



Central Venous Access Devices: Care and Maintenance in the Home

Caring for Children with CVADs

This learning module is intended as a review of foundational knowledge for practitioners in the community working with children with central venous access devices (CVADs). In order for the associated workshop to be effective it is recommended this module be completed prior to the session.

Contents

Indications
Devices
Care
Complications

Learning Outcomes

- ✓ Indications for central venous access device use
- ✓ Differentiate between the various types of central venous access devices
- ✓ Pre and post insertion care considerations
- ✓ Care and maintenance of central venous access devices
- ✓ Causes and prevention of common complications

Resources

Connected Care Learning Hub-Vascular access devices: <https://www.aboutkidshealth.ca/connectedcare>

Setting up your environment (video): <https://www.youtube.com/watch?v=K4Zxb1wdlY>

CVAD procedures: Cap change (video) <https://www.youtube.com/watch?v=rZW9ezjTGSi>

CVAD procedures: Dressing change (video) <https://www.youtube.com/watch?v=oozvH61j0g0>

Emergency CVAD procedure (video) <https://www.youtube.com/watch?v=B5hYzaCpOwo>

Suggested Supplemental Resource

Broadhurst, D., (2012). CVAD Complication Management: A Decision – Aid Tool. *Journal of the Canadian Vascular Access Association*, 6(1), 8-14.

O’Grady, N., Alexander, M., Burns, L.A., Dillinger, P., Garland, J.M., Heard, S.....& the Health care Infection Control Practice Advisory Committee. (2011). Guidelines for the prevention of intravascular catheter-related infections. *American Journal of Infection Control*, 39(4), S1-S34.

Registered Nurses’ Association of Ontario. (2005). Care and Maintenance to Reduce Vascular Access Complications. Toronto, Canada: Registered Nurses’ Association of Ontario.

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Introduction

There was a time when the use of central venous access devices catheters (CVAD) were rare and only seen in the most acutely ill child. Times have changed. It has been estimated that at any given time approximately one third of the children at SickKids has some form of central venous access, be it a temporary, short term, or long term device. The use of CVADs has become increasingly necessary for a number of reasons. The children treated at SickKids are generally highly acute and complex, and those who are able are completing their therapies at home via home care programs in order to restore life to as normal a state as possible. Earlier discharge also provides the opportunity, by freeing bed space, to admit children who are unable to be treated on an out-patient basis.

CVADs are invaluable; they provide us with the ability to administer medical treatments to our patients, and in some cases, treatments that could not otherwise be administered safely. However, like any other medical device, CVADs do have potential risks and complications associated with them. A thorough understanding of CVADs is imperative to provide safe care of patients with CVADs and to decrease the incidence of these risks. (O'Grady, 2011)

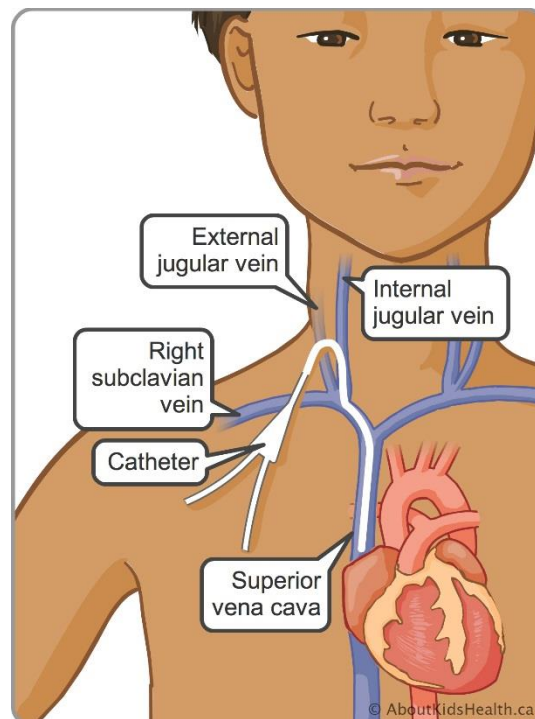
What is a Central Venous Access Device?

The term 'central venous access device' (CVAD) is a category of intravenous (IV) devices that provide access into the central venous system (i.e. the superior vena cava or the inferior vena cava). What makes a device a 'central' device is not where the device is visible exiting the body, but rather where the internal tip is positioned, and therefore where the treatment (i.e. medication, solution, and parenteral nutrition) is delivered to the body.

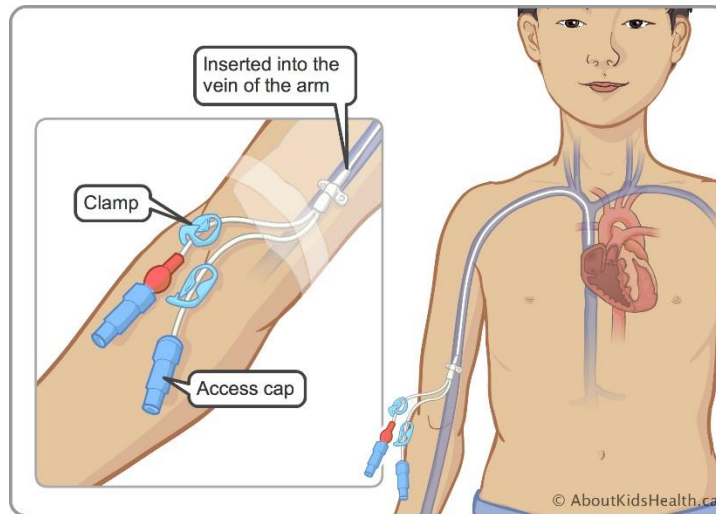
CVADs are intended for short term, acute use as well as long term use. There are also devices that are appropriate for intermittent, long-term use.

