Peripherally Inserted Central Catheter Experience in Long-Term Home Parenteral Nutrition Patients

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Abstract
Parenteral nutrition is administered through a central venous catheter (CVC). Peripherally inserted central catheters (PICC) are appropriate for home parenteral nutrition (HPN). The objective of this study was to examine a group of HPN patients with a PICC in place for more than six months, and the complications associated with PICC removal. Medical records from one home infusion pharmacy were retrospectively reviewed for PICC characteristics and complications leading to removal. Nineteen adult HPN patients had 26 PICC placements. Total PICC days were 22,262 with a mean of 856 (265-2500) days. Seven PICCs were in place for 3 to greater than 5 years. The overall complication rate was 0.58/1000 CVC days. Catheter related bloodstream infection (CRBSI) was the main cause of PICC removal. There was no evidence of symptomatic thrombosis. Patients experienced no infusion related complications. The PICCs were 88% polyurethane, 65% double lumen, and 54% were 5 Fr. No patient received alcohol or antibiotic lock therapy, and 8 patients had successful alteplase administered at least one time. All patients needed caregiver assistance for site care and dressing changes, but were independent in HPN infusion and flushing. This group of patients demonstrated that PICCs are a viable option HPN administration. The PICC overall complication rate was very low, and the most frequent complication leading to removal was CRBSI. The infection rate of 0.36/1000 CVC days is considered very low in an HPN population. This is the only HPN infusion study to date reporting 7 PICCs lasting 3 or more years, with 2 lasting greater than 5 years without complications resulting in removal. Patients received their prescribed therapy reliably and without interruption with this device. Larger studies are needed to confirm the efficacy of maintaining a PICC for very long-term HPN administration.

Keywords: Home Parenteral Nutrition, PICC, CVC complications

Background
Parenteral nutrition is administered through central venous catheters (CVCs). Devices typically used for infusion of long-term home parenteral nutrition (HPN) in patients with intestinal failure include tunneled catheters, infusion ports, and peripherally inserted central catheters (PICCs). These devices are often referred to as a patient’s lifeline. Successful HPN administration is dependent upon maintaining the CVC for many years without complications that lead to removal. These complications include catheter-related bloodstream infection (CRBSI), localized site and pocket infections, thrombotic and occlusion events, and CVC malfunctions.

A PICC is considered a device appropriate for therapy of any duration, and may remain in place for many months. Tunneled CVCs or infusion ports have a potential lifespan of many years. Often, PICCs are inserted when HPN is initiated before hospital discharge, with a plan for eventual replacement with a permanent device after a patient requiring HPN is stable in the outpatient setting. The Sustain Registry, a research database created to collect outcomes on patients requiring HPN in the United States, reported that the majority of the 292 adults in this registry used a PICC to administer their HPN. In practice, patients requiring HPN often have PICCs that remain in place for months to years.

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The objective of this study was to examine a group of patients requiring HPN with a PICC in place for more than 6 months, and the complications associated with PICC removal.

Methods
Permission was obtained from 1 home infusion pharmacy to conduct a retrospective review of medical records from January 2005 to April 30, 2016, for PICC insertion date, duration of access, material type and size, and complications leading to removal. PICCs in place for >6 months were included. Data collection also included patient age, gender, diagnosis, HPN solution, volume and cycle, use of lock and anticoagulation therapies, PICC tip location, and caregiver identification.

Results
Nineteen adult patients requiring HPN had 26 PICC placements. This group was a 13% cohort of the pharmacy’s total HPN population, who otherwise had tunneled or infusion port CVCs in place. Women represented 57% of patients with an average age of 52 years, and 68% of all patients had a diagnosis of short bowel syndrome. Total PICC days were 22,262 with a mean of 856 days (range = 265-2500 days). Two PICCs were in place for >5 years, 5 PICCs were in place for 3-5 years, 14 PICCs were in place for 1-3 years, and 5 PICCs were in place for <1 year but >6 months.

Catheter material consisted of 23 polyurethane PICCS, including 10 power injectable devices. Three PICCs were silicone with valved-tip design. There were no antimicrobial PICCs. The 2 PICCs in place for >5 years were both non-power injectable polyurethane. The majority (n = 14) were 5F size followed by 4F (n = 5) and 6F, 7F, and 8F sizes (n = 1 each). Four PICCs did not have French size on record. Seventeen (65%) were double-lumen and 9 were single-lumen PICCs. In the ≥3 year group of 7 PICCs, there were more double-lumen (n = 5) than single-lumen (n = 2) devices.

