Peripherally Inserted Central Catheters: Placement and Use in a Family Practice Hospital

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Background: **The peripherally inserted central catheter (PICC) is increasingly used in protracted intravenous therapy. The device has several advantages for family practice, but its use has been chiefly described in nursing and interventional radiology literature. We investigated the use of the PICC in a family practice teaching hospital.**

Methods: **Forty PICCs were inserted from 1993 to 1995 in 29 patients. Available records and radiographs were reviewed for indication, nature of placement attempts, indwelling time, PICC role in therapy, and attendant complications.**

Results: **Successful placement was achieved in 95 percent of instances requiring PICC use. Fluoroscopically guided placement, usually without venography, was found to be preferable to unguided bedside placement. In a few cases in which PICCs were placed, no other access was subsequently required to complete therapy. Few clinically serious complications were encountered. Most complications were related to placement at bedside.**

Conclusions: **Our experience supports the PICC as a minimally invasive, economical alternative for protracted intravenous therapy. Fluoroscopically guided placement was found preferable to unguided bedside placement. Physicians ordering or placing PICCs should understand fully how to assess placement. (J Am Board Fam Pract 1996; 9:235-40.)**

Introduction of the peripherally inserted central catheter (PICC) has widened the spectrum of alternatives for central venous access. Indications for placement include venous therapy that is ordinarily administered peripherally in patients in whom peripheral access is poor and all forms of central venous therapy traditionally given through large-bore catheters, except high-volume fluid resuscitation. The PICC is not suitable for frequent venous sampling or central venous monitoring.

Advantages of the PICC include its low cost, nonoperative insertion, low-maintenance longevity, and the variety of providers who can be credentialed to insert it. The PICC can be used in inpatient and home-care settings. Its advantages most specifically relevant to family practice are nonoperative insertion, low-maintenance longevity, and its use in the inpatient and outpatient settings.

We report the PICC placement and use experience of a 105-bed family practice teaching hospital and discuss the following issues: method of PICC placement, complications and their avoidance, and follow-up evaluation.

To date, these issues have been addressed chiefly in the nursing and interventional radiology literature.[1-8]

Methods

Forty PICCs were placed from 1993 through 1995. These devices, ranging in size from 3 to 6 French and all manufactured to 60-cm length, were obtained from GESCO, San Antonio, Tex, and Cook Incorporated, Bloomington, Ind. Placements were made in 29 patients. In some cases, patients received more than one PICC (multiple placements are summarized in Table 1). Patients

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Table 1. Summary of Multiple Peripherally Inserted Central Catheter (PICC) Placements.

Characteristics	Number
Total patients receiving PICCs	29
Total PICCs placed	40
Patients treated using different PICCs during separate disease recurrences	3
Patients treated using > 1 PICC during a single disease episode	7
Maximum number of PICCs in 1 patient	3

ranged in age from 14 to 73 years and had a mean age of 42 years at time of placement.

Twenty-four PICCs were placed at bedside without imaging guidance. Sixteen were placed under fluoroscopic guidance, including three with intravenous contrast venography to map available veins when none could be seen or palpated on physical examination.

Initial placements were performed by staff physicians in family medicine, general surgery, and diagnostic radiology, and by resident physicians in family medicine and nursing staff members who had formal training in PICC placement. In cases involving fluoroscopy, placement was accomplished by a team comprising a PICC-trained nurse and a general diagnostic radiologist.

Revisions of PICC placement were attempted in bedside-placement cases in which postplacement plain radiographs showed that initial placement was unacceptable. In cases of bedside placement in which immediate follow-up radiographs did not clearly show the PICC position, fluoroscopy was also used to localize the PICC tip.

Placement technique varied with device and site used (manufacturer's instructions are enclosed in PICC kits). The authors' preferred placement technique included obtaining informed consent, palpation or visualization of an antecubital vein, and sterile preparation of the puncture site. Venipuncture was performed using a needle in a peel-away sheath; the needle was then removed and a PICC inserted through the sheath. The PICC was advanced centrally with the aid of fluoroscopic observation. Once the central circulation was reached, the sheath was removed, and the PICC flushed and secured under a protective airtight dressing.

When no antecubital vein could be located by inspection, a small vein at the hand or wrist was cannulated with a small-gauge butterfly catheter, a tourniquet was placed proximally on the arm, and 20 to 30 cc of contrast medium (Omnipaque 300 contrast, Sanofi Winthop, NY) was injected to produce a venographic map of the upper arm. Venipuncture guided by fluoroscopy was then performed, and a PICC was inserted using the standard Seldinger technique. This method has previously been described in detail.[8]

After placement, two PICCs had leaks at or near the hub. These leaks were repaired with kits available from the manufacturers, and therapy was continued to conclusion.

