



## **Clinical Use and Complications of Peripheral Venous Cannulae among Adult Patients in a Nigerian Tertiary Hospital, Benin City: A Pilot Study**

**S. Adewoyin Ademola<sup>1\*</sup> and O. Ogunnowo Tolulope<sup>2</sup>**

<sup>1</sup>*Department of Haematology and Blood Transfusion, University of Benin Teaching Hospital, P.M.B. 1111, Ugbowo, Benin City, Edo State, Nigeria.*

<sup>2</sup>*Department of Medical Microbiology, University of Benin Teaching Hospital, P.M.B. 1111, Ugbowo, Benin City, Edo State, Nigeria.*

### **Authors' contributions**

*This work was carried out in collaboration between both authors. Author SAA conceived and designed the study protocol. Author OOT partook in the study design. Author SAA performed data analysis and wrote the initial draft. Author OOT appraised the draft. Both authors read and approved the final version.*

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### **ABSTRACT**

**Background:** Peripheral venous catheterization is a common medical procedure among hospitalized patients. Its use is fraught with potential complications including thrombophlebitis and blood stream infections. This necessitates provision of appropriate local protocols, meticulous use and regular surveillance, particularly in developing nations like Nigeria. This study therefore evaluates the pattern of use, care practices and complications associated with peripheral venous cannulae (PVC) in a Nigerian teaching hospital.

**Methods:** Using an interviewer-administered questionnaire, relevant bio-, clinical and laboratory data were collected through an interview process and case file reviews. A total of 143 consenting adult patients on admission in the different medical and surgical wards were interviewed consecutively over a period of two months.

\*Corresponding author: E-mail: [drademola@yahoo.com](mailto:drademola@yahoo.com);

**Results:** A total of 79 (55.2%) subjects had in-situ PVC during admissions. Commonest indications for PVC insertions were administration of intravenous fluid therapy (74.7%), followed closely by intravenous antibiotics (68.4%). Catheter-related complications were observed in 53.2% of PVC insertions, with phlebitis being the commonest (46.8%), followed by infiltration (17.7%). Length of catheter indwell times was significantly associated with phlebitis ( $p = 0.017$ ).

**Conclusion:** Authors recommend provision of local guidelines and protocols for PVC insertion and maintenance with emphasis on asepsis. There should be adequate information and proper documentation regarding PVC use, coupled with consistent surveillance and vigilance to detect complications promptly. Although, further studies are needed in this regard, routine maintenance PVC removal or replacement every 72 to 96 hours may be a better option in our locality.

*Keywords: Peripheral venous cannulae; clinical utility; complications; venous catheter; phlebitis; Benin city; Nigeria.*

## 1. INTRODUCTION

Peripheral venous cannulae (PVC) are small hollow tubings that are advanced percutaneously over a needle into a peripheral vein for infusion of intravenous agents. These intravenous agents include fluids (crystalloids, colloids), drugs, blood components/products, contrast media/dyes, and others [1]. Commonest sites of insertion include the cephalic, basilic veins, the dorsal arch of veins on the hands as well as other superficial veins [1].

PVC insertion is one of the commonest hospital interventions in patient care practices. Previous studies have reported that as much as 80% of hospitalized patients bear PVC at any point in time [1-5]. However, inappropriate use and sub-optimal care of PVC is associated with significant complications [6]. The potential risks include phlebitis, local sepsis, blood stream infections, infiltrations, extravasation, obstruction/loss of function and thrombo-embolism [7,8]. Phlebitis has been reported as the most common complication with incidence ranging from 3.7 to 67.24% in different clinical settings [9-13]. In the US, the prevalence of catheter related blood stream infection is estimated to be about 0.1% of all PVC inserted [14]. However, there is sparse local epidemiologic data on patterns of clinical use and complications of PVC in Nigeria. Complications of PVC use, if incurred, increases patient morbidities, prolongs hospital stay and heightens health care cost. There is therefore a need to determine the pattern of PVC use and its associated complications in our setting so as to develop appropriate protocols and preventive measures. Invariably, this will ensure better healthcare delivery and improve overall treatment outcomes [15]. Suffice also to say, proper and regular training/re-training of relevant personnel (clinical staff), aseptic protocols, and meticulous care of in-situ PVC, coupled with

regular, vigilant monitoring is crucial to ensuring optimal outcomes.

This article therefore seeks to evaluate the common indications for PVC insertion at the University of Benin Teaching Hospital (UBTH), its care practices, patterns of complications, as well as proffer solutions to reduce its attendant risks.

