# The use of peripherally inserted central catheters in intensive care: should you pick the PICC?

**R Tan, D Knowles, C Streater, AJ Johnston**

Peripherally inserted central catheters (PICCs) are useful routes for intermediate central venous access; however, there is a paucity of data regarding their use in the intensive care setting. We have been using PICCs on our ICU since 2006 and have undertaken a retrospective audit of all PICC use during one year to define complication rates. PICCs were inserted by a dedicated vascular access team (VAT). Microbiology and radiology databases were used to assess rates of line-related bacteraemias and catheter misplacements. Blockage rates were collected from VAT records. Data was available on 116 PICCs, corresponding to 1,558 line days. The median duration of placement of PICCs was 9 days (range 0-100) *in situ* with a misplacement rate at insertion of 12.1%. The catheter-related blood stream infection rate was zero. The blockage rate was 29.5/1,000 line days; 87% of these blockages were cleared using urokinase. We believe that PICCs can be safely used in intensive care patients.

***Keywords:*** *central venous catheterisation; peripheral catheterisation; critical care; complications*

## Introduction

Critically ill patients in the intensive care unit (ICU) commonly require venous access. In the acute setting, this is often a non-tunnelled central venous catheter (CVC) inserted into one of the central veins. However, these CVCs are not designed for long-term use (more than 1-3 weeks)[1] and they have a relatively high complication rate at insertion and while *in situ*. Once acute organ failure is resolving and patients are no longer requiring central venous pressure monitoring or multiple infusions, then alternative means of venous access are often sought. Peripheral cannulae can be used, but these are often limited by tissue oedema, multiple previous cannulation attempts, and the need for frequent phlebotomy. Furthermore, UK guidelines dictate that these cannulae are resited routinely every 72-96 hours, or earlier if clinically indicated.[2]

Peripherally inserted central venous catheters (PICCs) are a valuable route for short to intermediate-term central venous access. They have the advantage of being relatively simple to insert at the bedside under local anaesthesia, they are comfortable for the patient, and they have a relatively low complication rate.[3] While PICCs have been used extensively on general wards and in outpatients for several years, their use in the ICU setting has only recently been explored and there remains a paucity of data regarding insertion techniques and complication rates.[3]

The ICU at Addenbrooke's hospital is a 14-bed unit which admits over 800 patients per year from a variety of specialties. The ICU started using PICCs in 2006 in patients who were recovering from their acute illness but whom still required venous access. Since then their use in the ICU has dramatically increased, with a recent audit (July-December 2007) showing that 25% of central lines placed in ICU are PICCs. This represents a major change to our clinical practice and so we decided to survey all PICCs over a 12 month period to define baseline data and complication rates (PICC-related bacteraemias, misplacement rates and adverse line events) and to inform future directions.

## Methods

Vascular access requirements are assessed on all ICU patients on a daily basis using the Cambridge 'Required, Appropriate, Infected, Dressed' (RAID) assessment (see **Figure 1**). When a PICC is felt to be necessary by the intensive care consultant, the patient is referred to the vascular access team (VAT), a team of specially trained specialist nurses.

The VAT place PICCs on the ICU into one of the upper arm veins (usually basillic), with the patient supine and the arm abducted, using a Seldinger microintroducer split-sheath technique (Vygon, Cirencester, UK) under local anaesthesia and with ultrasound control. The PICCs are either 4 Fr single lumen or 5 Fr dual lumen Groshong lines (Bard, NJ, USA), depending on clinical need. During the insertion, the patient places their head on the ipsilateral shoulder to aid correct placement, and any resistance to insertion is overcome by redirection of the catheter, or by flushing the line during insertion. After insertion, the PICC is X-rayed to confirm a correct position (defined as being in the superior vena cava or at the superior vena cava/right atrium junction) and is then

