 2.281	6.833 ± 2.018	6.40	0.001*
VP 12	4.350 ± 2.261	6.616 ± 2.067	5.73	0.001*
VP 18	4.400 ± 2.263	6.738 ± 2.171	5.88	0.001*
VP 24	4.700 ± 2.257	7.216 ± 2.187	6.20	0.001*
VP 30	4.900 ± 2.509	7.233 ± 2.181	5.43	0.001*
VP 36	5.300 ± 3.027	7.566 ± 2.472	4.49	0.001*
VP 42	5.083 ± 3.076	7.350 ± 2.635	4.33	0.001*
VP 48	4.933 ± 2.950	7.200 ± 2.694	4.39	0.001*
VP 54	5.150 ± 2.962	7.516 ± 2.593	4.65	0.001*
VP 60	5.350 ± 3.046	7.583 ± 2.751	4.21	0.001*
VP 66	5.450 ± 2.965	7.583 ± 2.714	4.11	0.001*
VP 72	5.400 ± 2.964	7.583 ± 2.657	4.24	0.001*

VP=venous pressure. CVP=Central Venous Pressure. PVP=Peripheral Venous Pressure

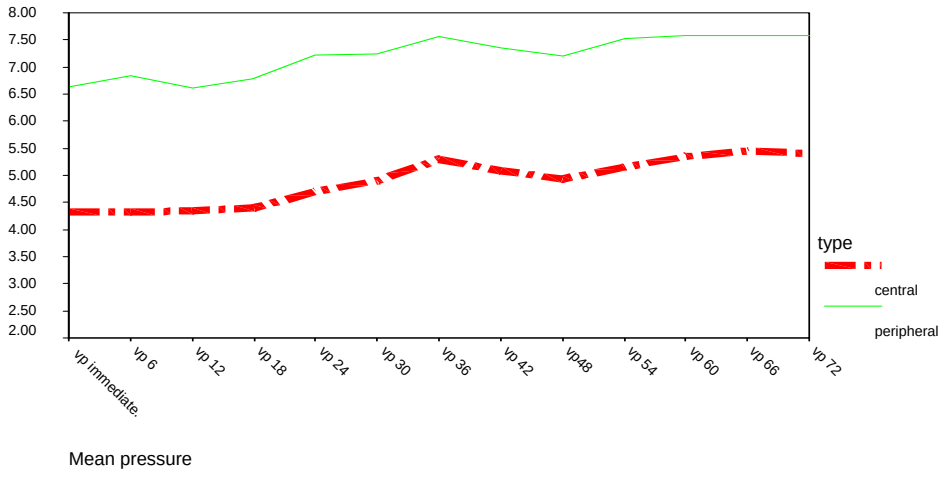

Figure (3): mean pressure of CVP and PVP

4. Discussion

Intravenous (IV) access in the ICU settings is now a routine for the administration of fluids, blood products, drugs, parenteral nutrition, and

hemodynamic monitoring. Unfortunately, this puts the critically ill patients at risk for iatrogenic infections especially blood stream infection originating from colonization of the catheter [14].

Critical care nurses play a vital role in the care of critically ill patients since they spend more time beside the patients. Nurses are responsible for assessing and preparing the patients before the insertion of vascular access devices (VADs) (either central or peripheral), role at time of inserting the catheters, role to prevent the development of complications, and have also an educative and counselor role in patient home care [15].

The results of the current study reveals that all CVCs were inserted for the **purpose** of hemodynamic monitoring and administration of medications, the administration of total parenteral nutrition (TPN) was not the main reason for central venous catheter insertion in this study. As for the peripheral venous catheters insertion was for the purpose of medication administration. This is in line with **Humar *et al.*,** [16], who noted that the majority of central venous catheters were inserted for fluid resuscitation or pressure monitoring.

The current study reveals that the **rate of colonization** of central venous catheters was higher than that of peripheral venous catheters. It is important to identify the source of microorganisms that commonly colonize CVCs. Compared to peripheral catheters, central venous catheters are associated with higher rate of line-associated bacteremia. The pathogenesis of intravascular catheter associated infections is complex and begins with attachment and colonization of either the outer or inner surface of the catheter by the infecting organism. The outer surface of the catheter may become colonized with organisms originating from skin, either by direct extension from the contiguous infectious process, or by hematogenous seeding. Alternatively, the inner surface of the catheter may become colonized by the introduction of organisms through the catheter hub [14,17]. Moreover, skin contamination is the most likely mechanism of infection in short-term catheters, whereas hub contamination is more frequent in long-term catheters [18,19].

The higher colonization rate of CVCs observed in this study may be due to the parenteral nutrition that is administered via the CVCs particularly those incorporating lipid emulsions that provides a supportive environment for organism growth or due to the proximity of CVC to oropharyngeal secretions and tracheostomy tube and presence of hair in this area [20]. These findings are in agreement with **Hammarskjold**,[21] who stated that TPN as a known risk factor for catheter related infection. With the **Maki** hypothesis [22], bacteria contaminating the area involving the catheter exit- site are involved in causing the infection. These bacteria may be sourced from various areas. Such bacteria are likely to colonize the exit-site, particularly if the colonized area is close to the exit site for example with a tracheostomy and a subclavian vein [23].