## 2. METHODOLOGY

This is a hospital based, cross sectional, pilot study carried out at the University of Benin Teaching Hospital, Benin City, Edo State, Nigeria. The survey was performed among hospital In-patients over a period of two months (between March and April 2015). Adult medical and surgical patients that were on admission during the study period were interviewed after detailed explanation of the intended study and informed consent obtained. Data was collected using a structured, interviewer administered questionnaire. Relevant bio-data including age, sex, hospital ward were noted. As well, clinical information such as length of hospital stay, use of PVC, indications for PVC insertion, duration of in-situ PVC (in days), catheter gauge, site of insertion, catheterized limb, concurrent antibiotic use and full blood count (FBC) parameters were also gotten through an interview process and case file review. Thereafter, the catheter site was visually inspected and manually examined for signs of infection and other PVC related complications. Pain at the PVC insertion site, as well as during use, tenderness, erythema were defined as phlebitis [7,16-18]. Infiltrations and extravasations were defined as local swelling with pain associated with infusion of non viscous and viscous fluids respectively [16-18]. All patients on admission above 18 years of age who gave their consent during the study period were recruited into the study. Unconscious, unstable and patients with impaired cognition

were excluded from the study. All cannulations were performed by doctors on the ward and occasionally by paramedical staff for patients admitted via the emergency room.

Data were inputted and analysed using the Statistical Package for Social Sciences (SPSS) version 16. Descriptive statistics were performed as appropriate. Association of phlebitis and variables such as age, sex, length of hospital stay, duration of in-situ PVC, catheter gauge, antibiotic therapy were tested using Chi square or Fisher exact test as appropriate. Results were presented in frequencies and tables. Probability score of 5% ( $p$  value = 0.05) is considered significant.

### 3. RESULTS

A total of 143 adult patients who were on admission during the study period were studied. Only 79 patients had in-situ PVC (55.2%) and were interviewed and profiled using a structured questionnaire (Table 1).

The mean age among the subjects with PVCs is 47.81 years, with a median age of 46 years (Table 1). Male to female ratio is 1.19: 1. About 63% percent of the patients were admitted on medical wards, others were surgical. The mean length of hospital stay was 12.03 days while as much of 70% of the patients were on some form of antibiotic treatment (Table 1).

Of the 79 subjects with in-situ PVCs, 3 (2.1%) had more than one PVCs simultaneously (Table 2). The mean duration of in-situ PVC stay was observed to be 3.43, with an interval of 1 to 14 days. Most of the subjects bore PVCs inserted within the last 4 days (Table 2).

The most frequently used catheter size (55.7%) is 20 g with colour code, pink. About 33% of the PVCs were on continuous use, while the rest were engaged intermittently. The commonest use was for administration of intravenous fluid therapy (74.7%), followed by administration of intravenous drugs (68.4%) and blood component therapy (30.4%) (Table 3).

**Table 1. Characteristics of patients with peripheral venous catheters**

Characteristics	Frequency (n)	Percentage (%)
<b>Age (years)</b>		
18 – 40	32	40.5
41 – 60	28	35.4
61 – 80	19	24.1
<b>Sex</b>		
Male	43	54.4
Female	36	45.6
<b>Hospital ward</b>		
Medical (On PVC)	50	
Surgical(On PVC)	29	
Medical (No PVC)*		
Surgical (No PVC)*		
<b>Length of hospital stay (days)</b>		
≤ 3	10	12.66
>3	69	87.34
<b>Antibiotic therapy</b>		
Yes	56	70.89
No	23	29.11
<b>Blood counts*</b>		
Total Leucocyte Count		
<b>Mean ± SEM = 11700 ± 6024, Min = 3100, Max = 28700</b>		
Granulocyte Count		
<b>Mean ± SEM = 7991 ± 759, Min = 1800, Max = 21400</b>		
Platelet Count		
<b>Mean ± SD = 233000 ± 16500, Min = 50000, Max = 539000</b>		
Haematocrit		
<b>Mean ± SD = 30.34 ± 1.30, Min = 11.4, Max = 50.6</b>		

*N* = 79 (100%), *N*\* = patients without PVC, *N*\*\* = 45 (Blood count parameters were retrieved for 45 subjects)