Most CVADs are inserted in the upper body and the internal tip of these catheters is positioned in the distal superior vena cava (SVC), ideally within the lower 1/3 of the SVC, optimally at the junction of the SVC and the right atrium of the heart (RNAO, 2005). These devices include:

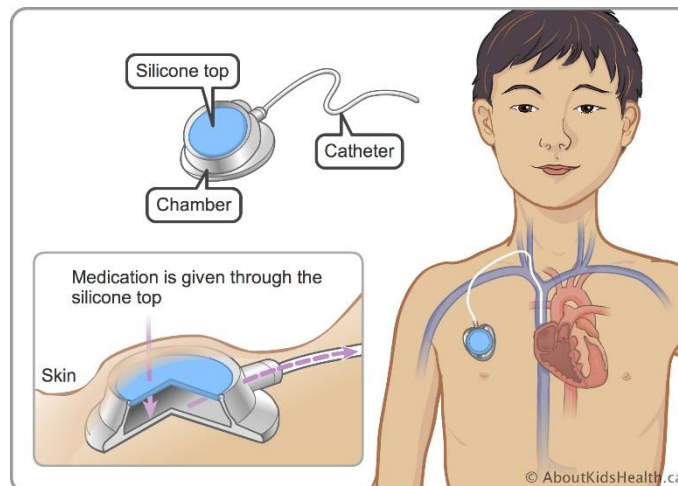
- **Tunneled external catheters** (commonly referred to as CVLs). Tunneled catheters are surgically tunneled through the subcutaneous tissue from the exit site on the chest to the location that the catheter enters the vessel (the entry site), usually the internal jugular vein on the lower portion of the neck. The hub end of the catheter is external and it is through the hub that the catheter is accessed for use.



- Peripherally inserted central catheters (PICCs).** PICCs are considered ‘peripherally inserted’ because they enter a peripheral vein (most commonly the basilic or cephalic veins), usually above the antecubital fossa. They are central catheters because, as previously explained, the tip of the catheter is in the lower third of the SVC. On rare occasions, a PICC may be placed in a peripheral vessel in the leg (usually infants only) and the tip would rest in the inferior vena cava. Some PICCs are cuffed, others use a securing device.



- Totally implanted venous access devices (Ports).** A port consists of a portal body (a chamber) with an attached catheter. The portal body is implanted into a ‘pocket’ that is surgically created in the subcutaneous tissue of the chest. Similar to tunneled external catheters, the attached catheter is tunneled through the subcutaneous tissue to the internal jugular vein where the catheter enters the vessel. The tip of the catheter rests in the SVC. When not in use the entire device is internalized. Only when accessed with a needle is there any external portion.



- **Percutaneous central venous catheters** (non- tunneled, temporary). These catheters are placed directly into the vein, usually the internal jugular (or femoral vein), occasionally the subclavian vein. These catheters are not tunneled and are usually sutured at the site. Often percutaneous catheters are inserted at the bedside in the critical care unit.

When CVADs are inserted in the lower body the internal tip of the catheter is positioned in the inferior vena cava (IVC) or external or common iliac veins.

These include:

- ✓ Femoral lines (see percutaneous central venous catheter above). Inserted directly into the common femoral vein, these are not tunneled and are usually sutured at the site.
- ✓ PICCs inserted in the leg (usually in infants). Most common vein used for a lower limb PICC is the common femoral vein (and rarely the great saphenous or popliteal vein).

Why Use a CVAD?

Although many children can safely and adequately receive their medical treatment with the use of peripheral IVs only, CVADs offer a number of features that make them more suitable, or even necessary, for some populations, treatment needs, or situations. These include:

- ✓ **Stability:** Depending on the device, CVADs can remain in situ for durations of weeks to years, eliminating the need for repeated venipuncture for peripheral IV access.
- ✓ **Rapid hemodilution:** Due to the large flow of blood through the SVC or IVC any medications or solutions infused through CVADs are rapidly diluted and distributed throughout the body. This rapid dilution allows for the administration of hypertonic solutions that would be damaging to smaller vessels.
- ✓ **Safety:** Drugs that are vesicants or vessel irritants are more safely administered through CVADs as there is less potential for extravasation (the inadvertent delivery of the drug into the tissue surrounding the vascular system) which can have serious consequences such as tissue damage or tissue necrosis.
- ✓ **Multi-lumen configurations:** CVADs are available in single and multi-lumen configurations, which allow multiple incompatible infusions to take place at the same time. This is possible because of rapid hemodilution.
- ✓ **Home IV therapy:** The use of CVADs allows many children who are medically able to receive their treatment at home. In some instances this is a short-term situation (e.g. 4-6 weeks of antibiotics to treat osteomyelitis) and in others it is a permanent lifestyle change (e.g. parenteral nutrition in short gut syndrome).
- ✓ **Blood sampling:** CVADs allow for blood sampling, and most blood tests can be taken from CVADs, decreasing the amount of venipunctures children require with blood monitoring.

- ✓ **Large blood flow:** The large volume of blood that flows through the SVC or the IVC provides the large volume/flow rates required for hemodialysis and plasma pheresis.

