Treatment of Central Venous Access Device Occlusion - Adult/Pediatric/Neonatal - Inpatient/Ambulatory/Emergency Department

Consensus Care Guideline

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Introduction:

Central venous access devices (CVAD) are used in the clinical care of adult, pediatric, and neonatal patients in both the inpatient and ambulatory settings. They facilitate the administration of drugs, fluids, blood products, and parenteral nutrition. They also allow for the aspiration of blood samples. Compromised CVAD function may interrupt treatment, increase morbidity, decrease patient comfort, and require catheter removal ± replacement resulting in inefficiency and increased cost.[1-6] In the event of a CVAD occlusion, the goal of therapy is to salvage the CVAD rather than replace or remove it. The purpose of this guideline is to provide recommendations for standardizing the management of mechanical, thrombotic, and chemical occlusions.[4,5]

Appropriate flushing and locking may help prevent CVAD occlusion. For flushing and locking recommendations, refer to: Adult – Flushing and Locking of Venous Access Devices and Pediatric – Flushing and Locking of Venous Access Devices.

Catheter clearance techniques for thrombotic or chemical occlusions of mid-line catheters are not included in this guideline since these are not central venous catheters.

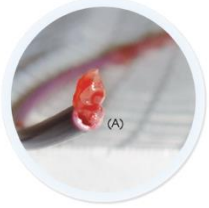
Recommendations provided in this guideline should be useful to physicians, advance practice providers, nurses, and pharmacists. They address appropriate action necessary for the assessment and management of occlusions due to mechanical, thrombotic, or chemical causes in adult, pediatric, and neonatal patients.

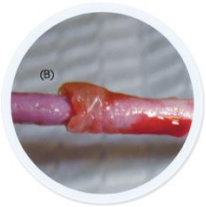
Definitions:

1. Type of occlusions[7,8]
   - 1.1 Mechanical – may be caused by kinks in catheter or tubing, CVAD dislodgement or tip migration, a clogged connector or filter, or incorrect positioning of patient or catheter.
   - 1.2 Chemical – caused by precipitate when incompatible drugs are administered or from lipid build up
   - 1.3 Thrombotic – caused by fibrin build up within or around CVAD or surrounding vessel

2. Degree of occlusion (Table 1)

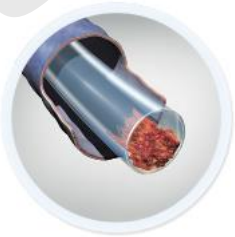
Table 1. Degree of CVAD Occlusions[8-11]

Degree of Occlusion	Signs	Causes	Diagram
Partial	Sluggish flow through catheter Resistance with flushing and aspiration	Mechanical Chemical Thrombotic	
Withdrawal	Able to infuse without resistance Unable to withdraw blood	Mechanical Thrombotic	

Complete	Unable to infuse or withdraw blood	Mechanical Chemical Thrombotic	

3. Type of thrombotic occlusion (Table 2)[11]

Table 2. Type of Thrombotic Occlusion

Type of Thrombotic Occlusion	Description	Diagram
Fibrin tail or flap	Extends from the catheter tip but is drawn inward, blocking the opening of the catheter lumen on aspiration attempts, resulting in an ability to infuse fluids but an inability to withdraw blood	
Intraluminal thrombus	Occurs when blood refluxes inside the catheter lumen, commonly caused by coughing, inadequate flushing after blood draws or after checking for blood return, or improper use of flush syringes	
Mural thrombus	Forms where the catheter touches or “rubs” the vein wall	
Fibrin sheath	Forms when fibrin adheres to the external catheter surface, which may include the entry site, and may encase all or part of the catheter like a sock and could completely cover the opening of the catheter tip	

Recommendations

1. Assessment of catheter patency should be done by a health care professional who is knowledgeable in CVAD use and maintenance.
2. Assess CVAD patency and identify the type of occlusion by flushing affected lumen(s) and attempting to withdraw blood using a 10 mL syringe of preservative free normal saline[9,12] *(UW Health GRADE moderate quality evidence, strong recommendation)*

   Sluggish blood flow is present when it is difficult to flush the CVAD or inability to withdraw less than 3 mL of blood in 3 seconds.[9,10] Table 3 lists common signs of CVAD occlusion and can assist in the assessment of occlusion type.

