Journal of Pediatric Nursing (2014) **29**, e3–e9

# Management of Peripherally Inserted Central Catheters (PICC) in Pediatric Heart Failure Patients Receiving Continuous Inotropic Support[1,2,3]

**Maeve Giangregorio BSN, RN, CPN*, Sandra Mott PhD, RN-BC, CPN, Elizabeth Tong MSN, RN, CPNP, Sonia Handa MPH, Kimberlee Gauvreau ScD, Jean Anne Connor PhD, RN, CPNP**

*Boston Children's Hospital, Boston, MA*

Received 4 January 2013; accepted 12 December 2013

**Key words:**
Peripherally inserted central catheter;
Pediatric;
Heart failure;
Cardiac;
Inotrope;
Inotropic infusion;
Heparin

The study aim was to evaluate present practice of maintaining PICC line patency in pediatric heart failure patients receiving continuous inotropes by comparing one cohort receiving low dose continuous heparin with one receiving no heparin. A case control retrospective chart review compared the two cohorts on duration of patency (measured in days) and need for thrombolytic agents. Median duration of patency for the heparin group was 24 days versus 16 days for the no heparin group ($p = 0.07$). Use of thrombolytic agents was 28% in the heparin group compared to 50% in the no heparin group ($p = 0.08$). Although not statistically significant, findings were clinically significant and supportive of current practice.


## Background

PEDIATRIC HEART FAILURE patients with deteriorating status and life expectancy less than a year are hospitalized for continuous inotopic infusion while awaiting cardiac transplant. the vesicant properties of inotropes require administration by way of a central venous access device. peripherally inserted central catheters (picc) are a specific type of central venous access that are inserted into particular peripheral veins and threaded into the central venous circulation. picc lines are not as restrictive as other central lines and therefore commonly used in pediatric heart failure patients. inotropes are drugs that improve the strength of contraction in heart muscle. therefore, maintaining a continuous infusion of inotropes is life-sustaining therapy. since the length of time a heart failure patient may require inotropic support varies greatly between patients and ultimately is unknown due to the nature of organ donation, maintaining picc line patency is crucial.

Central venous access is an essential tool in modern day healthcare for administering vital infusions such as total parenteral nutrition (TPN), medications including chemotherapy, vesicants, and long-term antibiotics as well as for gathering treatment-related intracardiac data (Beheshti, 2011; Griffiths & Philpot, 2002; Ryder, 1993). PICC lines provide a reliable IV site for children who have a known

[1] Poster Presentation: Giangregorio, M., Tong, E., Handa, S., Gauvreau, K., Connor. J. (2011, October). *Management of Peripherally Inserted Central Catheters (PICC) in Pediatric Heart Failure Patients Receiving Continuous Inotropic Support*. Poster Session presented at the 16th Annual Update on Pediatric and Congenital Cardiovascular Disease, Orlando, FL.

[2] Poster Presentation: Giangregorio, M., Tong, E., Handa, S., Gauvreau, K., Connor. J. (2012, December). *Management of Peripherally Inserted Central Catheters (PICC) in Pediatric Heart Failure Patients Receiving Continuous Inotropic Support*. Poster Session presented at the Pediatric Cardiac Intensive Care Society, Miami, FL.

[3] Podium Presentation: Giangregorio, M., Tong, E., Handa, S., Gauvreau, K., Connor. J. (2012, February). *Management of Peripherally Inserted Central Catheters (PICC) in Pediatric Heart Failure Patients Receiving Continuous Inotropic Support*. Podium Presentation at the 2011 Northeast Pediatric Cardiology Nurses Association Conference, Boston, MA.

* Corresponding author: Maeve Giangregorio, BSN, RN, CPN.
*E-mail address:* maeve.giangregorio@childrens.harvard.edu.

http://dx.doi.org/10.1016/j.pedn.2013.12.002
0882-5963/

history of difficult IV access, require frequent blood draws or need long-term intravenous therapy. The use of PICC lines in pediatric patients escalated in the early 1990s (Gabriel, 1994; Goodwin & Carlson, 1993; Mauro, 1998; Ryder, 1993). In 2010, almost 15 million central venous access cases of all types were performed (Beheshti, 2011).

The history of central venous IV therapy can be referenced back to hundreds of years ago, but the evolution of modern day central venous access is less than 100 years old. In 1929, Werner Forssmann, MD, documented the first peripherally inserted line into an intracardiac position (Sette, Dorizzi, & Azzini, 2012). The 1940s showed refinement of techniques that facilitated cardiovascular research (Beheshti, 2011). Central venous access by way of the subclavian vein was perfected by 1950. By 1968, the first internal jugular line was documented and used for central venous pressure (CVP) monitoring, which is an important element of cardiovascular management (Beheshti, 2011; Griffiths & Philpot, 2002; Ryder, 1993). In 1970 the concept of tunneled catheters was introduced (Beheshti, 2011; Ryder, 1993). With these essential concepts and techniques in place, the use of central venous access gained widespread acceptance and use.

