Best Practices in Pediatric Central Venous Catheter Care: A Case Study from Children’s Medical Center of Dallas

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Introduction

Unique challenges exist in pediatric patients with a central venous catheter (CVC). Due to limited vessels, patient activity level, and the potential need for anesthesia for CVC replacement, optimizing catheter performance is a priority. Infants and children with both acute and chronic diseases have improved quality of life with CVCs despite the fact that complications do occur (Revel-Vilk, Yacobovitchm, Tamary, Goldstein, Nemet, Weintraub, Paltiel, & Kenet, 2010). This case study will exemplify best practices related to CVCs at a leading pediatric institution.

Children’s Medical Center of Dallas

Children’s Medical Center of Dallas is an academic pediatric hospital in Texas dedicated exclusively to the comprehensive care of children from birth to 18 years of age. The hospital is licensed for 559 beds and is the seventh-largest pediatric healthcare provider in the nation. Children’s Medical Center is a designated Level 1 trauma center and includes specialties in nephrology, liver, heart, bowel, and bone marrow transplant.

CVCs are frequently required for pediatric patients due to the need for intravenous medication delivery, blood sampling, and reliable access. The presence of a CVC can lead to venous thrombosis, a serious and long-term complication. Pediatric patients have multiple risk factors due to the higher catheter-to-vessel ratio and the potential for vessel trauma with CVC insertion. Peripherally inserted central catheters (PICCs) represent a large proportion of CVCs inserted in pediatric patients (Advani, Reich, Sengupta, Gosey, & Milstone, 2011). There is a low tolerance of repeated venipunctures in young patients, leading to early insertion of PICCs and prolonged dwell times of PICCs (figure 1). Blood sampling is routinely performed on 3 french PICCs and larger (Knue, Doellman, Rabin, & Jacobs, 2005).

Coalition of Champions

Vascular Access Team

At Children’s Medical Center of Dallas, a specialized Vascular Access Team (VAT) provides around-the-clock service for both PICC and peripheral intravenous catheter (PIVs) insertion, troubleshooting, education, and data collection. The VAT utilizes high-tech tools and vessel measurement for inserting the proper size PICC. The pediatric VAT provides continuous coverage for vascular access needs in all age groups. The team has direct oversight of:

- PIV and PICC insertion
- PICC dressing changes
- PICC extension set changes
- PICC removals
- Outpatient CVC care and maintenance
- Troubleshooting
- Ongoing education
- Data collection
The VAT has close to 17 full-time equivalents; the day shift is staffed with six nurses and night shift with two nurses. Nurses on the VAT work 12-hour shifts. The bedside nurse is responsible for specific CVC maintenance procedures (figure 3). The VAT is supported by a medical director, nursing director, nursing manager, educator, and nurses.

Inserting PICCs in small, active patients requires intensive training. The small team of experts use ultrasound guidance, modified Seldinger technique, and navigation for bedside PICC insertions and achieves success rates >93%. The navigational system for catheter tip location has decreased the number of insertion malpositions and the number of chest x-rays. These types of strategies reduce vessel trauma, costs, and procedural time. Children’s Medical Center has benchmarked with other top pediatric institutions on PICC insertion success rates. Individual success rates are recorded monthly and additional clinical guidance is provided if the success rate falls below 80%. Interventional Radiology provides clinical support for specific patient populations and complex cases.

Pediatric PICCs are inserted at the bedside for patients in the intensive care unit. For stable patients, PICC insertions occur in a specified procedure room. Two nurses are involved with the procedure, along with a child life specialist and, if necessary, an anesthesia provider. The child life specialist provides procedural preparation and support. A sedation assessment is performed on all patients. Patients who are less than five years of age and older patients who are experiencing anxiety receive conscious sedation. Due to the potential need for many vascular access devices throughout a young patient’s lifetime, careful implementation of a pain management plan is imperative to avoid unnecessary emotional trauma.

Leadership

The leadership at Children’s Medical Center of Dallas has a long history of providing ongoing support for best practices in all phases of CVC care. A strong foundation is important as new products, technologies, and educational sessions are developed. The overriding goal of clinical excellence in CVC care is an expectation for every nurse and physician.

A multidisciplinary vascular access committee meets monthly and includes champions from pharmacy, medical staff, senior leadership, quality improvement, and the VAT. Agenda items include new products and practices, approval of policies and procedures, data analysis, and review of new research and guidelines. New products go through a value analysis prior to initiating a trial.