Due to the above list of CVAD's features, there are a number of clinical situations or categories that are clear indications for the use or need of CVADs. These indications include, but are not limited to:

- ✓ acute hemodynamic monitoring, resuscitation and management
- ✓ long term antibiotics/antifungals or antivirals
- ✓ long term parenteral nutrition
- ✓ poor peripheral venous access
- ✓ frequent blood sampling
- ✓ vesicant or irritant drug administration
- ✓ long term, intermittent drug administration (chemotherapy)
- ✓ hypertonic or hyperosmolar drug or infusate requirements

Types of CVADs

Type of Device	Features	Care Considerations	Common Uses
PICC – Peripherally Inserted Central Catheter	Single or double lumen Sizes: 2.6 Fr to 5 Fr. Cuffed or Un-cuffed	Easily dislodged if not dressed and secured properly Usually restricted to therapies < 6 months Requires routine flushing, locking, cap change, etc Activity restrictions; should not swim or immerse limb in water. Should be protected from water for bathing. PICCs <u>smaller</u> than 3 Fr cannot be reliably evaluated for patency via blood aspiration because of their small diameters.	Many therapies lasting weeks to months (i.e. Home TPN therapy, antibiotics, chemotherapy, etc) Children with difficult venous access.

Tunneled Central Catheter	Single or double lumen Tunneling improves stability of catheter and reduces risk of infection. Cuffed	Requires routine flushing, locking, cap change, etc. Activity restrictions; should not swim or immerse under water Should be protected from water while bathing.	All long term IV needs (i.e. chemotherapy, Home TPN, hemodialysis, etc)
Implanted Ports	Single or double lumen Fully implanted under skin therefore no daily care required when not accessed Decreased risk of infection since there is no external portion when not in use Improved body image	No activity/water restrictions when not accessed Heparinized once a month Accessing requires needle insertion Needle pain management required. Problematic for children with needle phobias	Chemotherapy: protocols administered in cycles Intermittent access requirements (i.e. hemophilia, osteogenesis imperfecta) Chronic conditions requiring frequent hospitalizations

Care and Maintenance of CVADS

The intent of all CVAD care is to keep the device in situ and functioning in a safe manner for the length of time the child requires the device. Although the potential for risks and complications cannot be totally eliminated, proper care of the devices can minimize the risks. Generally the care is aimed at maintaining patency of the device, minimizing the risk of developing a catheter-related infection, and avoiding accidental dislodgment of the catheters.

All CVAD care begins with a vigorous hand wash.



Aseptic No Touch Technique (ANTT)	Clean Procedure
ANTT is a technique used to prevent contamination of key parts and key sites by hand hygiene, non-touch technique, using new sterilized equipment and/or cleaning existing key parts to a standard that renders them aseptic prior to use (Loveday et al, 2014; Rowley & Clare, 2011; Rowley et al 2010) ANTT plus an aseptic field, mask and sterile gloves are required when the CVAD becomes more vulnerable to the introduction of bacteria (i.e. open exposure of the exit site and the catheter hub) which occur during; • Dressing change • Needleless connector change • Accessing a subcutaneous port	Does not require sterile gloves and sterile field however the principles of ANTT still applied when handling syringes, connections of tubing, IV bags, and proper prep of needleless connector with alcohol • Accessing a CVAD through a needleless cap (for hook-up, blood sampling, heparinizing) • Setting up (priming) and hooking up IV administration tubing (if using a needleless connector) • De-accessing a port

Dressing Care

- ✓ **Transparent semi-permeable membrane (TSM) dressing (e.g. Tegaderm IV Advanced®, Opsite®)**, should be the first choice for a CVAD dressing. Its benefits are as follows: it is transparent which allows for constant assessment of the exit site; its entire surface is adhesive providing better security for the catheter; its semi-permeable nature allows body vapor to evaporate through the dressing while it is also water-proof. Gauze should not be placed under transparent membrane dressing as this creates a possible moisture pocket. TSM dressings are changed every 7 days (O'Grady et al., 2011).
- ✓ **Sterile gauze and tape (e.g. Hypafix®)** dressings are most effective if there is moisture or exudate present at the exit site or the child has documented skin reaction to the TSM type of dressing. Gauze and tape dressings should be changed every 2 days (O'Grady et al., 2011).
- ✓ **Hydrocolloid Dressings (e.g. Duoderm®)** or silicone dressings (Mepilex®) are used if a child is known to react to all other dressings/tapes. Hydrocolloid and silicone dressing are associated with a lower incidence of skin reactions.
- ✓ Do not use topical antibiotic ointments or creams on exit sites (except when using hemodialysis catheters) because of their potential to promote fungal infections and antimicrobial resistance.
- ✓ Remember to cleanse the area with chlorhexidine to a distance *beyond* the margins of the dressing, and to cleanse any portion of the catheter that will be under the dressing.

Dressing Change Frequency

Dressing	2 days	7 days	PRN
TSM		✓	• If there is moisture, exudate or bleeding • If the dressing becomes soiled • If the dressing or securement device become loose • If the child complains of new, unexplained pain at the site and site is not visible • Daily dressing for suspected or confirmed site infection or daily observation required
Gauze and Tape	✓		
Hydrocolloid or Silicone	✓		
Securement Device		✓	

Needleless Connector Caps

Needleless connector can be divided by the complexity of their internal mechanisms (simple or complex) and by how they function (negative, positive or neutral displacement) (INS, 2016).

Design

- ✓ Simple Needleless Connectors allow a straight fluid pathway through the center lumen without any internal mechanism to control flow (e.g. a split septum accessed by a blunt cannula or male luer device).
- ✓ Complex Needleless Connectors have a variety of moving internal components that allow fluid flow in both directions (e.g. mechanical valves which are most often a one piece system placed on the catheter hub and access with a male luer device).