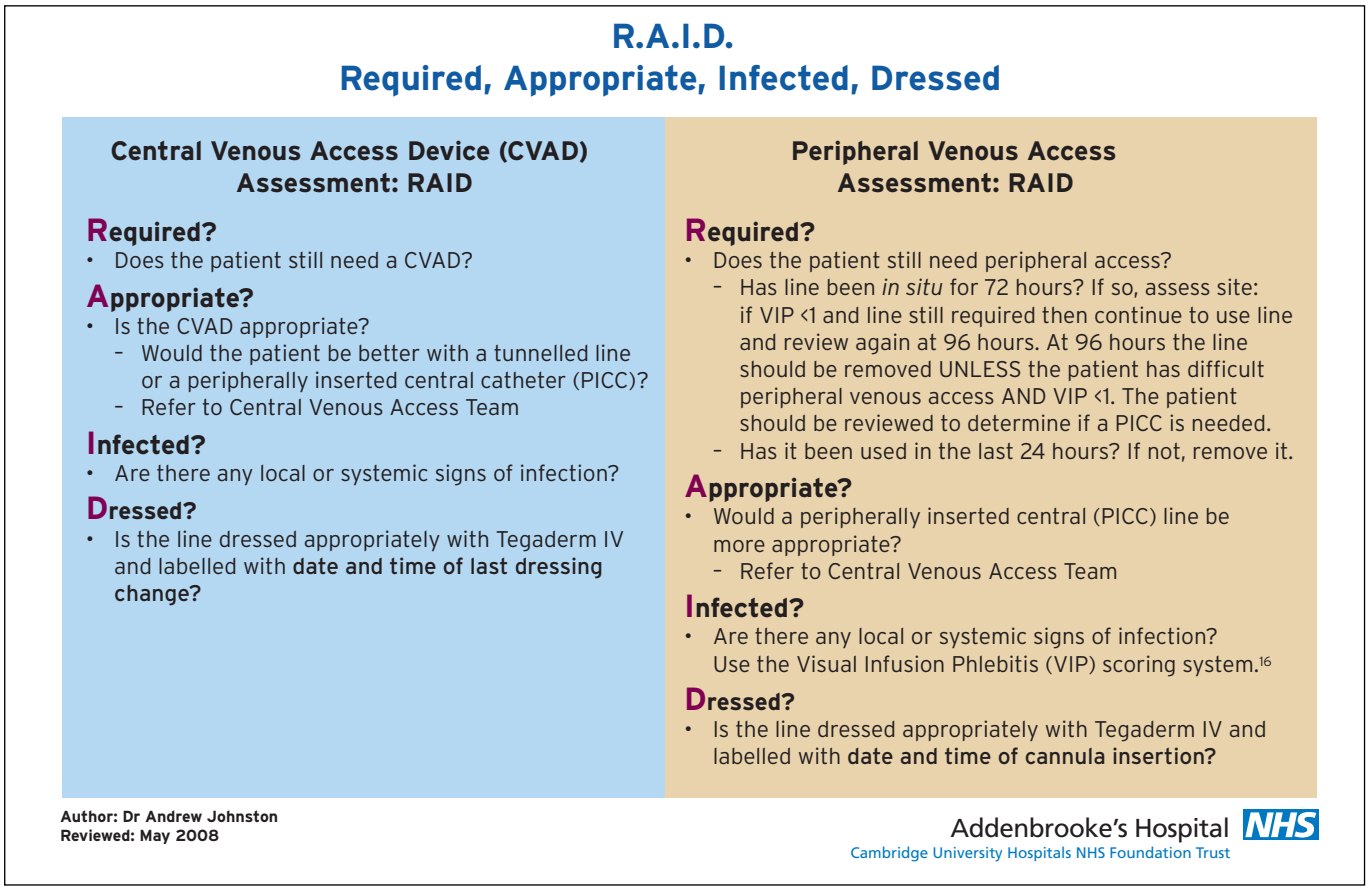


**Figure 1** Cambridge RAID assessment.

cared for using recommendations from the UK Department of Health Saving Lives – High Impact Interventions.[2] All PICC placements are documented by the VAT and registered on the hospital-wide CVC audit, and ongoing care of the line is documented on a daily basis by the nursing staff.

A retrospective data collection was carried out, identifying all ICU patients who had PICCs inserted during the period April 2007 to March 2008. This period was chosen because initial start-up issues had been resolved and staff were used to requesting and caring for PICCs by this time. The audit was registered with the hospital audit department according to Trust policy. These patients were then cross-referenced with VAT databases, hospital microbiology and radiology databases to determine:

1. PICC insertion date and removal date.
2. Position of PICC on chest X-ray (CXR). Correct position was defined as the PICC tip being in the superior vena cava (SVC) or at the junction between the SVC and right atrium. CXRs were assessed by two independent observers, a radiologist and an ICU doctor.
3. PICC adverse line events. Adverse events were categorised as either blockages that were cleared with urokinase, blocked lines which remained blocked despite urokinase and therefore required removal and re-siting, and leaking lines which required line removal and re-siting.
4. Line-related bacteraemias, as defined by:
   - Positive blood culture and positive line tip (Maki semi-quantitative method) with the same organism
   - Positive blood culture within two days of a positive line tip, or positive line tip within one week of a positive blood culture.