Moreover, **Turcotte *et al.*,**[24] stated that the choice of antecubital site for peripheral catheter insertion has less moisture, lower skin temperature, lower density of aerobic and anaerobic bacteria in comparison with the head and chest where CVC may be placed. Also, **Vanek**,[25] attributed these findings on peripherally inserted central venous catheters site being away from potential contamination by nasal and oral flora, drainage of respiratory secretions and tracheostomies.

The Infusion Nurses Society,[26] defines infiltration as the inadvertent administration of a nonvesicant solution into surrounding tissue, instead of into the intended vascular pathway. While extravasation is an inadvertent administration of a vesicant solution into surrounding tissue, instead of into the intended vascular pathway; a vesicant being an agent that has the potential to cause blistering or tissue necrosis. Common vesicants include chemotherapy, antineoplastic medications, certain vasodilators and vasopressors, parenteral nutrition, certain antibiotics and certain electrolyte solutions. Incidents that cause extravasation and infiltration include improper vein puncture, such as rupture of the vasculature, perhaps due to weakened vascular walls in patients with advanced age, disease states, abrasion by the cannula or the administration of a toxic agent [27,28].

This study reveals that PVCs have a higher rate of exit-site infection and infiltration than CVCs. This finding lies in accordance with **Richet**,[20] and **Giuffrida,** [29]. **Richet**, [20] stated that local complications namely infiltration occurred significantly more often with peripheral catheters than with central catheters.

It can be noted from the present study findings that catheter malfunction occurs with CVCs more than with PVCs, this may be due to excessive patient head movement, more therapeutic intervention and catheter manipulation. This finding is supported by **Kusminsky**,[30], who reported that catheter damage is frequently a result of excessive traction force and the catheter material can sometimes be faulty and ruptures or dilates. In this respect, **Kees**,[31] reported that, the risk of CVC fracture occurred mainly with excessive catheter manipulation during catheter care and due to defective CVC material.

On the other hand, it was found in the current study that the most frequently CVC tip isolated

pathogens are *Staphylococcus epidermidis* followed by *Pseudomonas*. Whereas, the most common organisms isolated from PVC tip are *Pseudomonas* followed by *Staphylococcus epidermidis*. These findings are supported with many studies. **Rao**,[14] reported that the most common colonization of peripheral intravenous catheters was with *pseudomonas* and *Coagulase negative staphylococci* while *Coagulase negative staphylococci* were the most common organisms isolated from central venous catheters followed with pseudomonas and candida.

O'Grady,[11], mentioned that the types of organisms that most commonly cause hospital acquired blood stream infections (BSIs) change overtime. During 1986-1989, *Coagulase negative staphylococci* followed by *Staphylococcus aureus* were the most frequently reported causes of BSIs . Pooled data from 1992 through 1999 indicate that *Coagulase negative staphylococci*, followed by *Enterococci* are now the most frequently isolated causes of hospital acquired BSIs. Candida spp is considered to be an important and emerging pathogen in recent years, increasingly contributing to blood stream infections[32]. In addition, **Elshal *et al.,***[33] reported that *Coagulase negative staphylococci* were the most common organism growing followed by *Pseudomonas aerginose* & yeast.

Moreover, **Kardag,**[34] reported that the microorganism isolated most commonly that cause catheter related septicemia was *Staphylococcus epedrmidis,* which is infectious microorganisms found in normal skin flora on the skin of the patient or the hand of healthcare personnel inserting the catheter. Also, **Fath-Allah,**[35] reported that *Staphylococcus epedrmidis* was the most frequent organism involved in central venous catheter related infection because dressing may provide a warm moist environment which promotes growth and colonization of skin organisms.

It is suggested that duration of catheterization is a risk factor for catheter infection. The present study shows that catheter colonization was significantly higher in CVCs kept in place for equal to or more than 11 days in comparison to catheters kept in place for less than 10 days. **Hammarskjold *et al.,***[21] and **Ali,**[36]reported that an increase in the duration of central venous catheters, causes an increase in the risk of colonization and catheter related infections [35] . **Rao *et al.,***[14] found that all the central venous catheters were colonized by the 11th day. They recommended a change of the CVC by the 10th day. While **Turcotte *et al.,*** [24] reported that the risk of catheter related infection is low until the end of the first week of catheterization and rises on day 10.

The present study reveals that the rate of colonization of peripheral venous catheters was 43.3%. Rates described in literature range from 3.8%-57% (**Roa *et al.,*** [14]). While a positive tip culture from central venous catheters was 65%. This is found to be higher than cultures done in a previous study conducted by **Sachdv *et al.,*** [37]. Possible reasons for these differences in rates could be the use of a three way connector attachments to central lines for increasing the number of infusion and/or lack of standardized protocol for replacement/change of catheters.

