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Review of Peripherally Inserted Central Catheters in the Singapore Acute-Care Hospital

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ABSTRACT

Peripherally inserted central catheters are frequently used whenever reliable central venous access is required for a prolonged period of time.

The objective of this study was to review utilisation profile, complication rates and outcomes of patients who were treated in our hospital with the therapy that required placement of the peripherally inserted central catheter.

We reviewed the medical records of all patients who had peripherally inserted central catheter placed between the beginning of July and the end of October 2002. Five patients who remained hospitalised at the time of review (six weeks after the last day of study period) were excluded. Seventy-eight patients with 94 peripherally inserted central catheters were analysed in detail. Sixty-four peripherally inserted central catheters (68.1%) were placed for prolonged antibiotic therapy, 27 (28.7%) mainly to administer total parenteral nutrition and 3 (3.2%) were inserted for other reasons. Catheters were in place before removal for a mean 17.2 days. Forty-eight catheters (51.1%) were removed after completion of therapy on average 20.2 days after insertion. Complications were frequent but minor. Thirty-three catheters (35.1%) were removed due to catheter-related complications. The most common complication were phlebitis followed by accidental removal.

In summary, peripherally inserted central catheters proved to be reasonably safe and a reliable way of providing therapy requiring prolonged intravenous access. Complications were frequent but relatively minor. Complication rates in our study were similar to those reported in other studies on this subject. Peripherally inserted central catheters remain a convenient and reasonable alternative to other centrally or peripherally inserted venous devices.

Keywords: peripherally inserted central catheter, catheter-related infection, central venous catheterisation

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INTRODUCTION

Multiple therapeutic agents, used in the acute care hospital, require reliable venous access for a prolonged period of time. Some of them like chemotherapy, total parenteral nutrition (TPN) or hypertonic solutions can be administered safely only through central venous access. Central catheters used in acute care hospitals can be classified into two types: central venous catheter (CVCs) and peripherally inserted central catheters (PICCs).

In our hospital approximately twenty-five PICCs are inserted each month. Popularity of such catheters is growing due to several advantages over other central venous catheters. The most important advantage is the safety of insertion and removal of PICC. Serious complications related to the insertion of PICC such as pneumothorax or hemothorax are exceedingly rare[1]. There are rare cases of minor bleeding but these usually stop with the application of local pressure. Because of this excellent safety record there are practically no contraindications for PICC placement.

In this study we wanted to review utilisation profile, complication rates and outcomes of patients who had PICC inserted in our hospital. Several previous studies evaluated patient populations with significant percentage of cancer patients receiving chemotherapy[2,3]. Since our hospital does not have an oncology department, all PICCs were inserted for indications other than chemotherapy. We also wanted to determine how our PICC utilisation compares to worldwide standards. It is the first local review of complications and outcomes of PICCs.

METHODS

Changi General Hospital is a 800-bed acute care, teaching hospital that provides a wide range of surgical and medical services. We reviewed case notes of 78 patients who had at least one PICC inserted between beginning of July and the end of October 2002. Fourteen patients had more than one PICC inserted. For characterising our patient population we used the

Table I. Prevalence of medical conditions associated with impaired immunity in the study population.

Condition	Number of patients (%)
Diabetes mellitus	27 (34.6%)
Malignancy	18 (23.1%)
Chronic renal failure	7 (9.0 %)
Liver cirrhosis	4 (5.1%)
Splenectomy	1 (1.3%)

Table II. Underlying infections requiring prolonged antibiotic therapy and the placement of the peripherally inserted central catheters.