CVC policies and procedures are evidenced-based and include the integration of current guidelines, standards, and recently published research. Revisions of policies and procedures are approved by senior leadership (chief executive officer, senior vice president), the clinical practice policy chair, the VAT medical director, and the infection prevention director.

CVC data are analyzed monthly for reports. A dashboard on the intranet includes number and types of CVCs, recent types of microorganisms responsible for CLABSI, complications, etc. Ongoing trends or significant changes in the CVC data are discussed.
Infrastructure  
*Policies and Procedures*

Infants and children with a CVC are a high-risk population for central line-associated bloodstream infections (CLABSIs) due to their age, weight, immune dysfunction, presence of additional access devices, and potential need for multiple procedures (Parilla & Jacobs, 2003). In the pediatric critical care units or oncology units, multiple catheter entries may be necessary due to the need for sedation or frequent blood sampling. Because of this, pediatric patients may have longer catheter dwell times than adult patients, which highlights the critical phase of CVC maintenance. Examples of CVC maintenance include dressing changes, scheduled changing of needleless connectors and tubing, and cleaning the catheter hub prior to access.

Decreasing CLABSI is an institution-wide initiative for Children’s Medical Center. The VAT is represented on all committees related to CLABSI. Evidence-based policies and procedures have been adopted for CVC insertion and maintenance as a means to reduce costs, morbidity, and mortality in the pediatric patient.

The majority of the pediatric CVC policies and procedures focus on reducing opportunities for microorganism colonization. This includes the point of care from handwashing to CVC dressing changes (figure 2). Coordination of blood sampling is encouraged to minimize the number of times the needleless connector is accessed. During physician rounds, the continued need for the CVC is addressed. If the CVC is not necessary for infusions or blood sampling, it is promptly removed.

Children’s Medical Center has made significant strides in reducing its CLABSI. The CVC policies and procedures include insertion, scrubbing the hub, tubing changes, dressing changes, and removal. The procedural steps are detailed and many include a process care map.

For a confirmed CLABSI, a root cause analysis (RCA) is completed. The RCA has been an effective strategy to examine risk factors for CLABSI. The collaborative process includes leadership, physicians, and nurses reviewing the patient’s history or medical record. Knowledge that is gained through this process is shared with all disciplines.

*Dysfunctional Central Venous Catheters*

Catheter occlusion can delay medication administration, can increase costs, and is a risk factor for CLABSI. (Baskin, Pui, Reiss, Wilimas, Metzger, Ribeiro, & Howard, 2009). A common size pediatric PICC is a 3 french; smaller catheters have higher occlusion rates (Kroe, Doellman, Rabin, & Jacobs, 2005). A patent catheter with a tip placement in the superior vena cava (SVC) or inferior vena cava (IVC) should flush and aspirate freely. Catheter occlusions can be categorized as thrombotic or non-thrombotic. Non-thrombotic occlusions include catheter tip malposition, and kinked or clamped catheter. Precipitates from medications or minerals can also lead to catheter occlusion. Pharmacy is involved with determining the appropriate clearing agent based on the precipitate composition.
The majority of catheter occlusions are thrombotic in nature, and catheter dysfunction can quickly arise if fibrin accumulates in or around the lumen (Jacobs, 2003). Inadequate flushing is also a risk factor for catheter occlusion. The type of thrombotic occlusion is dependent upon the location of the fibrin and includes total occlusion, partial occlusion, and a sluggish lumen. At Children’s Medical Center, nurses assess the quality of flushing and the ability to obtain a brisk blood aspirate. The nurse documents the catheter patency on the electronic medical record. If any lumen of the CVC becomes occluded, the physician is notified and the catheter clearance process begins.

Early detection of thrombotic occlusions is beneficial for restoring catheter patency. Clinician education has focused on recognizing when the catheter becomes sluggish. A sluggish catheter is defined as a catheter that has increased resistance with flushing or aspirating. The nurse’s role is important in ruling out mechanical factors. Common mechanical factors of CVCs include catheter tip malposition, and kinked or clamped catheter. The patient’s extremity may be repositioned and the insertion site examined for migration or a kinked or clamped catheter. If the catheter remains occluded, it is treated per hospital protocol by the VAT.