Table 3. Signs of CVAD Occlusion[6,9,12,13]

Infusion or Flushing	Aspiration
Resistance when flushing Sluggish flow Unable to infuse fluids Frequent occlusion pump alarm Infiltration, extravasation, swelling or leaking at insertion site	Unable to withdraw blood Sluggish blood return

3. Once the type of occlusion is identified it should be treated with the recommended management strategy.[14]
4. Attempt to resolve occlusion using mechanical manipulations first[14,15] *(UW Health moderate quality evidence, strong recommendation)*
5. If unable to determine the type of occlusion, initially treat as a thrombotic occlusion[10,14] *(UW Health low quality evidence, conditional recommendation)*
6. Alteplase is not effective in restoring patency to a CVAD due to mechanical or chemical occlusion[5,8,9,12,13,16] It should be used only to restore patency to lines occluded by thrombus.

Mechanical Occlusions

A CVAD occlusion caused by a mechanical process can be either internal or external. Common external causes include clamped or kinked catheter tubing. Common internal causes include incorrect positioning of the catheter tip, kinking of catheter inside vein, or the catheter tip adhering to the vessel wall.[8,14,17]

1. Assess catheter for signs of a mechanical occlusion[8,14,15,17]
   a. Visually inspect the CVAD and administration set for signs of kinked or clamped tubing, loose tubing connections, clogged filter, tight sutures, or change in external catheter length.
   b. Inspect visually and by palpation for catheter damage as seen by swelling, bulging, or leaking from CVAD.
   c. Consider subjective complaints from patients that may suggest occlusion (e.g., report of audible swishing sound, pain during infusion, or experiencing altered sensation during infusion)
2. Resolve the mechanical occlusion[8,14,15,17,18]
   a. Remove any add-on devices (cap/needleless connectors)
   b. Change dressings and assess sutures or other securement devices to ensure no kinking

   c. Replace clogged filter
   d. Repair or replace a damaged catheter
3. Attempt to move catheter tip away from vessel wall by repositioning patient (raise arms and sit forward, rolls shoulders backward, lie down, forced coughs, or deep inhalations)[18,19]
4. Consider a chest x-ray if catheter placement is questionable or to assess for internal kinking, pinch-off syndrome, and positioning of catheter tip.[14]
5. If initial radiographic examination is unremarkable, consider a dye study for further evaluation of possible catheter tip malposition, extensive fibrin formation, or thrombosis.[20,21]

Thrombotic Occlusions

Alteplase (Cathflo Activase®) is FDA approved (2005) for restoration of function to central venous access devices. Three clinical studies which demonstrate safety and efficacy were performed in patients with improperly functioning central venous access devices (CVADs). The trials are described in the prescribing information.[16] When used as directed, systemic plasma levels of alteplase are not expected to reach pharmacologic concentrations. If a 2 mg dose was administered by bolus injection into the systemic circulation, the concentration of circulating alteplase would be expected to return to endogenous circulating levels (5-10 ng/mL) within 30 minutes. UW Health has utilized Cathflo Activase® for catheter occlusion clearance for several years.

1. Assess for signs of a thrombotic occlusion (visible blood in the catheter or add-on devices, inability to infuse or aspirate blood, or sluggish flow)[8,12-14,18]
2. Alteplase (Cathflo Activase®) should be used to resolve thrombotic occlusions
   a. Anticoagulants such as heparin are ineffective for restoring catheter patency.[22]
3. Alteplase weight-based dose (*If the line is a double or triple lumen, the dose listed is sufficient to use for each occluded lumen): (*UW Health very low-quality evidence; conditional recommendation*)
   a. 30 kg or greater: 2 mg/2 mL[16]
   b. 10-30 kg: 1 mg/1 mL
   c. Less than 10 kg: select appropriate volume from Appendix A
   d. Implanted ports: 2 mg/2 mL regardless of weight or age
   e. Doses should not exceed 2 mg/2 mL

Appendix A. Pediatric PICC Line Volume (weight less than 10 kg)[16,22-24] :

The objective is to instill 110% of the internal lumen volume with alteplase, allowing the overfill to act on any clot outside of the catheter (Table 2). The systemic exposure of this additional alteplase is generally considered to be clinically negligible, and the benefit of ensuring adequate exposure of the clot to the instilled alteplase outweighs the risk in most situations.
NOTE: Pediatric central lines may be cut to fit smaller patients and so are not the original length provided by the manufacturer.
Please review Lines, Drains, and Airways (LDA) Properties in Health Link for the line length after cutting.
Priming volume = [Reduced length (cm) / total length (cm)] x total length priming volume
*If line is a double or triple lumen, the volume listed for the size of catheter is sufficient to use for each occluded lumen.

