Pediatric Central Venous Catheter Management: A Review of Current Practice

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Abstract

Due to small vessel size, obtaining stable access in pediatric patients is difficult. In addition, because needle stick pain is a concern for patients with chronic illness, central venous catheters are often utilized to provide intravenous treatment. Catheter occlusion is a common complication in pediatric patients and must be addressed to salvage the catheter and ensure successful therapy. The use of fibrinolytics for occlusion treatment have been successful in pediatric populations.
Keywords: *Pediatric, central venous catheter, catheter maintenance, central venous catheter occlusion*

Introduction

Central venous catheters (CVCs) are required to carry out numerous treatment plans for pediatric patients. Many life-threatening conditions require reliable and stable access for the infusion of medications and drawing of blood samples.[1] Pediatric patients have different vascular access needs than adults. For example, they have smaller veins to select from, creating fewer options for vascular access.[2,3] Added concerns for pediatric patients are the chronic side effects of unresolved needle stick pain. To reduce the trauma of repeated venipuncture, central lines are maintained for long periods of time. Long-term catheters are at a higher risk for developing complications, including occlusions.[3,4]

CVCs that are often utilized in pediatric patients are implanted ports, tunneled catheters, and peripherally inserted central catheters (PICCs). Skilled care and maintenance of CVCs is crucial for the longevity of the catheter and treatment success. An estimated 40% to 46% of CVCs develop complications.[1] A nonfunctional catheter can lead to a number of complications, including delays in treatment, an inability to provide nutrition for patients with intestinal failure, and additional needle sticks to obtain blood draws and additional access. In addition, an untreated CVC occlusion can increase a patient's risk for a central line-associated blood stream infection (CLABSI). It has been reported that pediatric patients with cancer have a CVC-related thrombosis 50% of the time. And another study showed that having a dysfunctional CVC was an independent risk factor of having a poor outcome in pediatric patients with a non-central nervous system cancer.[1]

This article evaluates the use of CVCs in pediatric populations, causes for CVC occlusion, evidence-based research and current practice on preventing catheter occlusion, and methods of treatment.

Venipuncture and Pediatric Patients

Evidence shows that venipuncture is an important source of pain in pediatric patients. Venipuncture and peripheral intravenous (PIV) cannulation are 2 of the most common sources of pain reported by hospitalized children.[5] Pain experienced early in life can have lasting negative effects. These effects vary across a wide range but affect a patient's neurological development, pain threshold, coping strategies, and pain perception. Unresolved childhood pain has been associated with adult fear, pain, and avoidance of health care.[6]

The brain rapidly matures shortly after birth. Repeated painful events can alter the formation of neuronal circuits. This can result in children becoming hypersensitive to pain.[6] A child born with a chronic medical condition may have a lifetime of access requirements. Repeat venipuncture can damage smaller vessels making future treatment difficult to initiate. It is imperative that venous access needs are assessed early in treatment planning to minimize the amount of venipuncture a pediatric patient may require.

Catheter Selection

Catheter selection for a pediatric patient should take into account several factors. These include treatment requirement, length of treatment, catheter placement options, and maintenance requirements.

The implanted port will provide stable long-term access. Using numbing cream, the port can be accessed relatively

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painlessly. It is also associated with fewer catheter occlusions when compared with tunneled catheters.[7] However, due to needing to be accessed with a needle it is not the best option if long-term daily access is required.

A tunneled catheter, such as a Broviac or Hickman catheter, is a good option for long-term treatment requiring daily access. Due to their external design, daily care and maintenance of these catheters are crucial to prevent CLABSI and complications. Caregivers of pediatric patients are often required to provide daily flushing and scheduled dressing changes for these lines and must be educated on aseptic and sterile technique.

PICC is a good option for short-term treatment. The PICC line is associated with the lowest frequency of catheter occlusion, most likely due to its short-term nature.[7] In pediatric patients PICC lines are at a high risk for accidental dislodgment, either during a dressing change or if the patient disrupts the dressing. Assessment of the catheter is important before initiating treatment to ensure that the PICC line has not been accidentally dislodged and remains in a central location.

Catheter selection is limited due to patient size. Smaller-gauged catheters used frequently in neonates and small pediatric patients are associated with higher incidence of complications.[4] When selecting a catheter, consideration must include duration of treatment needed and what device is available in the patient's size. Sizes fluctuate from 1-Fr PICC line to 12-Fr tunneled catheter. The inserter must consider all treatment requirements when selecting an appropriately sized catheter.

Catheter Maintenance

To prevent a catheter occlusion, it is important the catheter is maintained correctly. This includes ensuring that the line is correctly flushed at the appropriate interval. It is important to note that due to the different sizes of patients, the caregiver of the line must be aware of the size requirements to prevent occlusion and complications. Small-gauge catheters, such as a 1.9 Fr and smaller, must have fluids run continuously through the catheter to maintain patency. It is incapable of being locked off.[4]

According to research[4,8] and guidelines from the Joint Commission,[9] and the Infusion Nurses Society,[10] all CVCs should be flushed with normal saline before and after an infusion is administered or a blood sample is obtained from the line. Heparin assists in preventing occlusion. A standard amount of 10 units/mL heparin is used to maintain externalized catheters such as tunneled catheters and PICCs to fill the volume of the line. An implantable port requires monthly access and heparin flush with 100 units/mL heparin[4] (see Table 1). It is important to note that although heparin may aid in preventing a thrombus, it will do nothing to treat an established clot. Catheter salvaging is preferential over replacement to preserve a patient's veins and access for future use.[4]

Along with proper flush technique, the catheter site must be maintained by ensuring dressing changes are being performed at appropriate intervals and utilizing sterile technique. All tubing must be changed out at scheduled frequencies based on the product that was infusing. All access into the tubing must be done aseptically. By following these recommendations the CVC should be able to be maintained throughout the treatment without developing an infection or device-related complication (see Table 2).

Occlusion

An occlusion occurs when the CVC is no longer patent, and can either be a partial or complete occlusion.[4] A partial occlusion is when the catheter will infuse fluids, but not have a blood

Table 1. Catheter Flush Volume and Frequency for Pediatric Patients. Based on References 4 and 7-10

Peripherally inserted central catheter	• Lines ≥3 Fr and greater may be heplocked with 1 mL/10 units heparin • Lines <1.9 Fr cannot be heplocked, and may not be reliable for blood draws • Line dressing changes should be done weekly and as needed. An initial dressing change is recommended within 24 to 48 hours of insertion • Line waste and flush volumes ○ 1 cc waste ○ 1 cc 10 units/mL heparin
Port/tunneled line	• Port flush and waste volumes ○ 5 cc waste ○ 5 mL 10 units/mL heparin for 24-hour lock ○ 5 mL 100 units/mL heparin for 30 day lock • Hickman/Broviac >6 Fr flush and waste volumes ○ 3 mL waste ○ 3 mL 10 units/mL heparin for 24-hour lock • Broviac 2.7 Fr and 4.2 Fr flush and waste volumes ○ 1 mL waste ○ 1 mL 10 units/mL heparin for 24-hour lock
Alteplase	• Indicated in the presence of an inability to withdraw blood through the catheter, sluggish blood return, increased resistance while flushing, or inability to flush the catheter • Useful only for thrombotic occlusions