**Home Care**

Home care plays a significant role in pediatric patients who require CVCs for extended periods of time. Repeated hospitalization and outpatient therapy is often necessary. The CVC is cared for by family members, home care nurses, clinic nurses, and, when the patient is hospitalized, the bedside nurse. Consistent CVC care is vital to minimize unnecessary risk factors. A common example of this may be a young child with short-gut syndrome receiving total parental nutrition (TPN) through a tunneled CVC. The CVC is considered the patient’s lifeline as the patient may require therapy for months to years. This type of gastro-intestinal (GI) patient typically requires frequent monitoring of laboratory testing and daily TPN infusions.

The GI nurse coordinator is responsible for teaching long-term patients and their families CVC care and maintenance. The teaching begins as soon as the patient receives his or her CVC. In young patients, tunneled CVCs are more common than implanted ports, due to the smaller catheter sizes and ease of use. The family receives a CVC teaching packet that includes a skills checklist and DVD. The DVD shows step-by-step procedures of CVC care, such as flushing a CVC, dressing change, etc. Parents are instructed to call their home care company or their primary care team if a complication occurs, e.g., inability to flush a CVC. Patients and parents are empowered to stop the procedure if there are any breaks in sterile technique or improper care. Family members are naturally motivated to provide the best care possible for their child.

Nurses from home infusion companies caring for pediatric CVCs are encouraged to attend a four-hour workshop that is offered monthly. The GI coordinator teaches the workshop, which includes CVC care, maintenance, and recognition and management of complications. Components of the “SAVE that Line” campaign are also emphasized (figure 3). The workshop is tailored specifically to pediatric patients. Besides the challenge of maintaining patency in small catheter sizes, education includes use of a 10-mL syringe for flushing, frequency and volume of flushing, securing the CVC, and incorporating safe CVC practices into the activities of daily living (e.g. bathing). A skills checklist is completed by each attendee. Continuing education units
are rewarded upon completion of the workshop. As a result of these efforts, home care nurses feel more confident in caring for CVCs and community-acquired CLABSIs have decreased.

**Education**

CVC education for nurses and physicians is an ongoing effort on every unit with the goal of providing evidence-based practices for catheter insertion and care. The Children’s Hospital Knowledge Exchange (CHEX) is an online educational module that is utilized to enhance skills and knowledge related to CVCs.

Newly hired nurses receive education on all aspects of CVC care and maintenance by the VAT educator. On a daily basis, the VAT provides on-demand learning to the nursing units. Learning About Vascular Access (LAVA) education includes hot topics such as CLABSI, scrubbing the hub, catheter occlusion, etc. The rotating topics are also available as a hard copy to reinforce key points.

Residents are educated on the central line checklist for insertions and care and maintenance procedures. A simulation laboratory is an adjunct to this education. The simulation laboratory is currently being utilized for PIV insertions by both the nursing and medical staff. The virtual IV simulator is interactive and provides case studies for both neonatal and pediatric patients. Clinicians are required to attend the PIV simulation laboratory prior to inserting a PIV on a patient. The laboratory is shared by both Children’s Medical Center and The University of Texas Southwestern Medical School. Future endeavors will include CVC insertion procedures.

**Accountability**

Compliance of CVC care has improved with standardization of policies and procedures and customized insertion and dressing kits. CVC competencies for nurses are completed annually and have included stations that review CVC flushing, blood sampling, dressing change, etc. The 2011 National Patient Safety Goals for reducing CLABSI were implemented throughout the institution. Initial and ongoing CVC education is mandated at all levels. CLABSI has received heightened attention at every institution due to the Center for Medicare and Medicaid ruling of no reimbursement for a CLABSI (Miller-Hoover, 2011).

**Quality Improvement**

Quality improvement science is one of the cornerstones for decreasing CVC complications such as CLABSI or catheter occlusion. Data are collected daily on all CVCs for mechanical and infectious complications. Data include:

- CVC type, size, and location
- Tip placement
- Infectious complications (presence of fever, insertion site red or draining)
- Mechanical complications (ability to flush and aspirate lumen(s), treatment of thrombotic occlusions, catheter migration, extremity swollen or discolored)
- Dwell time
Data are recorded manually to capture specific data points and then entered on an electronic database. Reports can be viewed monthly to identify trends. Daily audits are performed by the VAT on CVC care. Any areas of improvement are discussed with the nurse. The audit may include:

- Is CVC dressing occlusive?
- Is the kardex updated with needleless connector and dressing change dates?
- Is there any dried blood on the needleless connector?
- In the past 24 hours, was the patient’s CVC accessed off the unit? If so, where?