Underlying infection	Number of catheters
Infection of the implanted orthopaedic device	14
Infective endocarditis	7
Surgical wound infection	6
Complicated skin and soft tissue infection	5
Complicated urinary tract infection	5
Osteomyelitis	5
Liver abscess	5
Melioidosis	5
Diabetic foot infection	4
Nosocomial pneumonia	2
Septic arthritis	2
Psoas muscle abscess	1
Cholangitis	1
Fever of unknown origin	1
Gram-negative bacteremia	1

Table III. Indications for the removal of the peripherally inserted central catheter. (CRBSI – catheter-related bloodstream infection)

Indication	Number of catheters (%)
Catheter-related (35.1%)	
• Phlebitis	20 (21.3%)
• Accidental removal	7 (7.4%)
• Definite CRBSI	1 (1.1%)
• Probable CRBSI	2 (2.1%)
• Occlusion	2 (2.1%)
• Catheter leakage	1 (1.1%)
Catheter-unrelated (64.9%)	
• Completion of therapy	48 (51.1%)
• Death	7 (7.4%)
• Patient request	3 (3.2%)
• Change in therapy	1 (1.1%)
• Undetermined	2 (2.1%)

number of the individual patients as the unit for counting. For all other calculations we used PICC placements rather than patients as the unit for counting. Single indication for insertion and single reason for removal was assigned to each PICC based on the review of clinical records.

All PICCs were inserted by the radiologist and the procedures were performed in the angiography suite. Seldinger's technique with standard aseptic precautions (mask, hat, sterile gowns, gloves and drapes) was routinely used. Accession vein frequently had to be localised by ultrasonography or venography. In our study, 38 insertions were guided by the ultrasonography and 25 by venography. The choice is based on the familiarity and confidence of the radiologist performing PICC placement. For the 31 PICC insertions, we could not determine if any imaging study was used to facilitate the PICC placement. Location of the tip of the catheter was always confirmed by the fluoroscopy and chest X-ray. Two types of PICCs are used in our institution: single-lumen (5-F) and double-lumen (6-F). Usually a radiologist decides which type of catheter will be used based on the indication for the PICC stated in the request form.

Nurses in the wards are instructed to change dressing daily and flush the catheter with heparinised saline three times a day. Drawing blood from the PICC for the laboratory tests is not allowed. We used the following definitions:

1. Phlebitis – induration or erythema, warmth, and pain or tenderness around catheter exit site[4].
2. Definite catheter-related bloodstream infection (CRBSI) – isolation of the same organism (identical species, antibiogram) from the catheter segment and the blood drawn from peripheral vein in the patient with clinical symptoms of BSI and no other apparent source of infection[5].
3. Probable CRBSI – Positive culture either from catheter segment or peripheral blood (in the patient with clinical symptoms of BSI and no other apparent source of infection) and defervescence within 48 hours of catheter removal and initiation of appropriate antibiotic therapy[5].

RESULTS

During the study period, 99 PICCs were inserted in 83 patients. We excluded five patients (five PICCs) who remained hospitalised at the time of review (six weeks after the last day of our study period). Therefore 94 PICCs in 78 patients were included into this analysis. During the study period twelve patients had two PICCs inserted and two patients had three PICCs inserted.

Average age was 58.3 (± 18.2) years (range 16 - 91). Eighteen patients (23.1%) were female and 60

patients were male (76.9%). Average hospitalisation lasted 44.5 (± 26.8) days (range 1 - 135). Twenty-seven patients (34.6%) had a history of diabetes mellitus and 18 patients (23.1%) were diagnosed with malignancy (Table I).

Sixty-four PICCs (68.1%) were placed for prolonged antibiotic therapy and 27 (28.7%) mainly to administer TPN. Three PICCs (3.2%) were inserted for other reasons. In two of these cases it was for palliative, analgesic therapy in patients with terminal malignancy. In one case PICC was inserted because of very difficult intravenous access in the patient with anasarca due to nephrotic syndrome.

Following specialties requested PICCs: Surgery – 35 (37.2%), Orthopaedics – 32 (34%), Medicine – 27 (28.7%). In fifteen cases (16%) the vein used for insertion of the PICC was not documented in the medical records. In the remaining 79 cases (84%) PICCs were placed in the following veins: basilar vein – 42 (53.2%), brachial vein – 15 (19%), cephalic vein – 13 (16.5%) and median cubital vein – 9 (11.4%).