4. Alteplase (Cathflo Activase®) kits are stocked on some patient care units in refrigerated Acudose cabinets or the kit will be sent from the central pharmacy
   Kit contents
   a. One vial of alteplase injection (Cathflo Activase®) for reconstitution 2 mg
   b. One bottle of sterile water for injection 10 mL
   c. Instructions for reconstitution
5. Reconstitute alteplase immediately before use.
6. Aseptically reconstitute by adding 2.2 mL sterile water for Injection to the vial, directing the diluent stream into the powder.[16]
   a. Let the vial stand undisturbed to allow large bubbles to dissipate.
   b. Mix gently, swirling until completely dissolved. Complete dissolution should occur within 3 minutes. DO NOT SHAKE.
   c. Inspect the solution to ensure it is free from foreign matter or discoloration. It should be a colorless to pale yellow transparent solution.
   d. The final concentration is 1 mg/1 mL.
7. Using a 10 mL syringe, draw up the appropriate dose and administer per procedure outlined in Nursing and Patient Care Policy AP 1.56 Central Vascular Access Device Use, Maintenance, and Removal (Adult and Pediatric).
   a. Do not force solution into catheter.
8. After a 30-minute dwell time, assess catheter function by attempting to aspirate blood. If the catheter is functional, go to step 10.; if not functional, go to step 9.
9. If catheter remains nonfunctional, let alteplase dwell for another 90 minutes (total dwell time is 120 minutes) and reassess function. If the catheter is functional, go to step 10. If the catheter is still occluded, a second alteplase dose of equal amount may be instilled, repeating steps 6-8.
   a. Consider extending dwell to 24-72 hours after consulting with the provider[22]
   b. **No more than two doses of alteplase may be administered per occluded lumen.**
10. If catheter function has been restored, aspirate blood volume indicated to remove alteplase and residual clot:
    a. For weight greater than or equal to 30 kg, aspirate 4-5 mL
    b. For weight less than 30 kg, aspirate a blood volume that is twice the administered volume of alteplase (e.g. aspirate 2 mL of blood when 1 mL of alteplase is administered) [*UW Health very low quality evidence; conditional recommendation*]
    c. Discard aspirate and flush catheter with 0.9% sodium chloride.
11. Discard any unused alteplase solution.
12. Contact provider if CVAD function is not restored after **second** alteplase administration.
    a. Consider chest Xray to verify catheter tip position
    b. Consider dye study to rule out mechanical occlusion or vessel thrombosis.
13. If CVAD function is restored, resume IV fluids, medications, or lock as appropriate.
14. Monitor for adverse effects, including bleeding.

Chemical Occlusions

Chemical occlusions occur when precipitates form within the lumen of the CVAD and when lipid residue builds from continuous administration of 3-in-1 parenteral nutrition. Common causes of chemical occlusions include co-administration of incompatible medications or lipid infusions.[7,15]

Catheter salvage is the main goal of treatment and attempts to clear chemical precipitate or lipid residue should be tried. Agents known to dissolve precipitate can be considered to restore patency. Chemical occlusions make up a smaller percentage of catheter occlusions therefore thrombotic and mechanical occlusions should be ruled out before treating for chemical occlusion.[7]

1. Assess for signs of a chemical occlusion through visual observation of precipitate or identification of co-administration of incompatible medications and/or fluids[15,25-29]
2. Select the corresponding clearance agent (Table 4) and instill sufficient volume to fill the catheter lumen.
3. Do not administer overfill.[14]
4. Use of 70% ethanol in a polyurethane catheter may result in damage to the catheter. Use with caution.