Function

- ✓ Neutral displacement needleless connectors contain an internal mechanism designed to prevent blood reflux into the catheter upon connection or disconnection (INS, 2016). These types of connectors are not dependent upon flushing techniques, they can be clamped before and after flushing.
- ✓ Positive displacement needleless connectors allows a small amount of fluid to be held in the device; upon disconnection of the syringe or administration fluid is pushed through the catheter lumen to clear any blood that refluxed into the lumen.
- ✓ Negative displacement needleless connector allows blood reflux into the catheter lumen upon disconnection of the administration set, syringe or blunt needle. Blood allowed to reside inside the lumen will lead to an occlusion therefore it is necessary to use positive pressure flushing technique to overcome this. This can be done by using a steady flush and then clamping the catheter while instilling the last part of the flush.

Routine Care

- ✓ Use ANTT to change needleless connectors
- ✓ Change needleless connectors no more frequently than 96 hours or PRN
- ✓ PRN changes are required if unable to clear blood from within connector cap
- ✓ Disinfect needleless connectors prior to each entry for 15 -30 seconds. Below you will see how your “scrub the hub” removes biofilm buildup in so reducing risk of infection.



Administration Sets

A clean procedure with attention to ANTT by ensuring open ends of tubing and other infusion set components (i.e. filters, y-pieces, extension tubing) are not contaminated as they are being set up.

	24 hours	96 hours	PRN
Administration Sets: Continuous Infusion		✓	• If any portion of the IV administration tubing set up has become accidentally disconnected new tubing must be initiated. • New tubing should always be attached to a newly inserted port needle.(O’Grady, 2011)
Administration Sets: Lipids, intermittent infusions	✓		• If any portion of the IV administration tubing set up has become accidentally disconnected new tubing must be initiated. • New tubing should always be attached to a newly inserted port needle.(O’Grady, 2011)

Common CVAD Complications

CVADs have become integral to the care of acutely and chronically ill children and have transformed the range of treatment, monitoring, and care for pediatric populations.

Despite the benefits of using CVADs, several risks have been associated with their use including occlusions, dislodgement, breakage, and central line associated bloodstream infections (CLABSI). CVAD complications increase morbidity and mortality, length of stay and overall healthcare costs.

Nurses caring for children with CVADs are instrumental in preventing complications. This next section will review common complications; signs and symptoms, potential causes, prevention and management.

Central Line Associated Bloodstream Infections

The most common, serious complication of CVADs is central line-associated bloodstream infections (CLABSI). Not only are catheter-related bacteremia's highly costly to the child and family in terms of morbidity and mortality but in addition provides an unnecessary financial burden to the family and the healthcare system.

If a child with a CVAD presents with a fever, a CLABSI should be considered part of the differential diagnosis.

The classic presentation of CLABSI is abnormal body temperature, abnormal WBC and other typical signs/symptoms of infection. However, the range of clinical presentations is broad and most episodes are not associated with any visible abnormality at the site of the catheter.

Typical signs and symptoms to assess for include:

- ✓ Temperature $\leq 36^{\circ}\text{C}$ or $\geq 38^{\circ}\text{C}$
- ✓ Abnormal WBC
- ✓ Tachypnea, respiratory distress, tachycardia
- ✓ Redness, pain, swelling or drainage at the insertions site or tunneled tract
- ✓ Appears unwell
- ✓ Signs of hemodynamic instability i.e. perfusion abnormality
- ✓ History of recent central line dysfunction or concerns with use of any lumen of the catheter i.e. line patency, pain, fever, unwell with infusion or flushing

Atypical signs and symptoms to assess for include:

- ✓ Parental concern
- ✓ Change in behaviours or interactions with caregivers
- ✓ Irritability
- ✓ Poor feeding
- ✓ Glucose changes

It is important to note, temperature changes or clinical symptoms may be blunted by recent use of antipyretics and anti-inflammatory use (i.e. corticosteroids and other immunocompromising therapy).

If you suspect a CLABSI:

- ✓ Notify the child's care team – see discharge instructions for contact information
- ✓ If signs of sepsis are present send child to local Emergency Department for further investigation and treatment.

There are 5 main theories of the pathogenesis of CLABSI

Cause	Prevention
Contamination on insertion	Maximal sterile barrier for all CVAD insertions; ✓ Cap to cover hair ✓ Mask ✓ Sterile gown ✓ Sterile gloves ✓ Sterile full body drapes Skin antisepsis with approved agent; ✓ Chlorhexidine with alcohol (#1) ✓ Povidone iodine ✓ Alcohol
Hematogenous spread	This refers to the contamination of a CVAD by bacteria or fungus that is present elsewhere in the body; bacteria and fungus have a propensity to attach to foreign objects and once attached may be difficult to eradicate. Though this risk cannot be eliminated it may be minimized. If a patient is known to have a pre-existing bacteremia a CVAD insertion is usually delayed until appropriate antibiotic/antifungal coverage has begun and a negative blood culture has been obtained.
Needless connector/hub contamination	Needleless connectors and catheter hubs provide bacterial access to the bloodstream through migration along the external and internal surfaces of the catheter ✓ Hand hygiene before all CVAD manipulations ✓ Scrub the Hub (15 – 30 seconds) ✓ Aseptic non touch technique (ANTT) with the needleless connector cap change ✓ Follow guidelines for needleless connector cap changes ✓ Change needleless connector cap when blood present or contamination suspected
Contamination from child's own skin flora	The normal flora on a child's skin may cause CLABSI as the catheter creates a break in the skin's usual defensive barrier. ✓ Skin antisepsis with approved agent ✓ Friction on application ✓ Clean beyond the border of the dressings

	✓ Clean the catheter that will be under the dressing ✓ Allow to dry on skin, this improves antimicrobial action of the agent and helps prevent contact dermatitis ✓ ANTT dressing changes as per guidelines
Contaminated infusate (rare)	✓ Using commercially prepared infusates when possible. ✓ Use ANTT when additives are mixed with any infusate

Treatment of Catheter Related Infections

Typically, all types of CLABSI (systemic, site, pocket, or tunnel) should be treated with systemic, IV antibiotics. Empiric treatment is often initiated based on signs and symptoms of infection and once identification of specific organisms is made treatment will be tailored to treat the specific organism.