The HPN therapy included fat emulsion for 16 patients, which increased the viscosity of the solution. The volume of the infusions ranged from 1000-3500 mL infused over an 8-24 hour time period. Rates per hour ranged from 100-300 mL/h and were not affected by French size or lumen number. There were no reported infusion-related problems despite these high infusion rates and the viscosity of the lipid-containing parenteral nutrition formula.

None of the patients used alcohol or antibiotic lock therapy for infection prophylaxis. Eight patients had successful alteplase therapy at least once for thrombotic occlusion.

Only 8 PICCs had insertion reports that confirmed tip location at the preferred cavoatrial junction. Fifteen patients had previously existing PICCs and did not transfer their insertion records when coming onto the service with the home infusion pharmacy. Three patients had no insertion report available from the discharging hospital.

All patients had home health registered nurses or trained family caregivers to deliver PICC site care. None of the patients were able to administer self-site care due to the location of the insertion site. All patients were independent in the administration of their HPN infusion.

Table 1 lists reasons for PICC removal and Figure 1 displays rates of complications leading to PICC removal. The primary cause for removal was CRBSI (n = 8) followed by damaged catheter material (n = 4), discontinuation of

<table>
<thead>
<tr>
<th>Patient</th>
<th>PICC Days</th>
<th>Complication Leading to Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>827</td>
<td>Damaged</td>
</tr>
<tr>
<td>2</td>
<td>1816</td>
<td>Age/routine change</td>
</tr>
<tr>
<td>3</td>
<td>520</td>
<td>CRBSI</td>
</tr>
<tr>
<td>4</td>
<td>911</td>
<td>CRBSI</td>
</tr>
<tr>
<td>5</td>
<td>365</td>
<td>Discontinued therapy</td>
</tr>
<tr>
<td>6</td>
<td>909</td>
<td>CRBSI</td>
</tr>
<tr>
<td>7</td>
<td>264</td>
<td>CRBSI</td>
</tr>
<tr>
<td>8</td>
<td>615</td>
<td>Damaged</td>
</tr>
<tr>
<td>9</td>
<td>1537</td>
<td>Age/routine change</td>
</tr>
<tr>
<td>10</td>
<td>1377</td>
<td>CRBSI</td>
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<td>11</td>
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<td>CRBSI</td>
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<td>12</td>
<td>672</td>
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<tr>
<td>13</td>
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</tr>
<tr>
<td>14</td>
<td>2500</td>
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<td>15</td>
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<td>17</td>
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<td>18</td>
<td>771</td>
<td>Discontinued therapy</td>
</tr>
<tr>
<td>19</td>
<td>614</td>
<td>CRBSI</td>
</tr>
</tbody>
</table>

CRBSI = Catheter-related bloodstream infection; N/A = Not applicable.
therapy (n = 4), PICC age (n = 2), malposition (n = 1), and 2 patients were lost to follow-up. Five of the PICCs were still in use without complications at the completion of the data collection period.

The overall complication rate was 0.58/1000 CVC days and the CRBSI rate was 0.36/1000 CVC days. There was no evidence of symptomatic thrombosis or occlusion related to PICC removal. The 4 damaged PICCs were polyurethane material that developed holes or cracks in the catheter or hub. Two patients had their PICC removed due to catheter age older than 4 years. It was decided by their health care team to proactively replace these PICCs before device failure occurred.

Discussion

Although this group included only 26 PICCs and 22,262 total days, the median dwell time of 643 days (range = 265-2500 days) with a mean of 856 days, exceed other published reports of PICCs used for HPN administration. Cotogni et al5 reported HPN PICC experience for 269 patients and a total of 55,293 days, but the median dwell time was only 184 days (range = 15-1384 days). In a 6-year study of CVC complications associated with HPN infusion, Christensen et al6 identified 126 PICCs used for HPN administration for 19,975 days and a mean dwell time of only 127 days. A retrospective chart review from a Boston home infusion agency7 reported 163 PICCs infused HPN for 19,104 days and a mean dwell time of 278 days. Although these studies report more numbers of PICCs used for HPN, the mean PICC dwell days are significantly less compared with this study.

The overall complication rate leading to removal was 0.58/1000 CVC days. This rate compares favorably to other reported rates of 0.85/1000 CVC days5 and 1.30/1000 CVC days.7 Christensen et al6 compared tunneled CVC vs PICC complications and concluded that the PICC was a higher risk device that should only be used for 3-6 months.