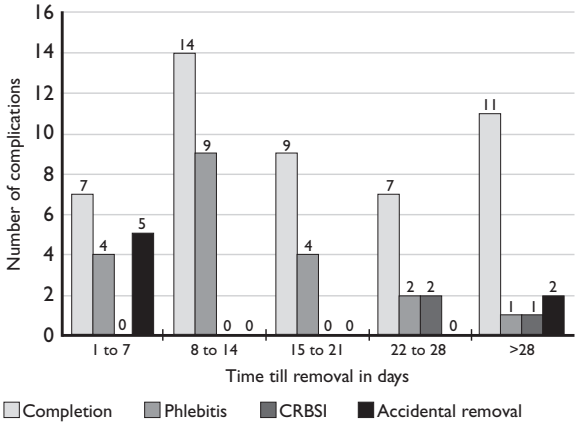
Surgical teams requested most of the PICCs inserted for the administration of the TPN (23 of the 27 catheters – 85.2%). They remaining four (14.8%) were requested by medical teams. Seventy-four of the PICCs (78.7%) were single-lumen catheters and 20 of them (21.3%) were double-lumen catheters. Double-lumen catheters were predominantly used for TPN (17 of 20). Sixty-four PICCs were inserted to administer antibiotics for the treatment of the variety of infections. Detailed description of underlying conditions which necessitate PICC placement are summarised in the Table II.

Eighty-five of the PICCs (90.4%) were removed before discharge. Nine patients were discharged with the PICC (9.6%) – four of them were transferred to another hospital and five continued intravenous therapy in outpatient setting. Seven patients died with the PICC in-situ. In none of them was PICC-related complication the cause of death. Five of these patients died because of advanced malignancy. Two patients refused surgical intervention (one for peritonitis and one for foot gangrene) and were treated conservatively. They died because of natural progression of the above-mentioned diseases.

On average the PICC was placed 22.5 days after admission (range 1 to 97 days).

Catheters were in place before removal for a mean 17.2 days (range 1 to 60 days, total 1,619 catheter-days). Removal of the catheter due to completion of the therapy occurred on average 20.2 days after insertion. If PICC was removed because of phlebitis it occurred after a mean of 14.2 days after insertion. Indications for removal of PICCs are summarised in Table III. Temporal distribution of the most common complications is presented in Fig. 1.

Fig. 1 Temporal distribution of the observed complications. (CRBSI – catheter-related bloodstream infection)



We observed one case of definite CRBSI. It occurred in a 52-year-old man with colon cancer who was treated with TPN and antibiotics for intestinal fistula. He developed sepsis and (other than the PICC) he had no apparent source of infection. The PICC was removed and Burkholderia cepacia was cultured from blood and the tip of catheter. He improved with the removal of the PICC and a course of ciprofloxacin.

Catheter tip was sent for culture after removal of 62 (66%) PICCs. Twenty-seven of these cultures (43.6%) were reported as no growth. Positive cultures grew following organisms: coagulase-negative staphylococcus – 8 (12.9%), methicillin-resistant Staphylococcus aureus (MRSA) - 6 (9.7%), Acinetobacter baumanii, Candida spp., Klebsiella spp., Pseudomonas aeruginosa – 2 (3.2%) each, Corynebacterium and Burkholderia cepacia – 1 (1.6%) each. In six cases (9.7%) culture yielded two different organisms and in five cases (8.1%) culture yielded three different organisms. PICCs used for TPN had slightly higher than average rate of phlebitis of 29.6% (vs. 21.3 % for a whole group) and lower than average rate of the catheter removal due to completion of the therapy 37% (51.1% for a whole group). Time to removal was 13.2 days and that was shorter than average dwell time for entire cohort (17.2 days).