Children’s Medical Center is a member of the National Association for Children’s Hospitals and Related Institutions (NACHRI), a leading pediatric organization focused on improving quality and patient safety. NACHRI led research from 29 pediatric intensive care units that resulted in a 43% decrease in CLABSI by standardizing CVC insertion and maintenance practices.

Children’s Medical Center is a national leader in minimizing PIV complications. Pediatric patients are a high-risk population for infiltration and extravasation. A culture of safe practices has been developed and implemented as a means of decreasing the incidence of extravasation. Children’s Medical Center has developed an infiltration scale that has been validated by the Institutional Review Board. PIV rounds are completed daily on patients receiving high risk infusates. A primary driver of reducing PIV complications has been selecting the proper vascular access device for infusion of irritants and vesicants. These types of targeted activities have the potential to expand into other pediatric healthcare organizations.

Electronic Medical Records

The advent of electronic medical records (EMR) has improved the process for planning, documenting, and retrieving patient information for improved efficiency and safety. EMRs can specifically assist clinicians with identifying patients who may benefit from a CVC by their condition or infusion of a high-risk medication or solution. Children’s Medical Center has developed a vascular access referral screen on the EMR. This screening is completed during the admission process and includes:

- Presence of a CVC
- Difficult venous access
- Vesicant therapy
- TPN
- Vasopressors
- Multiple PIV attempts (>4)
- Pain management
- Failure to thrive
- Delayed wound healing
- Malabsorption
- Hematology/Oncology diagnosis
The VAT is notified if one of the above therapies or patient conditions exist. Proactive vascular access planning can begin based on the type and length of therapy. The EMR also has a vascular access navigator that entails documentation for CVCs.

**Summary**

Children’s Medical Center of Dallas has demonstrated sustained clinical excellence in providing evidence-based care for CVCs. Many young patients have limited vessels or receive high-risk therapies that pose complication risks. Children’s Medical Center has successfully created a culture of safety in caring for patients with CVCs. The continuous process of collecting and analyzing data and reporting trends results in a greater understanding of CVC care and ultimately reduces complications for infants and children.
References


Figure 1: Criteria

<table>
<thead>
<tr>
<th>PICC Insertion Criteria</th>
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<tbody>
<tr>
<td>Need for IV access 5-7 days or longer</td>
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<tr>
<td>Infusion of vesicants or irritants (pH &lt;5 or &gt;9)</td>
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<tr>
<td>Infusion of TPN (osmolality &gt;600 mOsm/L)</td>
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<td>Infusion of chemotherapy</td>
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<td>Poor access, &gt;4 attempts to initiate a PIV insertion</td>
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<td>Need for frequent blood sampling</td>
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Figure 2: Roles of the RN with CVC Practices

<table>
<thead>
<tr>
<th>Bedside Nurse</th>
<th>VAT</th>
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<tbody>
<tr>
<td>Routine CVC flushing and blood sampling</td>
<td>Catheter occlusion management</td>
</tr>
<tr>
<td>CVC dressing changes except for PICCs</td>
<td>PICC dressing changes</td>
</tr>
<tr>
<td>Routine CVC tubing changes</td>
<td>Routine extension tubing changes on PICCs</td>
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<tr>
<td>Early recognition of complications</td>
<td>Complication management</td>
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<tr>
<td>Completion of CVC competencies</td>
<td>Provides ongoing CVC education to clinicians</td>
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Figure 3: I SAVE That Line

Implement insertion, care, and maintenance bundles to minimize the risk of intraluminal and extraluminal contamination.

Scrupulous hand hygiene is necessary before and after contact with any vascular access device.

Always disinfect every needleless connector prior to each access for solution and medication administration, flushing, or tubing changes.

Vein preservation is achieved by assessing for best device and site selection to reduce the risk for complications, such as thrombus formation and infection.

Ensure patency by flushing all lumens following institution policy. If lack of blood return or sluggish flow is encountered, take measures to restore patency.
**Figure 4: Infection Prevention**

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<thead>
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<th>Meticulous Care</th>
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<tr>
<td>Strict hand hygiene</td>
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<td>Scrub the hub for 15 seconds with alcohol and allow to dry for 15 seconds</td>
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<tr>
<td>Change CVC dressing every 7 days and PRN</td>
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<tr>
<td>Use appropriate dressing</td>
</tr>
<tr>
<td>Use chlorhexidine for skin antisepsis unless contraindicated due to allergy</td>
</tr>
<tr>
<td>Use chlorhexidine patch at CVC insertion site unless contraindicated due to allergy</td>
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