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ORIGINAL ARTICLE

A single institution experience of seven hundred consecutively placed peripherally inserted central venous catheter

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ABSTRACT

Introduction: **Peripherally inserted central venous catheters (PICCs) are being increasingly placed at the bedside by trained vascular access professional such as nurses. This is to increase the availability of the service, for cost containment, and to reduce the workload on the interventional radiologist. We describe a single institution experience with over 700 PICC lines placed by trained nurses at the bedside and determine the success rate, malposition rate of the PICC line , degree of support needed from the Interventional radiologist, and factors affecting a successful placement of a PICC line by the nurses.**

Methods: **Seven hundred and five PICC lines were placed at the South Nassau Communities hospital between July 2011 and November 2012 by trained vascular access nurses with interventional radiology backup. Bedside ultrasound was used for venous access, an electromagnetic catheter tip detection device was used to navigate the catheter into the desired central vein and catheter tip position was confirmed using a portable bedside chest X-ray.**

Results: **The nurses, with a malposition rate of 3.8%, successfully placed 91.6% (646/705) catheters. Interventional radiology support was needed for 59 cases (8.4%) and 17 cases (2.4%) for failed placement and catheter malposition adjustment, respectively. Risk factor such as presence of pacemaker wires and multiple attempts at insertion were factors predictive of an unsuccessful placement of a PICC line by the nurses.**

Conclusions: **Bedside placement of PICC line by trained vascular nurses is an effective method with a high success rate, low malposition rate and requires minimal support from interventional radiology.**

Key words: **Electromagnetic guidance, Peripherally inserted central venous catheters, Ultrasonography**

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INTRODUCTION

There has been an increasing use of medium and long-term intravenous therapy (1). This is primarily from the increased use of extended duration of antibiotics to treat resistant infections such as osteomyelitis and increasing usage of chemotherapeutic drugs. Peripherally inserted central catheters (PICCs) have emerged as a choice for long-term intravenous access (2). PICC lines were initially placed by interventional radiologist in radiology suites. Recently, there has been a move toward placing these lines at the bedside by trained vascular access proceduralist. This has been done to increase the availability of the service, for cost containment, and to reduce the workload on the interventional radiologist (3-5).A successful bedside placement of a PICC line needs to achieve three objectives. These are successful venous access, accurate direction of the catheter into the intended vein and confirmation of catheter tip position. Various studies have described different methods to achieve the above-stated objectives such as simple palpation or bedside ultrasound for venous access, fluoroscopy to direct the catheter and a chest X-ray for tip position confirmation (3-7). We describe a single institution experience with a completely bedside placement of a PICC line by a team of Nurse Proceduralists with the use of ultrasound guidance for venous access, use of an electromagnetic navigation system for directing the catheter and use of portable bedside chest X-ray for tip position confirmation. The objective of the study was to determine the success rate, malposition rate and factors predicting an unsuccessful attempt at placement of a bedside PICC line catheter by the Nurse Proceduralist.

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METHODS

The PICC lines were placed at the bedside by a team of trained and credentialed vascular access nurses at the South Nassau Communities hospital. The Department of Interventional Radiology at the South Nassau Communities hospital provided the technical backup for failed insertion cases. For clarity of the description, we will call the PICC line placed by the nurses as PICCRN and the interventional radiologist as PICCIR. The contraindications for placement of PICC were as follows:

1. Glomerular Filtration Rate (GRF) <60 ml/min. This was due to potential for the PICC line to cause central venous stenosis, thus interfering with creation of an arterio-venous fistula in the future.
2. International Normalized Ratio (INR) >2.5, Platelet <50,000
3. Prior modified radical mastectomy
   Patients with an International Normalized Ratio (INR) >2.5 and platelet count <50,000 were directly referred to interventional radiology, as they were deemed high risk for bleeding and thus were considered appropriate for placement of the PICC by the interventional radiologist with advanced skills.