Available records and radiographs were reviewed for PICC placement indication, method and site of placement, puncture number, PICC course and terminus, catheter indwelling time, role of PICCs in intravenous therapy prescribed, and complications.

A standard for acceptable PICC course and terminus was defined as a nonlooping, smooth catheter path from insertion to tip, with the tip lying in the region of the mid-superior vena cava and aligned in the direction of normal blood flow.

Results

PICC use in our series was principally indicated for antibiotic therapy and parenteral nutrition. No PICCs were placed for cancer chemotherapy. Indications in our series are listed in Table 2.

Of the 24 PICCs inserted at bedside without guidance, 16 (67 percent) were acceptably placed

Table 2. Diagnoses Indicating Peripherally Inserted Central Catheter (PICC) Use.

Diagnosis	Number of Occurrences
Pancreatitis	12
Osteomyelitis	7
Diverticulitis	3
Other infections	3
Pain control	2
Hyperemesis	1

Table 3. Sites of Bedside Peripherally Inserted Central Catheter (PICC) Misplacements.

Site	Number
Intracardiac terminus	3
Jugular terminus	2
Coiled, external or internal jugular	1
Coiled, axilla	1
Subclavian terminus	1

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as shown by initial follow-up radiograph. PICC position was established by plain radiographs in 14 of these cases; the other 2 required fluoroscopy to establish tip position.

Eight of 24 bedside placements (33 percent) did not meet our standard for correct initial placement. These misplacements are described in Table 3. Five of these 8 were successfully revised under fluoroscopy, and 1 of 8 was accomplished with simple unguided retraction. In the remaining 2 no revision was attempted. Thrombosis had already occurred in one case. In the other, placement was in the axillary vein; tonicity of the therapeutic agents was reduced and therapy proceeded.

Sixteen of 18 PICC insertions that were attempted with fluoroscopy resulted in satisfactory placement. In the 2 unsuccessful attempts, PICCs were inserted in a vein but could not be freely advanced through the proximal upper arm. In 1 of these 2 attempts, successful fluoroscopic-guided placement followed immediately by means of an alternative venipuncture site, for an overall fluoroscopic-guidance placement rate of 16 of 17 cases (94 percent). The other unsuccessful attempt using fluoroscopy was discontinued after successful initial venipuncture, because venous access did not prove durable. Multiple other peripheral venipunctures had similar outcomes in this patient.

Table 4. Location of Peripherally Inserted Central Catheter Placements.

Location	Number	Percent
Right arm	20	50
Left arm	18	45
Right external jugular	2	5

Table 5. Role of Peripherally Inserted Central Catheter (PICC) as Means of Access.

Access Type	Number	Percent
PICC only	27	82
PICC and large-bore catheter	3	9
PICC and peripheral intravenous lines*	2	6
No follow-up	1	3

*Excludes cases in which an initial peripheral intravenous line was placed but discontinued within 72 hours.
Note: 33 courses of therapy were given via PICC; 3 of 29 patients treated had recurrent disease.

Table 6. Complications Resulting from Peripherally Inserted Central Catheter Placement.

Complication	Number	Comments
Initial misplacement	8	None
Accidental removal	4	None
Thrombosis	2	None
Catheter leak	2	Repaired
Dysrhythmia	1	Resolved with repositioning
Catheter fracture	1	At hub, upon placement as guide wire was withdrawn from catheter. Catheter had not been preflushed
Catheter dysfunction	1	On last day of therapy; catheter withdrawn without incidence

Four of the 18 placements attempted with fluoroscopy involved venographic mapping. Three succeeded; the other was the above-described case in which access did not prove durable. An average of 1.37 venipunctures per PICC placed was required in the cases in which venipuncture number was recorded. Location of placement is summarized in Table 4.

PICCs were the only means of access in a majority of cases. Table 5 summarizes cases in which both PICCs and other means of access were used. PICCs replaced large-bore catheters in two cases; in only one case was a large-bore catheter required to replace a PICC.

Catheter indwelling time ranged from 2 to 76 days, with wide variation relating to placement indication. In a number of cases, exact date of discontinuation was not recorded. Typical therapy courses for total parenteral nutrition and osteomyelitis-directed antibiotics were 2 and 6 weeks, respectively.

Complications encountered are displayed in Table 6; most were related to initial placement. We experienced no entry-site or catheter-related infections.

Discussion

Of 41 instances in which PICC placement was requested, satisfactory final venous access was obtained in 39 (95 percent). We compared this experience with that of Cardella et al,[7] who reported 98.7 percent PICC central placement success using contrast venography in a study of 155 patients. This rate was achieved by the inter-

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ventional radiology service of a tertiary-care teaching hospital.