DISCUSSION

Peripherally inserted central catheters have been used in clinical practice for several decades. Studies have shown that PICC is the safe and convenient way of administration of medications and parenteral hyperalimentation. In most of these studies a significant percentage of PICCs were inserted to facilitate the administration of the chemotherapy. Our hospital does not have an oncology department and all PICCs were inserted for indications other than chemotherapy. The most significant difference between our study

and other studies on this subject is the fact that almost all catheters in our review were inserted for the administration of antibiotics or TPN. The PICC offers some advantages over the traditional CVC[5]. It is much safer to place and it does not require tunneling or implantation via surgical procedure. In some institutions, PICCs are inserted by the registered nurses at the bedside[6,7]. PICCs are associated with a significantly lower rate of mechanical complications (hemothorax, pneumothorax) and are cheaper than CVCs. They are easier to maintain and have a longer dwell time compared to peripheral (or even some central) catheters. Since they are smaller and more comfortable than CVCs they allow early discharge and outpatient continuation of the therapy[8]. However, (as with any implantable intravenous device) their use is sometimes complicated by development of phlebitis, thrombosis or catheter-related bloodstream infections (CRBSI). Several reviews[9-11] and guidelines[4,5] for the prevention and the management of the catheter-related infections (CRI) were published up to date.

All complications related to PICC use observed in our study occurred after catheter insertion. Most of them were minor but frequently they necessitated the removal of the catheter. Every third PICC had to be removed because of complication. The most common complication was phlebitis followed by accidental removal. Dwell time of the catheters removed due to phlebitis was on average six days shorter than those removed due to completion of the therapy (14.2 vs. 20.2 days). We observed only one definite and two probable CRBSIs. Other studies of this clinical problem showed similar results. Lam et al[12] reported a mean time to removal of 14.1 days. In their study 46.7% of catheters were removed due to completion of therapy. They observed higher rates of leakage (8.9%) and occlusion (12.6%) but lower rates of phlebitis (2.2%). Walshe et al[2] observed that 39% of all PICCs were removed after completion of therapy and 32.8% of them were removed due to PICC-related complications. Mean time to removal in this study was 30 days. In another study Ng et al[1] reported the following rates: removal due to completion – 49.2% (411 of 835), removal due to PICC-related complication – 31.1% (260 of 835) and mean time to removal 40.2 days.

Results of our study showed that complication rates are similar but time to removal is shorter than in the above-mentioned studies. Even removal due to completion of therapy occurred earlier in our cohort than in the other studies. This is in part due to different study population. In the study conducted by Walshe et al, 93.7% of patients had underlying malignancy[2]. In these patients therapy of infections, pain management or chemotherapy may require much longer IV access. In the study by Ng et al[1] time to completion of therapy was longest in transplant and HIV-infected patients who also frequently required prolonged intravenous therapy. We did not have even a single patient with these pathologies in our cohort.

Another reason for early completion of therapy in our patients could be too fast decision to insert PICC. In our study seven patients completed the therapy and had catheter removed within seven days of insertion. In three of these patients primary indication for PICC was TPN and in four therapy with antibiotics. It seems possible that the decision to insert PICC was made too quickly and the procedure could have been avoided.

Complication rates were slightly higher and time to removal slightly shorter for the PICCs inserted for the administration of TPN. This was also observed in other studies[1,13]. Some authors found TPN administration to be a risk factor for the development of catheter-related infection[8].

We observed only one case of definite and two cases of probable CRBSI (total 3.3%). All three occurred relatively late (4th week or later). This compares favourably with the two above-mentioned studies. In these other studies researchers noted the incidence of CRBSI to be 7.4%[2] and 8.6%[1] respectively. It seems that CRBSI is a relatively late complication of PICC and our lower incidence is probably related to the shorter average dwell time[10].