A bedside ultrasound device (Site-Rite; Bard Access System Inc., Salt Lake City, Utah, USA) accessed the peripheral veins. The catheter was placed using a modified Seldingers's technique. The catheter was trimmed to the desired length on the basis of external surface marking from point of insertion to the desired central venous tip position. The catheter was navigated into the superior vena cava using an electromagnetic catheter tip detection device (Sherlock II Tip location system; Bard Access System. Inc.). Final placement was confirmed using bedside portable chest X-ray. A malposition was defined as the location of the catheter tip more than 2 cm from the intended position, on a portable chest X-ray with an anterior view, and read by a radiologist. Majority of the lines were intended to be placed at the superior vena caval–atrial junction and the rest in the proximal subclavian vein. The nurses were allowed to pullback malpositioned catheter to the intended position. An attempt was defined as a successful venipuncture with a flash of blood in the needle hub. A failed attempt was defined as either as an unsuccessful venipuncture or an unsuccessful attempt to cannulate the vein after a successful venipuncture. There was no limit on the number of attempts.

Statistical analysis was done using SPSS version 17.0 for Windows (SPSS, Chicago, Illinois, USA). Analyses of categorical variables were done using Pearson's Chi-square test or Fisher's exact test when appropriate. Continuous variables with a normal distribution and those with a non-normal distribution were analyzed using the Student's *t*-test and Mann–Whitney *U* test, respectively. A multivariate analysis was done using a logistic regression method. A p value <0.05 was considered statistically significant.

RESULTS

There were 718 requests for placement of a PICC line from various services in the hospital between July 2011 and November 2012. Four lines request were withdrawn by the requesting service before placement. Either the nurses or the Interventional radiologist could not place nine lines. The remaining 705 lines were successfully placed in 705 patients, 646 (91.6%) by the nurses and 59 (8.4%) by the intervention radiologist, after a failed attempt by the nurses. The mean age of the patients was 65.6 years; 50.4% patients were male. Fifty-five patients (7.8%) had known risk factors such as presence of pacemaker wire precluding a successful placement of PICC line. Out of the 59 cases, which constituted the unsuccessful attempt by the PICCN, 49% (29/59 cases) failed due to intravenous access from unsuccessful venipuncture and the rest 50.8% (30/59 cases) (50.8%) due to inability to cannulate the vein (Table 1).

Long-term intravenous antibiotics infusion (48.7%) was the most common indication for the PICC line placement (Table 2).

The right upper extremity and the basilic vein were the most commonly used access points. A median of four French catheter sizes was inserted, with a malposition rate of 3.8% (27 cases). Although the Superior Vena Cava/Right Atrium (SVC/RA) junction was the preferred site for the catheter tip placement, especially when highly irritant or vesicant medication was infused, the

TABLE I - DEMOGRAPHIC DATA

	N=705
1. Age, Mean/SD	65.6/17.3
2. Gender	Male 355 (50.4%)
3. Risk factor	55 (7.8%)
Prior central venous access	15 (2.1%)
Automatic Implantable Cardioverter Defibrillator (AICD) Pacemaker	7 (1%)
End Stage Renal Disease (ESRD)	22 (3.1%)
Morbid obesity	6 (0.9%)
Severe contractures	2 (0.3%)
History of Deep Vein Thrombosis (DVT)	2 (0.3%)
4. Registered Nurse (RN) placed	646 (91.6%)
Interventional Radiology (IR) placed	59 (8.4%)

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TABLE II - PICC LINE PLACEMENT INDICATIONS

Indication	N=705
TPN	110 (15.6%)
Long-term antibiotics	343 (48.7%)
Difficult access	157 (22.3%)
Home IV access	45 (6.4%)
Irritant/Vesicant	40 (5.6%)
Critical care medications	4 (0.6%)

TABLE III - PICC LINE INSERTION CHARACTERISTICS

	N=705
1. Side insertion: Right	584 (82.8%)
2. Vein accessed	
Basilic	457 (64.8%)
Cephalic	63 (8.9%)
Brachial	164 (23.3%)
3. Attempts, Median/Range	1/1-4
4. Size (Fr), Median/Range	4/2-6
5. Lumens, Median/Range	2/1-3
6. Catheter length inserted (cm), Mean/SD	43.58/4.9
6. Position of tip	
Superior Vena Cava/Right Atrium (SVC/RA)	398 (68.4%)
Subclavian vein	175 (30.1%)
Axillary vein	1 (0.2%)
Brachial/Cephalic vein	4 (0.7%)
Inferior vena cava	4 (0.7%)
7. Malposition	27 (3.8%)
Reposition by Registered Nurse (RN)	10 (43.5%)

subclavian vein was chosen as the site when the need for the PICC line was for simple infusion of intravenous fluid due to poor peripheral veins. Of the catheters malpositioned (most of them due to overinsertion beyond the desired point), the Nurses could reposition 43.5% of the cases by pulling back the catheters. There were no cases of retrograde malposition into the internal jugular vein (Table 3).