Treatment of local infections with topical ointments is usually ineffective and may result in resistant organisms. Therefore local infections should also be treated with systemic antibiotics (O'Grady et al., 2011; RNAO, 2005).

CLABSI Bundles

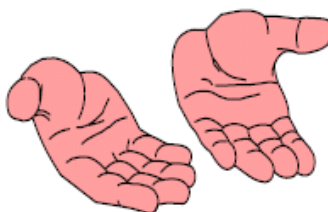
The Institute for Healthcare Improvement (IHI) describes a bundle as groupings of evidence-based best practice that improve patient care, but only when applied together will they result in improved patient outcomes. Below you will find the summary of care element used to reduce CLABSI.

Prevention of CLABSI: The Bundle	
Hand Hygiene	✓ Hand hygiene should be performed before and after accessing, repairing, or dressing a CVAD
Skin Antisepsis	✓ Prepare clean skin with a $\geq 0.5\%$ chlorhexidine preparation with alcohol for dressing changes
Daily Assessment	✓ Daily discussion of line necessity and functionality
Dressing Assessment	✓ Regular assessment of dressing to assure clean/dry/ occlusive ✓ Replace dressing as per best practice guidelines
Standard Access Procedure	✓ Disinfect cap before all line entries by scrubbing with an appropriate antiseptic; alcohol (15 second scrub and allowed to dry) or an alcohol / CHG containing product ✓ Access the port only with sterile devices ✓ Sterile gloves used for needle access for all implanted ports

Standardized dressing, cap and tubing change procedures/timing	✓ Scrub skin around site with CHG for 30 seconds followed by complete drying ✓ Change administration tubing as per best practice guidelines ✓ Change dressing as per best practice ✓ Document date dressing/cap/tubing was changed or is due for change ✓ When hub of catheter or insertion site are exposed, wear a mask (all providers and assistants)—shield patient's face ✓ Sterile gloves used for dressing and cap changes
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Adapted from <http://www.solutionsforpatientsafety.org/wp-content/uploads/SPS-Prevention-Bundles.pdf>

It cannot be overemphasized: proper hand washing is the cornerstone of good aseptic technique.



Occlusions

A CVAD that is functioning well is a catheter that flushes easily and has brisk blood return. This may be dependent on the size of the catheter. The small catheters, lumen volumes and low infusion rates seen in pediatrics put the CVAD at increased risk of occlusions (AVA, 2016).

Degree or Type of Occlusion	Symptoms/Signs		Causes
	Ability to infuse	Ability to aspirate	
Partial	Sluggish flow Resistance with flushing	Resistance	Mechanical, chemical, or thrombotic occlusion
Withdrawal	Yes	No	Mechanical or thrombotic occlusion
Complete	No	No	Mechanical, chemical, or thrombotic occlusion

Source: CVAA: Occlusion Management Guideline (2013)

Causes of CVADs Occlusion

Difficulty flushing a CVAD, occlusion or inability to obtain blood return can be related to a number of causes. These include:

Mechanical occlusion: Occlusion of a CVAD involving a component of the infusion which can be caused by external or internal factors:

- ✓ **Kinks or clamps** on the external portion of the catheter or IV tubing.
- ✓ **Internal catheter migration/malposition.** The internal tip of any CVAD can be inadvertently malpositioned at the time of insertion or may spontaneously move out of optimal position at any time following the insertion. This change of position may happen without any external signs. A CVAD with its internal tip malpositioned may or may not function properly. Occasionally, children who have had their CVAD in situ for years may outgrow their device, hence a previously well-positioned CVAD may present with a catheter that now appears short.
- ✓ **Positional:** Internal catheter in good position (SVC) but 'positional'. The internal tip of a CVAD is not static and undergoes minor position changes frequently. These position changes can be related to: body position changes (i.e. sitting, lying, arm movements) or alterations in intrathoracic pressure (i.e. due to coughing, crying, valsalva maneuver, hemodynamic status). While the function of a CVAD may be temporarily altered by any of these situations it is important to remember that function may also be restored by these same situations (i.e. have child change position, cough, move arm.)

Chemical occlusion: Often related to crystallization of incompatible solutions and/or medications. Usually creates a sudden blockage of a catheter that was previously patent.

Thrombotic occlusion: The body's natural response to irritation or damage to the innermost layer of a blood vessel, the tunica intima, is development of fibrin (the insoluble protein responsible for the semisolid character of a blood clot). The body recognizes a CVAD as a foreign object and attempts to encase it in fibrin; in some cases this is known to begin within 24 hours of the CVAD insertion. The presence of fibrin often causes no problems and is therefore left undetected, however the amount and position of the fibrin may alter the function of the CVAD.