**Table 2. Details relating to peripheral catheter use**

<b>Characteristics</b>		
<b>Number of In-situ PVC*</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
None	64	44.8
Single	76	53.1
Simultaneous( $\geq 2$ )	3	2.1
<b>Percent In-situ PVC = 55.2%</b>		
<b>Duration of In-situ PVC (days)</b>		
$\leq 3$	53	67.1
$>3$	26	32.9
<b>Mean<math>\pm</math>SD = 3.43<math>\pm</math>2.25, Median = 3, Min = 1, Max = 14</b>		
<b>Catheter gauge</b>		
Yellow 24 g	6	7.5
Blue 22 g	9	11.2
Pink 20 g	44	55.7
Green 18 g	20	25.3
Gray 16 g	-	-
<b>Infusion rate</b>		
Continuous	26	32.9
Intermittent	53	67.1
<b>Insertion site</b>		
Back of hand	31	39.2
Wrist	3	3.8
Forearm	39	49.4
antecubital area	5	6.3
Upper arm	1	1.3
<b>Catheterised limb</b>		
Upper	78	98.7
Lower	1	1.3
<b>Catheterised limb</b>		
Right	34	43
Left	45	57

$N = 79, N^* = 143$

The most common site of insertion is the forearm (49.4%), followed by back of the hand (39.2%) and less frequently the antecubital area, the wrist and upper arm, mostly on the left upper limb (Table 2). The lower limb was catheterized in only one of the subjects. Catheter related complications were reported and observed in 53.2% of the subjects. The most common complication was phlebitis (46.8%), followed by infiltrations (17.7%). Other complications such as extravasation, palpable cord, dislodgement, plaster allergy and obstruction were less frequently observed (Table 3).

Increasing duration of catheter in-dwell times was significantly associated with incidence of phlebitis among the patients,  $p$  value = 0.017 (see Table 4). No significant association was observed between phlebitis and other variables such as age, sex, antibiotic use, catheter gauge

and length of hospital stay. However, patients with longer hospital stay were more likely to bear PVCs exceeding 3 days,  $p$  value = 0.013 (see Table 5).

#### 4. DISCUSSION

The rate of PVC use among hospital patients was observed to be 55.2%. In previous epidemiologic studies reported from other regions, the rate of PVC use among hospitalized patients widely varied from at least one third to 80% [1,3]. PVC was more commonly used among medical patients (63.3%) compared to surgery patients in the index study. This may be related to the more critical or acute states associated with patients on medical wards, which place them at greater demands for antibiotic therapies, fluids and blood products. Oral or parenteral antibiotics were used in over 70

**Table 3. Indications and complications of catheter use**

Indications and complications	Frequency (n)	Percentage (%)
<b>Clinical indications*</b>		
Intravenous fluid	59	74.7
Blood components	24	30.4
Intravenous drugs	54	68.4
Cytotoxics and others	6	7.6
<b>Catheter-related complications</b>		
Yes	42	53.2
No	37	46.8
<b>Catheter related complications*</b>		
Phlebitis	37	46.8
Infiltration	14	17.7
Extravasation	2	2.5
Palpable cord	2	2.5
Dislodgement	1	1.3
Plaster allergy	1	1.3
Obstruction	2	2.5

*N = 79 (100%). \*multiple responses*

percent of the patients, suggesting that infections are a major cause or co-morbidity among patients in our setting. Little wonders intravenous drugs including antibiotics accounted for 68.4% of PVC use among patients in the index study. Occasionally, some patients were found to bear two PVCs simultaneously. Such include patients in the immediate post-operative periods and patients with shock (cardio-vascular collapse) during resuscitation. Phlebitis was observed in 46.8% of patients bearing PVCs as the most frequent complication, similar to observations from other studies [9–13,19-21]. Phlebitis may be mechanical, infective or chemical [7]. As a limitation, this study neither graded the degree of phlebitis nor the type (cause). Also, patients with phlebitis were not followed up for possible progressive local sepsis or blood stream infections due to lack of adequate time and resources for microbiologic culture. This gap needs to be closed through further research in the future. Nonetheless, this study provides valuable information on trends and complications of PVC use among hospital patients in Nigeria. About 33% of patients studied had in-situ PVCs exceeding 3 days and this was observed to be related to increased rates of phlebitis among patients in the index study. A similar trend was also observed in some earlier studies [22]. This trend formulated the basis for routine maintenance practices and removal every 72 to 96 hours, as recommended by US CDC and UK