In our series only 16 of 24 PICCs (67 percent) placed without fluoroscopic guidance were acceptable. This rate compares with a 74 percent success rate for similar unassisted placements among 150 patients also reported by Cardella and co-workers.[7]

While revision of the catheter placement was successful in almost all initially unacceptable bedside efforts, we believed our best placement option was to use fluoroscopy from the outset. This approach attained 94 percent overall success, eliminated the need for repeated films and additional views, and saved much time spent coordinating clinicians' and radiologists' efforts to read and act on results of postplacement radiographs. Most importantly, by using fluoroscopy, we eliminated the risk of dangerous misplacement. Misplacements have been associated with increased frequency of thromboses, dysrhythmias, and other complications.[2-5]

When bedside placement is performed, the responsible clinician must be able to recognize placement error or know when to obtain assistance. PICC placement is seldom emergently required, and a radiologist is usually available to assist. If a radiologist is not available, however, the clinician must be able to recognize a coiled or otherwise misdirected catheter despite easy passage and initial adequate catheter function. Correlation of the perceived PICC tip location on follow-up radiographs with the expected tip location based on the length of catheter introduced is necessary to avoid outcomes in which, for example, the catheter appears to end appropriately in the superior vena cava but is actually intracardiac, or in which the catheter appears to terminate too peripherally but is actually well-placed centrally. In such cases we have observed that posteroanterior and lateral chest radiographs will often yield more information than anteroposterior portable images. If posteroanterior and lateral views do not confirm the location or cannot be obtained, a contrast medium can be introduced in the PICC to improve its visibility or fluoroscopy can be used.

Although we found fluoroscopically guided placement preferable to that at bedside, we have not found an indication for routine use of intravenous contrast venography in PICC insertion. This technique has been reported with high rates of success.[7] In some centers intravenous contrast venography is used for all PICC placements. Emphasis has been placed on its value for proximal upper arm placement (usually the basilic or cephalic vein) in patients with very poor access more distally.[7,8] We found it necessary in only 3 of 40 placements (8 percent), possibly because of better antecubital access in our patient population. Placement without venography obviates both the additional venipuncture(s) at hand or wrist required for venography, unless the patient has a preexisting intravenous line, and the expense and administration of intravenous contrast medium.

Once placement is confirmed, our experience suggests no indication for further follow-up radiographs. As has been discussed in other reports, follow-up chest radiographs are appropriate when catheter-related complications are suggested by patient complaints such as arm pain, edema, dyspnea, or palpitations or if there is evidence of catheter migration, partial withdrawal, or malfunction.

Results obtained in our work are also similar to those of tertiary care institutions on the role of the PICCs in intravenous therapy. In one report 100 percent of patients receiving a PICC were treated by PICC only.[7] Eighty-two percent of our cases have been treated with PICC alone. PICCs have played an important role in every case in which they have been required for our patients.

Complications, except those related to bedside misplacement, have been few. Complications of clinical importance were both axillary or subclavian venous thromboses, which were diagnosed clinically and confirmed sonographically. One occurred idiopathically 7 days after fluoroscopically guided insertion through the right antecubital fossa and cephalic vein. Upon diagnosis, a new PICC was inserted contralaterally, anticoagulation therapy was begun, and the patient's antibiotic therapy was completed without further incident.

In our other instance of thrombosis, bedside placement resulted in complex PICC coiling in the left axilla (Figure 1). This misplacement was not adequately corrected because the PICC was described as having "advanced easily and functioned well"—necessary but insufficient conditions for satisfactory placement.[3] Thrombosis ensued within 1 day and the PICC was removed;

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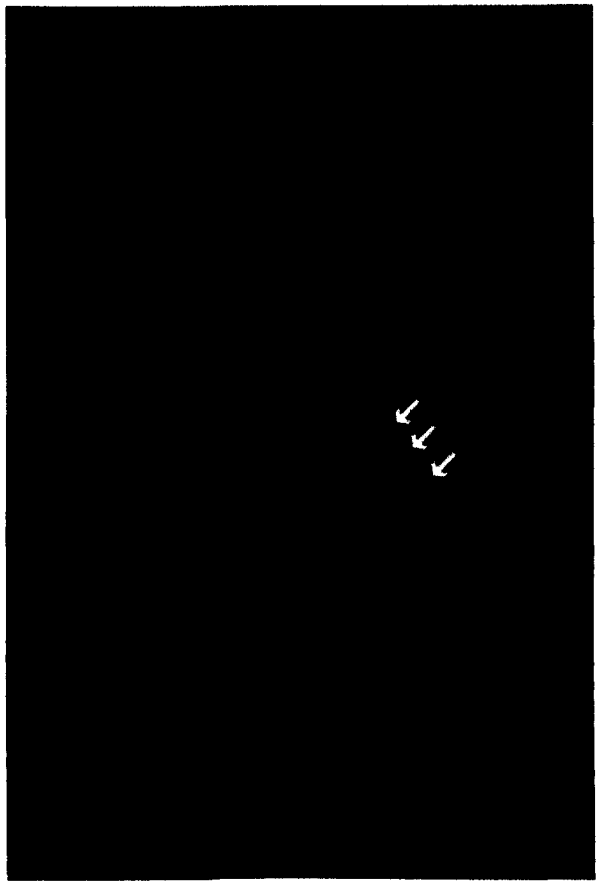