- ✓ **Tip clot.** Fibrin that has developed at the internal tip of the catheter, often only partially attached to the catheter. When flushing or infusing through the catheter the positive pressure causes the fibrin to float away from the lumen opening allowing for normal infusion. However when attempting to draw blood from the catheter, creating a negative pressure or vacuum, the fibrin is drawn back onto the lumen opening, causing a withdrawal blockage.
- ✓ **Fibrin sheath/sleeve clot.** Fibrin that has developed around the catheter like a sleeve; the fibrin may grow along the length of the catheter and protrude beyond the tip. If the fibrin occludes the lumen opening, the infused solution flows backward between the catheter and the fibrin (as if in the space between an arm and a sleeve). This can cause difficult flushing, difficulty drawing blood, leaking at the site, swelling in the neck, and pain or discomfort when using the CVAD.

- ✓ **Vessel thrombus.** A child with a CVAD is at risk of developing a thrombus in the vein associated with the CVAD. Though many thrombi go undetected, others are detected due to presenting symptoms, including pain and edema of the affected limb. Others are incidentally detected while doing tests for other reasons (i.e. Echo). The presence of a thrombus usually does not require device removal. Treatment of a thrombus is at the discretion of the primary service in consultation with Thrombosis service.

Treatment of Occlusions

CVAD occlusions should be treated as soon as possible though need not be treated as an emergent matter. The urgency of the procedure is in relation to need for central access (e.g. hemodialysis, TPN).

Assessment and Management of a CVAD Mechanical Occlusions

Assessment	Key Points
Assess CVAD for mechanical occlusions; - Assess administration set for kinks or closed clamps. - Assess for clogged filter or needleless connector. - Assess catheter for kinks, closed clamps, tight sutures, or change in external length. If any mechanical obstruction are identified and corrected assess the CVAD for patency. If CVAD then flushes freely and blood return restored: continue to use CVAD as usual	- Catheter should be removed from securing devices/tapes for thorough assessment as some kinks are difficult to detect. - If patient uses a non-transparent CVAD dressing should be removed to assess catheter for kinks underneath before proceeding. - Change in external length may indicate change in tip location. Notify the responsible health care team as further investigation may be needed (i.e. chest x-ray to check proper tip location).
Assess by visual inspection and palpation for damaged catheter as evidenced by the following; - Swelling along the catheter pathway - Catheter material bulging - Leaking from catheter	Notify the MD or referring Clinic to arrange follow-up (see discharge instructions)
Is the child complaining of hearing gurgling/swishing sounds or pain during flushing? This may indicate catheter tip malposition	- Notify the MD or referring Clinic to arrange follow-up (see discharge instructions) - Or send child to the Emergency Department as further investigation may be needed.
Assess for a positional CVAD catheter (internal or external); Prior to access, scrub the hub of the needleless connector with an antiseptic swab	The cause of some catheter blockages may be the position of the internal tip resting on the vessel wall. Changes to the child's position may alter the internal tip position and restore patency.

for 15-30 seconds. Allow cap to dry for 15-30 seconds. 2. Flush the CVAD with normal saline using the turbulent flush (push/pause) technique. 3. Have patient change positions while trying above flushing techniques. This includes; changing from lying to sitting, turning head to opposite side of CVAD, and moving arm into different positions (for PICC.)	• Push/pause technique on syringe plunger may create turbulence in catheter facilitating clearance of blockage.
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Assessment and Management of a CVAD Thrombotic Occlusions

Once a mechanical occlusion has been ruled out, you will need to consider whether or not a thrombosis is the cause of the occlusion. Thrombotic occlusions are responsible for most catheter occlusion. Early recognition and intervention will increase the possibility of reestablishing catheter patency therefore decreasing the risk of more serious complication or the need for catheter replacement (AVA, 2016). If a thrombotic occlusion is suspected, the treatment is the administration of alteplase which is a tissue plasminogen activator. If you suspect the catheter patency is questionable contact the referring health care team or the Vascular Access Service at SickKids.

Assessment and Management of a CVAD Chemical Occlusions

Occlusions can be caused by the infusion of crystallized medication or the formation of precipitates with the catheter lumen caused by drug incompatibilities. If the catheter patency becomes sluggish or blocked after administration of an infusion or medication you should assess the catheter and tubing for presence of visible precipitates. Also, review the recent infusion and medication history to help determine the possible cause of the chemical occlusion. Once the incompatibility has been determined a treatment can be identified. If a chemical occlusion is suspected contact the referring health care team or the Vascular Access Service to plan treatment. A medication/infusion history will be helpful in identifying the appropriate unblocking agent.

Precipitate	Treatment (unblocking agent)
Lipid residue	Ethanol
Acidic drug precipitate (low pH: less than 6.0)	Hydrochloric acid(HCl) 0.1N
Alkaline drug precipitate (high pH: greater than 7.0)	Sodium hydroxide (NaOH) 0.1mmol/L Sodium bicarbonate (NaHCO ₃) 8.4%

From CVAA (2013), Occlusion Management Guideline

Preventing Blockages: Implications for Practice

There are a number of practices that can help prevent CVADs from becoming blocked. These practices do not take any extra time and should be readily incorporated into daily, basic CVAD care.