A comparison between the PICC lines placed by the Nurses and IR only revealed a significant difference in the laterality of the extremity accessed. The interventional radiologist was more likely to use the left upper extremity. This is evident, as the Nurses would have made several attempts commonly in the right upper extremity before making a referral to the radiologist (Table 4).

TABLE IV - A COMPARISON BETWEEN PICCRN AND PICCIR LINES

	PICCRN=646	PICCIR=59	
Age (years), Median/SD	65.5/17.2	66.45/17.8	p=0.06
Male gender	330 (51.2%)	25 (42.4%)	p=0.19
Risk factor	47 (7.3%)	8 (13.6%)	p=0.12
Side: Right	551 (86.6)	33 (63.5%)	p=0.00
Vein accessed			
Basilic	426 (67.2%)	31 (62%)	p=0.58
Cephalic	58 (9.1%)	5 (10%)	
Brachial	150 (23.7%)	14 (28%)	
Catheter size (Fr) Median/ IQR	4/4-5	4/4-5	p=0.47

TABLE V - MULTIVARIATE ANALYSIS OF FACTORS AFFECTING UNSUCCESSFUL PLACEMENT OF A PICCRN

	Reference	OR/95% CI	p
Age years		0.98 (0.96-1.0)	0.22
Gender: Male	Female	1.49 (0.69-3.22)	0.30
Risk Factor: Present	Absent	2.59 (1.03-8.48)	0.04
Right upper extremity access	Left	0.328 (0.14-0.76)	0.09
>2 Attempts	<2 Attempt	2.97 (2.15-4.08)	0.00

A logistic regression analysis found the presence of preprocedural risk factors (odds ratio 2.59) and more than one attempt at insertion (odds ratio 2.97) as significant factors adversely affecting a successful placement of a PICC line by the nurses (Table 5).

During the study period, there were no significant complications such as perforation of the intracranial veins, perforation of central veins, arrhythmias requiring intervention and arterial injury.

As the primary objective of the study was the feasibility of placement of PICC lines by nurses at the bedside, secondary data such as line infection rate were not collected specifically for this study.

DISCUSSION

PICCs were first described in 1975 as an alternate route for central access through a peripheral vein (2). Long-term central venous access is becoming an increasingly

important component of healthcare today. Long-term central venous access is used for various reasons such as the administration of chemotherapy, antibiotics and total parenteral nutrition (1).

Traditionally, PICC lines were done by interventional radiology with fluoroscopic image guidance (2). It is increasingly becoming a trend in hospitals, especially with a high-volume need for PICC lines, to utilize dedicated PICC lines team capable of placing these lines at the bedside (5). These PICC lines are commonly performed by registered nurses with training and credentialing in vascular access (3, 6, 7). The advantages of using a dedicated PICC line team are a decrease in waiting time, easing congestion in the interventional radiology department and performing the procedure at the bedside, thus minimizing logistics of patient transport. This leads to cost reduction and increased patient satisfaction (1, 4, 5, 8). Cost reduction comprises multitude of reasons. Firstly, performing the procedure at the bedsides minimizes the use of the sophisticated, costly interventional radiology suite. Secondly, it has a direct impact on the length of stay, as there is less scheduling conflict when the procedure is performed at the bedside, thus leading to an earlier discharge of the patient from the hospital. Cost reduction can be as significant as 24% (5). Patient satisfaction stems primarily from less waiting time.