## Results

### Number of lines placed

A total of 140 PICC lines were inserted over 12 months; one other PICC insertion was attempted but was not possible. This is an insertion success rate of 99.3%. All PICCs were placed into one of the upper arm veins under ultrasound control.

### Duration of line placement

There were no data on duration of line placement for 24 of these lines, therefore line duration data is based on data from 116 lines. The total number of line days for these lines was 1,558. The median duration of PICCs was 9 days, range 0-100 days.

Lines that were only *in situ* for 0-1 days were assumed to represent misplaced/failed lines and after removing these data from the analysis (17 data sets – 12 lines in for 0 days and 5 for 1 day), the adjusted median PICC duration was 13 days, range 2-100 days (**Figure 2**).

### Misplacement rates

Misplacement data were available on 124 lines. Fifteen lines were misplaced, with 11 lying in the internal jugular vein; this is an overall 12.1% misplacement rate and a rate of internal jugular misplacement of 8.9%.

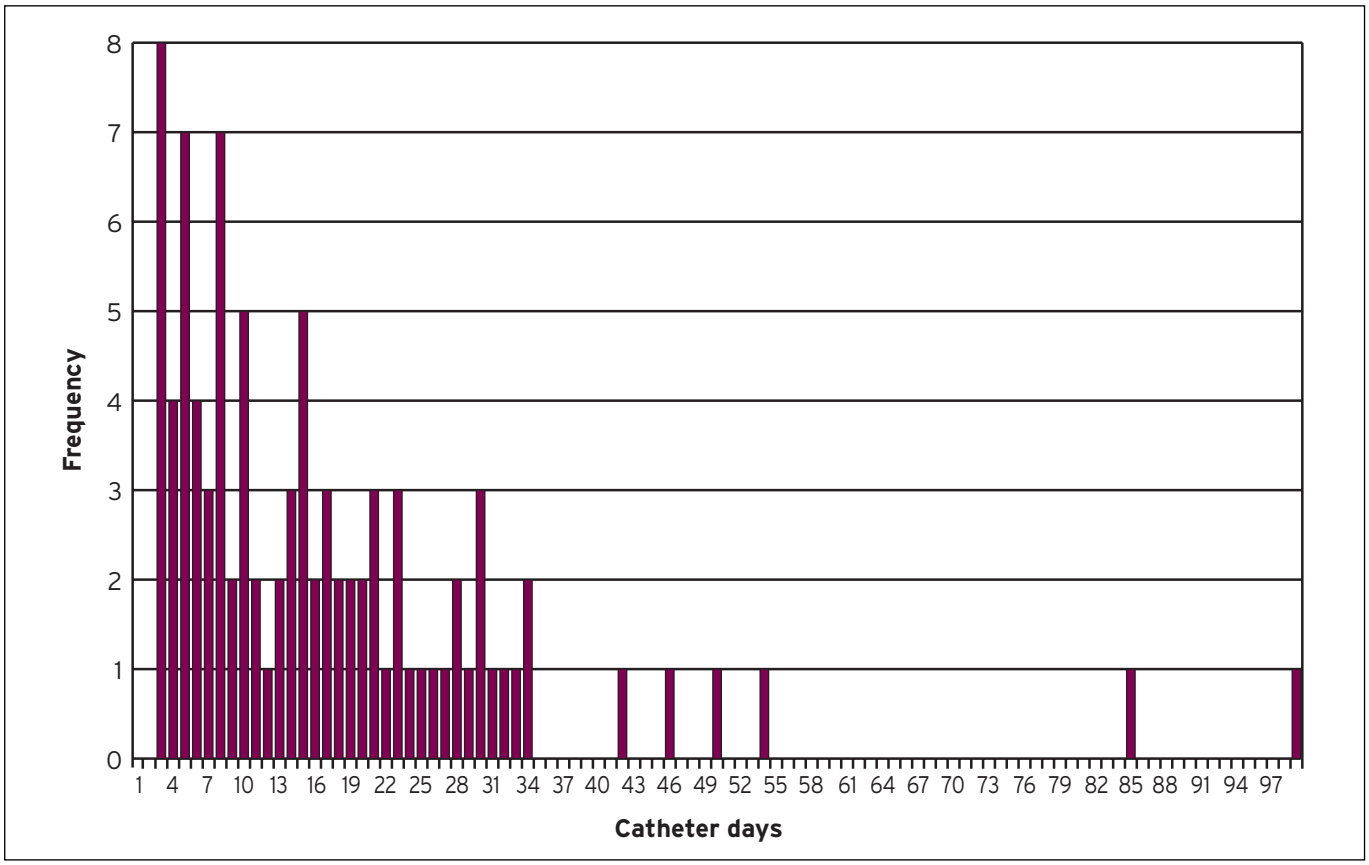


**Figure 2** The distribution of PICC line days – PICCs that were only *in situ* for 0-1 days have been removed from the data (see text).

### Infection rates

No lines in this audit fulfilled our criteria for a catheter-related bloodstream infection.

### Adverse line events

Adverse line events were categorised as either blockages that were cleared with urokinase (40 cases), blocked lines that remained blocked despite urokinase and therefore required removal and re-siting (6 cases), and leaking lines that required line removal and re-siting (2 cases).

There were 29.5 blockages/1,000 line days, and an adverse line event incidence of 30.8 per 1,000 line days.

## Discussion

Most ICU patients require some form of venous access, but their requirements and the most suitable form of access alters as the patient's condition changes. In the acute setting, short-term catheters can be inserted directly into one of the central veins to allow multiple infusions and central venous pressure monitoring; however, these have a relatively high incidence of infection (about 2.7/1,000 catheter days),[4] a relatively high complication rate, are often uncomfortable for the patient, and cannot normally be left *in situ* for more than 1-3 weeks.[1] Once the acute problems have resolved, and the patient's vascular access requirements have altered, short-term peripheral cannulae or tunnelled lines can be inserted, but both of these techniques have disadvantages. PICCs have many features that are potentially advantageous to the ICU patient; they are relatively easy and comfortable to insert, they provide access to the central circulation, they have a relatively low incidence of infection, and can potentially be left *in situ* for many weeks. Despite these potential advantages, there is a paucity of data in the literature regarding their use in ICU.