Prevent Reflux of Blood in CVAD Tip	Flushing and Locking	Medication Compatibility
Infusion rate Ideally rates of 20mL/hr (per lumen) should be maintained to ensure patency. It is recognized that not all patients can tolerate this amount of fluid and lower rates may be used. AVA (2016) has suggested rates as low as 1-2mL/hour however the increased risk of catheter occlusion should be considered.	Routine assessment of catheter function: • Flushes easily • Aspirate for brisk blood return Intervene promptly at the earliest sign of occlusion	Assess for compatibilities of medications
Do not let the infusion run dry	Knowledge of the proper clamping sequences for the needleless connector in use	Thorough and adequate flushing of lines (5-10mL of flush solution) is necessary between incompatible infusions
Prevent syringe plunger reflux from rebounding against the bottom of the syringe by stopping at 0.5mL mark when flushing	Use * turbulent or “start – stop” flushing technique	
	Standardized flushing protocol - see patient’s discharge instruction	
	Flush with normal saline after each medication/infusion/blood sampling to clear medications/blood from catheter lumen	
	Lock CVAD after completion of final flush – see patient’s discharge instruction	

*** Turbulent flush** is a method of flushing CVADs that helps maintain patency. When applying pressure to a syringe plunger use a ‘stop and start’ motion, rather than one smooth, continuous motion. This creates turbulence within the catheter (and within the port reservoir) that discourages the buildup of fibrin, lipids, medications, etc. on the inner wall of the catheter.

Malposition /Migration

Catheter malposition is defined as a CVAD tip that has migrated from the original catheter tip location. The optimal tip location for a pediatric patient is in the SVC/RA junction, however catheter tip for neonates may be higher. Complications from tip migration include arrhythmias, thrombosis, and vein perforation (AVA, 2016). Post insertion malposition can be attributed to increased intrathoracic pressure seen with coughing, crying, vomiting or poorly secured catheters.

Symptoms of catheter malposition may not be obvious. Common symptoms include;

- ✓ Inability to flush, infuse or aspirate
- ✓ Arrhythmia
- ✓ Headache, swelling, redness, or discomfort in the arm, shoulder or neck
(Gorski, Perucca,& Hunter, 2010)

Treatment

Treatment for catheter tip malposition varies, depending on the cause. If a catheter is too short or too long will need to have the catheter repositioned in hospital by the Interventional Radiologist. A positional catheter tip may spontaneously reposition into the correct location by repositioning the patient, raising the head of the bed, flushing or changing the intrathoracic pressure by coughing or valsalva maneuver. If the catheter malposition persist (function remains positional) the catheter may need to be further investigated by the hospital healthcare team.

Preventing Catheter Malposition/Migration

- ✓ Monitoring catheter function routinely- does it flush well and is blood return brisk?
- ✓ It is important to assess and document the external length of the catheter.
- ✓ Ensure the CVAD is well secured and that the dressing is dry and intact. (See tips for securement on page 23)
- ✓ Additional support for young children during dressing changes may avoid accidental withdrawal of the catheter.

Dislodgement

Most of the tunneled central catheter and PICCS inserted at SickKids will have a “dacron cuff”, the cuff is buried under the dermis as an internal securing device for the lines. The purpose of the dacron cuff is two-fold:

1. It *helps* to minimize the migration of bacteria through the tract and into to bloodstream.
2. Over time the tissue will grow into the fibers of the cuff and this action *helps* to anchor the line in place.

It is very important however to remember that this dacron cuff is not enough on its own to protect the CVADs from being accidentally dislodged or completely pulled out.

Signs and symptoms of dislodgement include;

- ✓ External length increased
- ✓ Dacron cuff exposed
- ✓ Difficult to aspirate
- ✓ Leaking at exit site
- ✓ Edema
- ✓ Burning sensation or pain with infusions

Treatment

What you do will depend on how much of the catheter has been pulled out. If the line has been completely pulled out apply pressure to the site to stop any bleeding apply band-aid/dressing to site. Please note if a tunneled central line is pulled out you will need to apply pressure at neck as this is where the catheter enters the blood vessel (see image on page 3). Notify caregiver and the responsible health care team to determine next steps.

If the cuff has been 'pulled' and is partially or completely exposed the catheter is at great risk of falling out. Although every attempt should be made to secure the lines so that they do not get dislodged, if it does happen, further attempts should be made to prevent the catheter from coming out completely. There are two important reasons:

1. In many cases, depending on how far the line has come out, the line can continue to be used for vascular access (though it may be important to determine if the line is still 'central' or not).
2. When the catheters are replaced it may be possible to use the same access or tract to insert the new line. This is less involved and less invasive for the patient.

What to Do if the Cuff Comes Out:

- ✓ Ensure line is **extremely well secured** to prevent further migration of the line.
- ✓ Notify the child's health care team to determine the plan of care. Things to consider;
 - **If the device is a PICC** and the tip is no longer in the SVC the line can be used as a midline or peripheral IV. In this case medications and solutions need to be changed to those safe to be given via a peripheral line
 - If the line is being used for medications or solutions that must be infused through central access only (i.e. TPN with dextrose >12.5%) a chest x-ray should be done to determine if the internal tip is still in the SVC (or IVC if lower limb line). If the tip remains in the SVC the line may continue to be used as central access.
 - **If the device is a tunneled central line** and the position of the internal tip is not clear, the line should be heparinized until a full investigation can be done. The child may require peripheral IVs until this time

Prevention

- ✓ Ensure the CVAD is well secured and that dressing is dry and intact. (See tips for securement on page 23).
- ✓ Additional support for young patients during dressing changes may avoid accidental withdrawal of the catheter.

Breakage/Catheter Fracture

CVADs can become damaged if appropriate measures are not taken during insertion or during care and maintenance of the catheter. Causes include: flushing against resistance, use of small volume syringes, stress on the catheter due to clamping, patients pulling on the external portion of the catheter or getting the catheter or infusion caught causing a pulling force on the line. Catheters can also fracture because manufacturing design/quality control (AVA, 2016, Gorski, Perucca,& Hunter, 2010).