The primary reason for PICC loss in this study was CRBSI. This is not surprising because the most frequently reported complication for HPN therapy is CRBSI.8 The macronutrients contained in the parenteral nutrition formula provide a friendly CVC intraluminal environment for the formation of a microbial biofilm layer, which increases the potential for CRBSI.9 This group demonstrated a very low CRBSI rate of 0.36/1000 CVC days compared with a reported range of 0.38-4.58 (median = 1.31) per 1000 CVC days for HPN patients using various devices.1

Christensen et al6 reported a CRBSI rate of 1.3/1000 CVC days and a shorter time to first CRBSI with PICCs in his 6-year study comparing tunneled CVCs and PICCs used for HPN administration. Toure et al10 report a PICC CRBSI rate of 1.05/1000 CVC days in their prospective observational study of 204 tunneled CVCs and PICCs used for HPN administration. Only Cotogni et al5 report a lower CRBSI rate of 0.05/1000 days.

The absence of symptomatic thrombosis in this group was unusual, because there is often an association between thrombosis and PICC use.6,7,10 Incidence of venous thrombosis can be reduced when the distal CVC tip is placed at the cavoatrial junction.11 In addition, infusion of HPN further increases the incidence of thrombosis.12 The 8 available PICC insertion reports in this group document desirable distal tip location at the cavoatrial junction. The remaining PICCs in this study did not have tip location reports on file, but it can be assumed that the tip placement was acceptable due to the absence of symptomatic thrombosis in this group.

The use of primarily smaller 4F (n = 5) and 5F (n = 14) catheter size may have also contributed to lack of symptomatic thrombosis. In a prospective, observational hospital study, a significant reduction in PICC-associated deep vein thrombosis was reported when a single-lumen, smaller 5F insertion policy was initiated.13

Multilumen PICCs have also been associated with increased complication rates leading to removal. A strong correlation was found between CRBSI and double- and triple-lumen PICCs.14 A university hospital study reported similar findings of significant reductions in CRBSI and thrombosis when they instituted a practice change from multilumen to single-lumen PICC insertions.15 In our cohort, the use of double-lumen PICCs did not contribute to symptomatic thrombosis, but 5 of the 8 CRBSI incidents did occur in double-lumen PICCs.

Catheter material has been identified as a contributing factor for PICC complications. Polyurethane PICCs demonstrated a lower rate of infection, malposition, thrombus, and rupture in a review of prospective and retrospective studies published over a 13-year period.16 Cohen et al17 compared durability of polyurethane and silicone, finding that silicone developed more tears or pinholes over time. In contrast, an unexpected finding in this group was that 4 polyurethane PICCs had cracks in the hub or tubing leading to removal, whereas the 3 silicone PICCs had no evidence of damage.

The need for a caregiver is an important factor to be considered before PICC placement. Rarely, as with this group, can the PICC site be cleaned and dressed adequately by the patient alone, because the location of the PICC insertion site is the basilic or cephalic vein at the antecubital fossa or upper inner arm.1,2,18 Use of an extension set allowed these patients to be independent with HPN administration and

**Figure 1.** Number of complications leading to peripherally inserted central catheter removal. CRBSI = Catheter-related bloodstream infection; D/C = Discontinued.
flushing. Caregivers included family members, hired professionals, and home health nurses. These services will most likely remain in place for the life of the PICC depending upon the individual needs and available resources. This may place an additional financial burden on patients already receiving an expensive therapy.

Limitations
This study was limited by the small number of subjects and devices. Furthermore, there are little published data available to compare results for very long-term PICC use for HPN.

Conclusions
This group of patients demonstrated that PICCs are a viable option for very long-term HPN administration. The PICC overall complication rate in our study was very low compared with other published reports. The most frequent complication of CRBSI was expected, but the rate was quite low. It is not clear from this small cohort whether the primary use of double-lumen PICCs removed for CRBSI was a contributing infection risk factor.

This is the only HPN infusion study to date reporting 7 PICCs lasting 3 or more years, with 2 lasting >5 years without complications resulting in removal. Five PICCs were still in use at the completion of the study period. Patients received their prescribed therapy reliably and without interruption with this device. Larger studies are needed to confirm the efficacy of maintaining a PICC for very long-term HPN administration.

Disclosures
The authors have no conflicts of interest to disclose.

References