On the other hand, central venous cannulation is an invasive procedure that is considered as a minor surgery requiring local anesthesia as well as a common long-term intravenous access that may lead to life-threatening complications. Therefore a number of alternative techniques have been explored to obtain information on hemodynamic states without the complications associated with CVC cannulation. The current study investigates one of those techniques by using peripheral venous pressure and its correlation to CVP. **Based on** this study findings, it can be said that a significant relation was found between CVP and PVP at different times of measurements.

First, it is important to know that the expectation that PVP and CVP are related is not new. In 1943, **Holt's** [38] demonstrated the pressure in the antecubital vein and found that it tracks intrathoracic pressures in spontaneously breathing patients [39]. The claim by **Sykes** [40], in 1963, that measurement of CVP was a useful adjunct to volume resuscitation was criticized for being technically unwidely. More recently, a study conducted by **Munis *et al.,*** [39], who investigated the correlation between CVP and PVP in a wide variety of patients and arm positions, surgeries, blood loss and catheter sites, they stated that in the absence of extravasation or obstruction by clotting, IV catheters continue to flow unimpeded into the central circulation and this implies that fluid continuity is maintained between PVP and CVP sites despite changes in venous geometry that may occur with repositioning and despite any venous valves that may intervene between the PVP site and the central circulation.

The significant correlation between PVP and CVP found in this study agreed with other studies. **Munis *et al.*,**[39] compared PVP with CVP in 15 patients undergoing craniotomy or spine surgery with different patient positions. They indicated a highly significant relationship between PVP and CVP.

A striking finding, of the present study, is that a 2 mmHg difference between PVP and CVP was sustained which is almost identical with the data described in earlier publications. **Munis *et al.,*** [39] reported a PVP-CVP difference of 3 mmHg. **Amar**

et al., [7] observed mean PVP values of 9 mmHg and a mean CVP value was 8 mmHg. **Hadimioglu *et al.*,**[41] found that PVP values, in a population of 30 patients undergoing kidney transplantation, showed a high degree of agreement with CVP and that PVP monitoring may be a rapid, noninvasive tool for estimating volume status in patients without significant cardiac dysfunction.

Also, **Tugrul *et al.,***[42] who used different catheter sizes inserted in the dorsal hand or forearm for PVP measurement and in internal jugular or subclavian for CVP measurement. They used different patient positions during simultaneous measurement of PVP and CVP measurement at random time points. They found a constant relationship between PVP and CVP with 2-mmHg difference between the two measurements. They assumed that the two sites of measurements (peripheral and central) are part of the same venous continuum and the difference between PVP and CVP is likely to be because of the resistance to venous drainage from large veins.

Also, **Hoftman *et al.*,**[43] confirm that PVP correlates with CVP even under adverse hemodynamic conditions in patients undergoing liver transplantation. However, **Leipoldt *et al,* [45].,** who stated that peripheral venous pressure measured from an IV catheter in the hand predicts CVP poorly in pediatric patients. However, they stated that IV site does not affect agreement in adults and that further evaluations are warranted in the pediatric population to determine the potential usefulness of PVP sites proximal to the hand [44] .

Finally it can be seen that in critically ill patients, pressure measured via a catheter inserted into a peripheral vein correlates with central venous pressure and whether changes in one are mirrored by changes in the other. So, peripheral venous catheter can be used as a minimally invasive technique to estimate volume status to minimize complications arising from using the central venous catheter.

Conclusion

According to the results of the present study, it could be concluded that the rate of colonization of central venous catheters was higher than that of peripheral venous catheters. While PVC had a higher rate of infiltration than CVC. Also, catheter malfunction occurred with CVC more frequently than with PVC. Moreover, a significant correlation was found between peripheral venous pressure and central venous pressure. It was found that in critically ill patients, pressure measured via a catheter inserted into a peripheral vein correlates with central venous pressure and whether changes in one are mirrored by changes in the other. So, peripheral venous catheters can be used as a minimally invasive technique to estimate volume status and to minimize complications arising from using the central venous catheters.

Recommendations

Based on the findings of the present study, the following recommendations are suggested:

Clinical practice:

1. The site of catheter insertion should be selected and assessed before catheter insertion to minimize the occurrence of complications.
2. The care and maintenance of vascular access devices should start from the time of catheter insertion and last until catheter removal to prevent the occurrence of complications.
3. Duration of placement of central venous catheter should not exceed 10 days while duration of peripheral venous catheter should not exceed 72-96 hours.
4. The insertion site should be examined daily for local signs of exit-site infection.
5. Peripheral venous catheters can be used instead of central venous catheters for estimation of body volume status to minimize the occurrence of complications.

Suggested Further Research:

- Study of the effect of dominance of the arm on the peripheral and central venous pressure relationship.

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10/28/2011