guidelines [3,23-26]. However, some other authors have argued and contended the practice of routine catheter replacement every 3 – 4 days. Their studies suggested that there is no significant difference in rates of phlebitis between patients that underwent routine 3 to 4 day replacement and patients that had replacement on clinical grounds alone [27-29]. It is also important to note that the incidence of phlebitis among patients on PVCs is affected by other possible variables such as operator techniques and expertise, the infusate and its rate, meticulous asepsis, availability and quality of materials and supplies [30,31]. However, the incidence of phlebitis was observed to be higher with longer catheter in-dwell times in the index study. Infiltrations and extravasations were associated with infusion of non-viscous and viscous agents respectively. Extravasations in particular cytotoxic agents could be associated with tissue necrosis with skin loss and gangrene. Particular attention has to be given to avert this, observing that some of the patients (7.6%) had intravenous cytotoxic therapy. Longer hospital stays portend a longer catheter in-dwell times and a higher risk of phlebitis. It is therefore necessary that clinicians establish guidelines and ensure proper maintenance practices (care bundles) regarding PVCs, based on local experiences and patterns of complications, as this has been shown to reduce complications [32].

**Table 4. Association of phlebitis with other variables**

Variables	Phlebitis		p-value
	Yes	No	
<b>Age groups</b>			0.604
	18 – 40	13	19
	41 – 60	15	13
	61 – 80	9	10
<b>Antibiotic therapy</b>			0.910
	Yes	26	30
	No	11	12
<b>Sex</b>			0.155
	Male	17	26
	Female	20	16
<b>Catheter In-dwell times</b>			0.017
	1 - 2 days	8	20
	3 – 7 days	26	22
	>7 days	3	0
<b>Catheter guage</b>			0.846
	Blue 22 g	4	5
	Pink 20 g	19	25
	Green 18g	11	9
	Yellow 24g	3	3
<b>Length of hospital stay</b>			0.188
	≤ 3 days	2	8
	4 – 14 days	24	24
	≥ 15 days	11	10
<b>Infusion rate</b>			0.296
	Continuous	10	16
	Intermittent	27	26

**Table 5. Association of catheter in-dwell times with other variables**

Variables	Catheter in-dwell times (Days)		p-value
	≤ 3	More than 3	
<b>Age</b>			0.160
	18 – 40	25	7
	41 – 60	18	10
	61 – 80	10	9
<b>Hospital ward</b>			0.223
	Medical	36	14
	Surgical	17	12
<b>Length of hospital stay</b>			0.013
	≤ 3 days	9	1
	4 – 14 days	35	13
	≥ 15 days	9	12

N = 79 (100%)

Additionally, other factors such as poor role definitions, inter-professional conflicts, excess workloads, fragmentation of care (shifts and call duties), inadequate knowledge and training among clinical staff which may further threaten patient safety as observed in other studies needs to be addressed and tackled.

## 5. CONCLUSION AND RECOMMENDATIONS

All clinical staff should pay closer attention at PVC maintenance during routine patient care. Roles should be well defined, as well as provision of local guidelines and protocols for

PVC insertion and maintenance. Cannulation of a peripheral vein should be performed under strict aseptic process. Antiseptic cleansing of the skin should be performed first. The choice of insertion site depends on factors such as location of prominent vessels and clean skin, operator skills and perhaps patient's choice. Preferably, points of flexion such as wrist and antecubital area should be avoided. Checks for prominent vessels to cannulate should progress torso-dorsally, aided with use of tourniquets [1]. A longitudinal study will be required to better define other complications of PVC use such as catheter related blood stream infections, as well as to justify or refute the routine catheter replacement every 72 to 96 hours among patients in our setting. However, routine PVC removal or replacement may be more appropriate in our setting, particularly if clinically indicated.

Prior to insertion, the attending should ensure that a clear indication for its use. The date and time of insertion should be properly documented. Every 12 hours, at most 24 hours, and the clinical utility of all in-situ PVC among the patients should be assessed with the following three questions: how long has it been in use? Is it still required? Is it properly maintained? [16]. The PVC site should be visually inspected and palpated for an evidence of inflammation, infection, infiltration and other possible risk. Bad cannulae should be removed immediately and re-sited if still required. Proper documentation must be ensured. Surveillance (vigilance) checks should be performed during clinical or hand-over rounds by nurses and doctors. Proper hand hygiene practices must be engaged when handling PVC [1]. Compromised PVC dressing should be replaced to prevent dislodgement. PVC that is no longer in use should be removed as soon as possible.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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