Signs and symptoms include:

- ✓ Wet dressing
- ✓ Leaking or swelling at the insertion site
- ✓ Leaking catheter

Treatment

Despite these efforts, a catheter may be found to leak or it may sustain damage to its external portion. It is important to remember that if this does occur a few of the CVADs used at SickKids can be repaired. If a catheter is found to be leaking or broken, the following steps should be taken:

- ✓ All attempts should be made to flush and heparinize the catheter; and the catheter should then be clamped.
- ✓ The site of the leak should be cleansed and covered with sterile gauze.
- ✓ Notified the health care team or go to the Emergency Department

Preventing Catheter Breakage

Damage to the external portion of CVADs can be minimized or prevented. Suggestions to prevent damage include:

- ✓ Ensure the catheter clamp is situated on the thicker, reinforced section of the catheter meant for the clamp
- ✓ Do not bend or kink the catheter in the same location over and over as this may cause wear and weakening of the catheter
- ✓ Prevent the catheter from repeated twisting by always securing the catheter to the body with a securing device or by taping the hub end to the child with hydrocolloid and tape. This prevents the catheter from twisting or kinking, which can lead to catheter damage (and will also help secure the line)
- ✓ Flush with 10 mL or larger size syringe
- ✓ NEVER forcefully flush a catheter

- ✓ NEVER flush a resistant catheter with a small (1mL or 3mL) syringe. The small syringes exert large amounts of pressure and may easily damage the internal or external portion of a catheter. (The pressure generated is extreme despite the fact that normal manual pressure is applied to the syringe plunger.) In extreme cases the catheter may be completely embolized internally
- ✓ NEVER use scissors anywhere near a CVAD

Tips for Securing Tunneled Central Catheters and PICCs

All CVADs must be well secured to the child's body to prevent the catheter from migrating or being dislodged. Things to remember when securing a CVAD include:

- ✓ When changing CVAD dressings ensure the catheter is taped in a 'hook' or 'J' position to reduce risk of dislodgement.
- ✓ If the CVAD has a manifold with 2 holes (a triangular piece) it is StatLock® compatible and should always have a StatLock® in place. The dressing is not enough on its own to adequately secure a CVAD.
- ✓ For CVADs that are not StatLock® compatible (currently the silicone Cook® catheters), the catheter should be **looped** under the **dressing** to allow for slack. This slack will prevent the tension from reaching the exit site should the catheter or IV tubing sustain an unexpected tug.
- ✓ The securement device (StatLock®) or hydrocolloid and tape secures the remaining part of the catheter to the body.
- ✓ As much as possible IV tubing should not be allowed to generously hang where it may easily be tangled in people's feet, chairs, IV poles, etc.
- ✓ Parents should be instructed to pay close attention to IV tubing and the catheter when picking up or moving their child. As well, parents and children (when age appropriate) should be instructed on proper ways of securing the CVAD so that they may also be involved in ensuring the security of the catheter.

Here are a few examples of well secured CVADs:



Accessing and De-accessing Implanted Ports

Accessing subcutaneous ports is a procedure that can be intimidating, however this does not need to be the case; it is important to take the time to understand the parts of and the positioning of a port to make accessing/needle insertion a routine procedure. The following are some important steps and hints to make port accessing easy and less intimidating.

- ✓ **Palpate/Assess.** Before creating your aseptic field take the time to assess the port by palpating it, feeling for location, depth, mobility and position. If done well this will take more time than the actual needle insertion. Also, a thorough assessment will make you more confident with the actual needle insertion.
- ✓ **Needle selection.** Typically there are 3 lengths of port needles (non-coring Huber needles): $\frac{3}{4}$ inch, 1 inch and 1½ inch. There is no formula for determining the correct size; often the child or parents know the size usually used. Otherwise, the child must be assessed to determine how much subcutaneous tissue is above the port. It is safer to have a needle that is a little too long than too short as one that is too short may be easily dislodged (this information should be found within the discharge information).
- ✓ **Child positioning.** The child can be lying or sitting; the child and the nurse must both be comfortable. If the child chooses to sit it is helpful to ensure that his/her back is supported by the back of a chair or the head of the bed. This decreases ability to back away from the needle as it is being inserted. In some situations a parent may also hold the child.

- ✓ **Inserting the needle.** Insert the needle at a 90 degree angle to the surface of the port (as determined during the assessment/palpation). Use a firm, constant pressure until the needle is felt hitting the back of the port; you should feel a definite 'click' as the needle hits the back. The pressure needed to insert the needle is probably greater than you anticipate the first few times. Note: *you cannot damage the port by using adequate pressure to insert the needle.* Once the needle is in place, if you are unable to flush or aspirate blood, ensure the needle is in far enough by simply pushing down on the needle until you can feel the back of the port. Failure to insert the needle completely is often the cause of a newly needled port that that will not flush or draw back.
- ✓ **Port needle removal.** Ensure the port is flushed and heparinized before removing the needle. Care must be taken that a needle-stick injury does not occur by activating the safety device during the needle removal.

Parent Teaching at Home with a CVAD

The child and their caregivers should have received basic safety measures when their child was in hospital however it is always helpful to review care instructions now that they are at home.

The child and family caregivers are encouraged to assist with keeping the CVAD well secured. They should be taught basic emergency care which includes:

- ✓ What to do should the catheter break or leak
- ✓ What to do should the dressing become loose
- ✓ What to do should the needleless connector cap come off
- ✓ Instructions regarding who to contact if they have problems or return to SickKids should the CVAD require repair.

Families should also be provided with an emergency care kit, which includes: padded green clamps, alcohol swabs, sterile gauze, connection caps and tape. These items are simply placed in a clear bag and the family should be instructed to keep it with the child at all times.

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