The use of ultrasound to guide the insertion of PICCs is a well recognised technique with a cannulation success rate of approximately 94.6%.[5,6] However, as far as we are aware, this technique is not widely practised in intensive care. The use of ultrasound for cannulation is potentially advantageous in ICU patients who are oedematous, have often had multiple previous cannulations, and whose veins are often difficult to palpate. One earlier study of PICCs in ICU that did not use ultrasound reported an insertion success rate of 97.8%; however, 28% of these insertions required a cut-down technique.[3]

Our cannulation success rate of 99.3% using ultrasound is very encouraging. Another advantage of using an ultrasound-guided insertion technique is that veins in the upper arm, away from the antecubital fossa, can be accessed. It is our experience that these veins allow a much more secure and comfortable PICC fixation.

PICC misplacement is a relatively common complication and we report an overall misplacement rate of 12.1%, which is consistent with reports of correct positioning in 44-99% of PICC insertions.[7-12] One recent paper reported a misplacement rate of 62.9% after blind PICC insertion[13] and a misplacement rate of 7.9% has been reported in ICU

patients.[3] In ventilated patients, the effects of inspiration and negative intrathoracic pressures on venous flow are disrupted and this may lead to an increase in PICC misplacement rate. Indeed, it is our observation that in spontaneously breathing patients PICCs that are misplaced into the internal jugular vein may drop down into the correct position within 24 hours of insertion. The rate of internal jugular vein misplacement in our series (8.9%) is consistent with other studies.[13]

Catheter-related bloodstream infections are an important cause of morbidity and mortality with long-term indwelling central venous catheters. PICCs are thought to have a relatively low incidence of infection with one systematic review quoting an infection rate of 2.1 per 1,000 catheter days in hospitalised patients.[4] This rate is much higher than with PICCs used exclusively in the outpatient setting (approximately one per 1000 catheter days). In our audit we found no PICC-associated bacteraemias; there are a number of possible reasons for this low rate. Firstly, we have a well developed team of expert specialist nurses (the VAT) who insert the PICCs and who have developed strategies for expert care of the lines post insertion based on epic2 guidelines. These strategies include the use of 2% chlorhexidine in 70% alcohol, an aseptic no-touch technique for accessing the line, the use of needleless injection posts, daily inspection of the line site, and weekly dressing changes. Secondly, it is our belief that insertion into veins above the antecubital fossa allows for easier fixation and stabilisation of the line, which may contribute to a reduced infection rate.