Figure 1. Initial chest radiograph obtained immediately postplacement shows complex PICC coiling in the axilla. Symptomatic thrombosis ensued within 24 hours (catheter course indicated by white arrows).

however, the patient, who was admitted for pancreatitis, was not prescribed anticoagulants because of the risk of hemorrhage. Her thrombosis resolved spontaneously. This complication occurred relatively early in our experience and was the chief factor in our decision to offer fluoroscopic placement guidance.

Complications occurring in our series have also been reported in previous work.[5-7] Other reported complications have included catheter fracture, migration, infection, and pulmonary embolus. Our case number is not large enough to judge relative complication frequency, but we underscore the avoidable complications of misplacement and accidental removal. Accidental removal can be minimized by secure dressing or by suturing the catheter to skin; patient and staff education is also necessary, particularly in settings where PICC use is new. Misplacement can be avoided by using fluoroscopy.

We report no infection-related complications, probably because of a healthier patient population and shorter indwelling times than those reported elsewhere.[2] We also credit the clinical nursing staff's rigid adherence to infection control measures when working with PICCs. These measures have been described in several reports.[1-3,5] Similarly, close nursing service involvement in initial patient education and follow-up care has limited problems with catheter dysfunction.

Extension of our results to settings involving cancer chemotherapy or other immunosuppressive procedures is not yet possible. Peripheral venous access in these patients is difficult, and they are clearly at higher risk for infection-related problems. Although such patient populations have been treated using PICCs,[7] we recommend large-bore or implantable devices because they require frequent venous sampling.

Conclusions

Our experience supports using the PICC in the family practice hospital because it is a minimally invasive, economical alternative to the large-bore catheter or implantable port.

The PICC can be placed at bedside or with fluoroscopy. The latter offers a single-step procedure and eliminates the considerable risk of misplacement at bedside. Venography was rarely necessary for placement in our series unless a suitable vein could not be found on inspection. When venography is needed, it can usually be done on a general radiology service with fluoroscopy; usually no special intervention capability is required. If bedside placement is planned to minimize cost or for other reasons, the physician must promptly and accurately assess placement and, when necessary, revise it.

Once placed, the PICC will serve with few complications if secured, dressed, and flushed correctly.

We strongly recommend that physicians considering PICCs review in advance literature on techniques for placement and maintenance.[2,3,5-8] We also recommend that manufacturers' instructions, which we have found to be very clear, be closely followed.

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References

1. Roundtree D. The PIC catheter: a different approach. Am J Nurs 1991;91:23-6.
2. Goodwin ML, Carlson I. The peripherally inserted central catheter: a retrospective look at three years of insertions. J Intraven Nurs 1993;16:92-103.
3. Ryder MA. Peripherally inserted central catheters. Nurs Clin North Am 1993;28:937-71.
4. Longely DG, Finley DE, Letourneau JG. Sonography of the upper and jugular veins. AJR Am J Roentgenol 1993;160:957-62.
5. James L, Bledsoe L, Hadaway LC. A retrospective look at tip location and complications of peripherally inserted central catheter lines. J Intraven Nurs 1993;16:104-109.
6. Lum PS, Soski M. Management of malpositioned central venous catheters. J Intraven Nurs 1989;12:356-64.
7. Cardella JF, Fox PS, Lawler JB. Interventional radiologic placement of peripherally inserted central catheters. J Vasc Interv Radiol 1993;4:653-60.
8. Andrews JC, Marx MV, Williams DM, Sproat I, Walker-Andrews SC. The upper arm approach for placement of peripherally inserted central catheters for protracted venous access. AJR Am J Roentgenol 1992;158:427-9.

ABFP Announcement

Policy Statement Regarding Changes in Reciprocity Agreements

The Board of Directors of the American Board of Family Practice has made a decision that eligibility to sit for the American Board of Family Practice Certification Examination through reciprocity will be available only to physicians who have satisfactorily completed formal training in family practice.

After the July 1998 examination, physicians will not be allowed to sit for the ABFP examination via the reciprocity route unless they have completed formal training accredited by a nationally recognized accrediting organization within the country in which they are certified. Applications will have to be satisfactorily completed by February 1, 1998. This means that Canadian applicants who have not completed a residency will have to have resided in the United States prior to August 1, 1997.

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