Since the beginning of the 21st century, the number of published articles describing PICC line use, management and complications has increased dramatically, thus reflecting the general acceptance and use of this particular type of central line (Westergaard, Classen, & Walther-Larsen, 2013). Better quality catheter construction, advanced insertion techniques, and less incidence of serious complications associated with PICC lines all contributed to the steady increased use of PICC lines since 1980 (Goodwin & Carlson, 1993; Westergaard et al., 2013). In addition, PICC line insertion generally is performed with light or no sedation and with little risk of procedural complications (Westergaard et al., 2013). PICC lines also allow a patient to be mobile and provide the opportunity to complete IV treatment outside of the hospital setting making them a safe and valuable home care option (Westergaard et al., 2013).

Although complications such as infection and occlusion still exist with PICC lines, their occurrence is not greater than with other central lines, and typically they are more easily rectified with fibinolytics and antibiotic locks (Griffiths & Philpot, 2002; Westergaard et al., 2013). Catheter occlusion is one of the most frequently documented complications of PICC line management, and rates can be as high as 36% of lines (Kerner, Garcia-Careaga, Fisher, & Poole, 2006). Catheter occlusion is described as a blockage resulting in the loss of patency for infusion and/or the loss of a blood return in the PICC line (Buswell & Beyea, 1998). Complications other than occlusion include, but are not limited to: cardiac arrhythmia, cardiac tamponade, catheter related thrombosis, and catheter related infection (Barrier, Williams, Connelly, & Creech, 2012; Feehery, Allen, & Bey, 2003; Hadaway, 1990; Masoorli, 1997; Richardson & Bruso, 1993; Ryder, 1995; Vesely, Stranz, Masoorli, & Hadaway, 2002; Wickham, 1990).

## Clinical Issue and Practice

Prior to 1990, at a northeast pediatric institution, heart failure patients who remained hospitalized while awaiting heart transplant were managed in the cardiac intensive care unit (CICU). Maintaining a continuous infusion of inotropes to these patients was the most important element of their care as the cardiac function of these heart failure patients was very poor. Without the continuous infusion of inotropes, their low cardiac output causes life-threatening symptoms associated with cardiogenic shock. Management in the CICU was necessary based on their dependence on invasive central lines for medication delivery and central venous pressure (CVP) monitoring; both of which require intensive nursing supervision. Since inotropes had to be administered into a central vein due to their vesicant properties, peripheral access was not an option unless used as a short-term bridge in therapy. By the early 1990s the successful placement and use of PICC lines permitted the care of pediatric heart failure patients on the inpatient cardiac unit. PICC lines offered reliable delivery of inotropes, the ability to monitor CVP, and required less intensive monitoring by nurses.

As the number of heart failure patients managed on the inpatient cardiac unit increased, practice issues related to PICC line management became more evident. The most common issues related to identifying proper flushing practices and catheter occlusion. Inotropes typically infuse at a slow continuous rate, which promotes stasis and allows catheter occlusion to occur more easily. Low flow states are described in the literature as a contributing factor to catheter occlusion (Krafte-Jacobs, Sivit, Mejia, & Pollack, 1995). The retrograde back up of stagnate blood into lines is also a major contributor to occlusion making adequate flushing crucial to maintaining line patency (Krafte-Jacobs et al., 1995).

The standard of PICC line care at our institution includes routine intermittent manual flushes with low dose heparin to maintain line patency. This practice is based on line maintenance recommendations from the official professional organization (Infusion Nurses Society, 2000, 2006, 2011). However, manually flushing a PICC line that is delivering an inotropic infusion generates a bolus of inotropic medication to the heart failure patient. A bolus of inotropes can cause symptomatic tachycardia, hypotension, diaphoresis and dizziness. Prolonged presence of these symptoms required examination by a physician and increased monitoring by nursing staff until symptoms resolved. Due to the frequent and often severe symptoms experienced by the heart failure patients receiving inotropes through a PICC line following the manual flushing of their line, the practice was discontinued. Subsequently the incidence of PICC line occlusions increased. When antithrombolytics did not restore patency to a PICC line, a new PICC line had to be placed as maintaining the infusion of inotropes was essential.

As the perceived incidence of complications grew, clinicians sought to change practice. After many failed strategies, the use of continuous low dose heparin (heparin