The policy in our hospital is that line tips are only sent for microbiological assessment if there is a suspected line infection. For this reason we are unable to make any comment about line colonisation rates.

There are little data in the literature about adverse line events and so comparisons are difficult; however, our adverse line event rate of 30.8/1,000 catheter days and blockage rate of 29.5/1,000 catheter days provides data that can be used to inform future studies. By far the most common problem was a blocked lumen and in the majority of cases (87%) this could be fairly simply resolved using urokinase.

PICCs are associated with a recognised incidence of venous thrombosis (23.3-38%) and venous stenosis (7.5%) and therefore their use should be avoided in patients who are likely to require long-term renal support.[14,15]

We believe that PICCs offer an advantage over centrally inserted central venous catheters in the ICU recovery phase. They provide a safe and comfortable route for short to intermediate-term central venous access and are associated with a low rate of infection when inserted and cared for correctly. Further work is needed to fully define adverse line events and to inform future studies.

## References


1. **Pratt RJ, Pellowe CM, Wilson JA *et al.*** epic2: National evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. *J Hosp Infect* 2007;65 Suppl 1:S1-64.
2. **Department of Health.** Saving Lives: reducing infection, delivering clean and safe care. London; DH: 2007.
3. **Ng PK, Ault MJ, Maldonado LS.** Peripherally inserted central catheters in the intensive care unit. *J Intensive Care Med* 1996;11:49-54.
4. **Maki DG , Kluger DM, CJ Crnich DM.** The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published prospective studies. *Mayo Clin Proc* 2006;81:1159-71.
5. **Parkinson R, Gandhi M, Harper J, Archibald C.** Establishing an ultrasound guided peripherally inserted central catheter (PICC) insertion service. *Clin Radiol* 1998;53:33-36.
6. **Nichols I, Humphrey JP.** The efficacy of upper arm placement of peripherally inserted central catheters using bedside ultrasound and microintroducer technique. *J Infus Nurs* 2008;31:165-76.
7. **James L, Bledsoe L, Hadaway LC.** A retrospective look at tip location and complications of peripherally inserted central catheter lines. *J Intraven Nurs* 1993;16:104-09.
8. **Neuman ML, Murphy BD, Rosen MP.** Bedside placement of peripherally inserted central catheters: a cost-effectiveness analysis. *Radiology* 1998;206:423-28.
9. **Deitel M, McIntyre JA.** Radiographic confirmation of site of central venous pressure catheters. *Can J Surg* 1971;14:42-52.
10. **Johnston AO, Clark RG.** Malpositioning of central venous catheters. *Lancet* 1972;2:1395-97.
11. **Bridges BB, Carden E, Takacs FA.** Introduction of central venous pressure catheters through arm veins with a high success rate. *Can Anaesth Soc J* 1979;26:128-31.
12. **Ragasa J, Shah N, Watson RC.** Where antecubital catheters go: a study under fluoroscopic control. *Anesthesiology* 1989;71:378-80.
13. **Venkatesan T, Sen N, Korula PJ *et al.*** Blind placements of peripherally inserted antecubital central catheters: initial catheter tip position in relation to carina. *BJA* 2007;98:83-88.
14. **Allen AW, Megargell JL, Brown DB *et al.*** Venous thrombosis associated with the placement of peripherally inserted central catheters. *J Vasc Interv Radiol* 2000;11:1309-14.
15. **Gonsalves CF, Eschelman DJ, Sullivan KL *et al.*** Incidence of central vein stenosis and occlusion following upper extremity PICC and port placement. *Cardiovasc Intervent Radiol* 2003;26:123-27.
16. **Jackson A.** Infection control – a battle in vein: infusion phlebitis. *Nurs Times* 1998;94:68,71.



**Robert Tan** Speciality Trainee, John Farman Intensive Care Unit

**Daniel Knowles** Speciality Trainee, John Farman Intensive Care Unit

**Carmel Streater** Specialist Nurse Manager, Vascular Access Team

**Andrew J Johnston** Consultant in Intensive Care
andrew.johnston@addenbrookes.nhs.uk

Addenbrooke's Hospital, Cambridge