The question arises of the efficacy of placement, safety profile and the degree of input from interventional radiology. In earlier times of venous access by palpation and placement of PICC by predetermined measurement based on external surface marking, the success rate ranged between 73% and 83% (6, 7). Use of bedside ultrasonography with novel electromagnetic catheter tracking systems has led to increasing successful placement of the PICC line at the bedside in the order of 94% of the cases in some studies (1, 5). In our study, the success rate was 91.6%, which is similar to other studies using similar methods. With the use of a novel electromagnetic guidance system, catheter tracking is in real time, thus preventing inadvertent migration into the intracranial veins such as the sigmoid sinus causing perforations. Bedside ultrasonography helps selective puncture of the veins thus minimizing arterial puncture and injury. The degree of IR support varies from 16% for minor assistance such as catheter repositioning to 13% for major assistance for a failed placement (7). In our study, the degree of IR support was 8.4% for failed catheter placement (Major) and 2.4% for minor assistance such as catheter repositioning. Certain factors such as dialysis lines, pacemaker wires and morbid obesity were collectively significant factors precluding a successful placement of a PICC line by the nurses. Further, of the 8.4% cases with a failed insertion by the PICC nurses, 50.8% was due to an inability to cannulate the vein. This is because of a conservative approach by the nurses not to force the guide wires if met with significant resistance, to prevent venous perforation. Interventional radiology on the contrary, with the help of fluoroscopy with additional help from intravenous contrast agents, is able to more aggressively cannulate the veins by negotiating difficult kinks or stenosis in the veins that form anatomical distortions. In addition, if more than two attempts have been made, it may be prudent either to abort the procedure or switch to the opposite side if not contraindicated. Recurrent attempts at cannulation again reiterate the fact that a difficult anatomical defect is present that needs a more sophticated technique such as fluoroscopy or an alternate access such as a different vein. Thus, it has been recommended to have close coordination between the IR department of the hospital and the PICC team to thus increase the efficiency and overall effectiveness of the PICC line placement (3, 4). The prevalence of malposition is variable from studies, as there is no standardized definition as what constitutes a malposition. It was 3.8% in our study, which is comparable to other studies of 2.1% (7). However, of the 3.8% (27/705) catheters malposition, 43.5% (10/27) could be repositioned by nurses themselves, as these were due to catheters inserted beyond the desired position and had to be simply pulled back.

CONCLUSION

Bedside placement of a PICC line by trained vascular nurses is a very effective method with a high success rate, low malposition rate and requires minimal support from interventional radiology.

The data of this study have been presented at Nassau Surgical Society Meet as a poster in December 2012, Uniondale, New York, USA.

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REFERENCES

1. Horattas MC, Trupiano J, Hopkins S, Pasini D, Martino C, Murty A. Changing concepts in long-term central venous access: catheter selection and cost savings. Am J Infect Control. 2001;29(1):32-40.
2. Hoshal VLJr. Total intravenous nutrition with peripherally inserted silicone elastomer central venous catheters. Arch Surg. 1975;110(5):644-646.
3. Barber JM, Booth DM, King JA, Chakraverty S. A nurse led peripherally inserted central catheter line insertion service is effective with radiological support. Clin Radiol. 2002; 57(5):352-354.
4. Cardella JF, Cardella K, Bacci N, Fox PS, Post JH. Cumulative experience with 1,273 peripherally inserted central catheters at a single institution. J Vasc Interv Radiol. 1996;7(1):5-13.
5. Robinson MK, Mogensen KM, Grudinskas GF, Kohler S, Jacobs DO. Improved care and reduced costs for patients requiring peripherally inserted central catheters: the role of bedside ultrasound and a dedicated team. JPEN J Parenter Enteral Nutr. 2005;29(5):374-379.
6. Lassen K, Christensen AH, Revhaug A, Lindsetmo RO. A completely nurse-driven PICC-line service in a surgical ward: a prospective audit of the implementation-phase in unselected patients. Clin Nutr. 2006;25(3): 541-542.
7. Gamulka B, Mendoza C, Connolly B. Evaluation of a unique, nurse-inserted, peripherally inserted central catheter program. Pediatrics. 2005;115(6):1602-1606.
8. Loughran SC, Borzatta M. Peripherally inserted central catheters: a report of 2506 catheter days. JPEN J Parenter Enteral Nutr. 1995;19(2):133-136.

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