As expected, the vast majority of PICCs removed because of phlebitis were sent for culture. To our surprise the majority of PICCs removed from asymptomatic and clinically stable patients after completion of prescribed treatment (34 of 48 or 70.8%) were also sent for culture. Frequently it was done on the day of discharge with no intention to act on positive culture result. In these cases culture result did not subsequently influence clinical management.

CONCLUSION

The main goal of our study was to collect clinical data, which would allow us to optimise utilisation of PICCs in our hospital. Based on this data we propose the following recommendations:

1. PICC should be considered in therapy of infections that require more than two weeks of intravenous antibiotics (e.g. infective endocarditis, melioidosis, osteomyelitis, liver abscess or infection of implanted orthopaedic device). It should be avoided whenever standard treatment protocol allows early switch to oral antibiotics or when routine treatment consists of a course of antibiotics of less than two-week duration.

2. Despite the higher than average rate of complications, PICC remains the most convenient way of administration of the TPN.
3. Routine flushing of PICC with heparinised saline three times a day probably contributed to the very low rate of thrombosis and catheter occlusion in our study. We think that this practice should be continued.
4. Catheter fragment should be sent for culture only when catheter-related infection is suspected. Routine culture of all removed catheters should be discouraged.

In summary PICC proved to be a reasonably safe and reliable way of providing therapy requiring prolonged IV access. Complications are frequent but relatively minor. Complication rates in our study were similar to these reported in other studies on this subject. The PICC remains a convenient and reasonable alternative to other centrally or peripherally inserted venous devices.

REFERENCES

1. Ng PK, Ault MJ, Ellrodt AG, Maldonado L. Peripherally inserted central catheters in general medicine. Mayo Clin Proc 1997; 72:225-33.
2. Walshe LJ, Malak SF, Eagan J, Sepkowitz KA. Complication rates among cancer patients with peripherally inserted central catheters. J Clin Oncol 2002; 20:3276-81.
3. Groeger JS, Lucas AB, Thaler HT, Friedlander-Klar H, Brown AE, Kiehn TE, et al. Infectious morbidity associated with long-term use of venous access devices in patients with cancer. Ann Intern Med 1993; 119:1168-74.
4. Mermel LA, Farr BM, Sherertz RJ, Raad II, O Grady N, Harris JS, et al. Guidelines for the management of intravascular catheter related infections. Infect Control Hosp Epidemiol 2001; 22:222-42.
5. Pearson ML. Hospital Infection Control Practices Advisory Committee. Guideline for prevention of intravascular device related infections. Infect Control Hosp Epidemiol 1996; 17:438-73.
6. Mazzola JR, Schott-Baer D, Addy L. Clinical factors associated with the development of phlebitis after insertion of a peripherally inserted central catheter. J Intraven Nurs 1999; 22:36-42.
7. Intravenous Nurses Society. Peripherally inserted central catheters. J Intraven Nurs 1997; 20:172-4.
8. Tokars JI, Cookson ST, McArthur MA, Boyer CL, McGeer AJ, Jarvis WR. Prospective evaluation of risk factors for bloodstream infection in patients receiving home infusion therapy. Ann Intern Med 1999; 131:340-47.
9. Raad I. Intravascular-catheter-related infections. Lancet 1998; 351:893-8.
10. Safdar N, Kluger DM, Maki DG. A review of risk factors for catheter-related bloodstream infections caused by percutaneously inserted, noncuffed central venous catheters: implications for preventive strategies. Medicine 2002; 81:466-79.
11. Mermel LA. Prevention of intravascular catheter-related infections. Ann Intern Med 2000; 132:391-402.
12. Lam S, Scannell R, Roessler D, Smith MA. Peripherally inserted central catheters in an acute-care hospital. Arch Intern Med 1994; 154:1833-7.
13. Smith JR, Friedell ML, Cheatham ML, Martin SP, Cohen MJ, Horowitz JD. Peripherally inserted central catheters revisited. Am J Surg 1998; 176:208-11.