Table 4. Types of Chemical Occlusion and Treatment Options[15,25-29]

Cause	Clearance Agent	Dwell Time
Calcium Phosphate Precipitate	L-Cysteine 50 mg/mL	Irrigate with gentle to and fro motion for 1-2 minutes. If not restored, dwell 60 minutes and repeat above hourly
Acidic Drug Precipitate – pH < 6 (ex. vancomycin, piperacillin, parenteral nutrition amino acids)	L-Cysteine 50 mg/mL	60 minutes
Alkaline Drug Precipitate – pH > 7 (e.g. phenytoin, acyclovir, ganciclovir, ampicillin, heparin)	Sodium bicarbonate ($NaHCO_3$) 8.4% 1 meq/mL	60 minutes
Lipid Deposition (e.g. parenteral nutrition)	70% Ethanol	60 minutes

5. May repeat instillation of catheter clearance agent once if necessary[18]
6. If patency is restored, then follow the procedures outlined in Nursing and Patient Care Policy AP 1.56 Central Vascular Access Device Use, Maintenance, and Removal (Adult and Pediatric)
    a. Adults: withdraw 5 mL, discard, and flush catheter with 20 mL 0.9% sodium chloride
    b. Pediatrics: withdraw 1-2 mL, discard, and flush catheter with 5-10 mL of 0.9% sodium chloride
6. Resume IV fluids, medications, or lock CVAD as appropriate
7. If patency is not restored, consult provider.[14]

Disclaimer

Consensus care guidelines assist clinicians by providing a framework for the evaluation and treatment of patients. This guideline outlines the preferred approach for most patients. It is not intended to replace a clinician's judgment or to establish a protocol for all patients. It is understood that some patients will not fit the clinical condition contemplated by a guideline and that a guideline will rarely establish the only appropriate approach to a problem.

Methodology

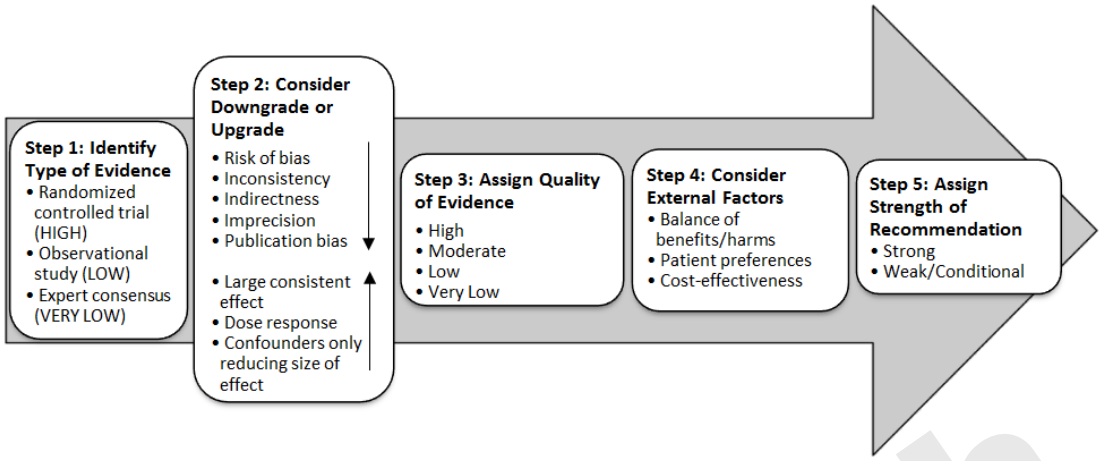


Table 1. GRADE Ranking of Evidence

High	We are confident that the effect in the study reflects the actual effect.
Moderate	We are quite confident that the effect in the study is close to the true effect, but it is also possible it is substantially different.
Low	The true effect may differ significantly from the estimate.
Very Low	The true effect is likely to be substantially different from the estimated effect.

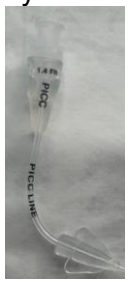
Table 2. GRADE Ratings for Recommendations for or Against Practice

Strong (S)	Generally, should be performed (i.e., the net benefit of the treatment is clear, patient values and circumstances are unlikely to affect the decision.)
Conditional (C)	May be reasonable to perform (i.e., may be conditional upon patient values and preferences, the resources available, or the setting in which the intervention will be implemented.)

Appendix A. Pediatric PICC Volume Tables for Patients < 10 kg

Effective 5/17/2024. Contact CCKM@uwhealth.org for previous versions

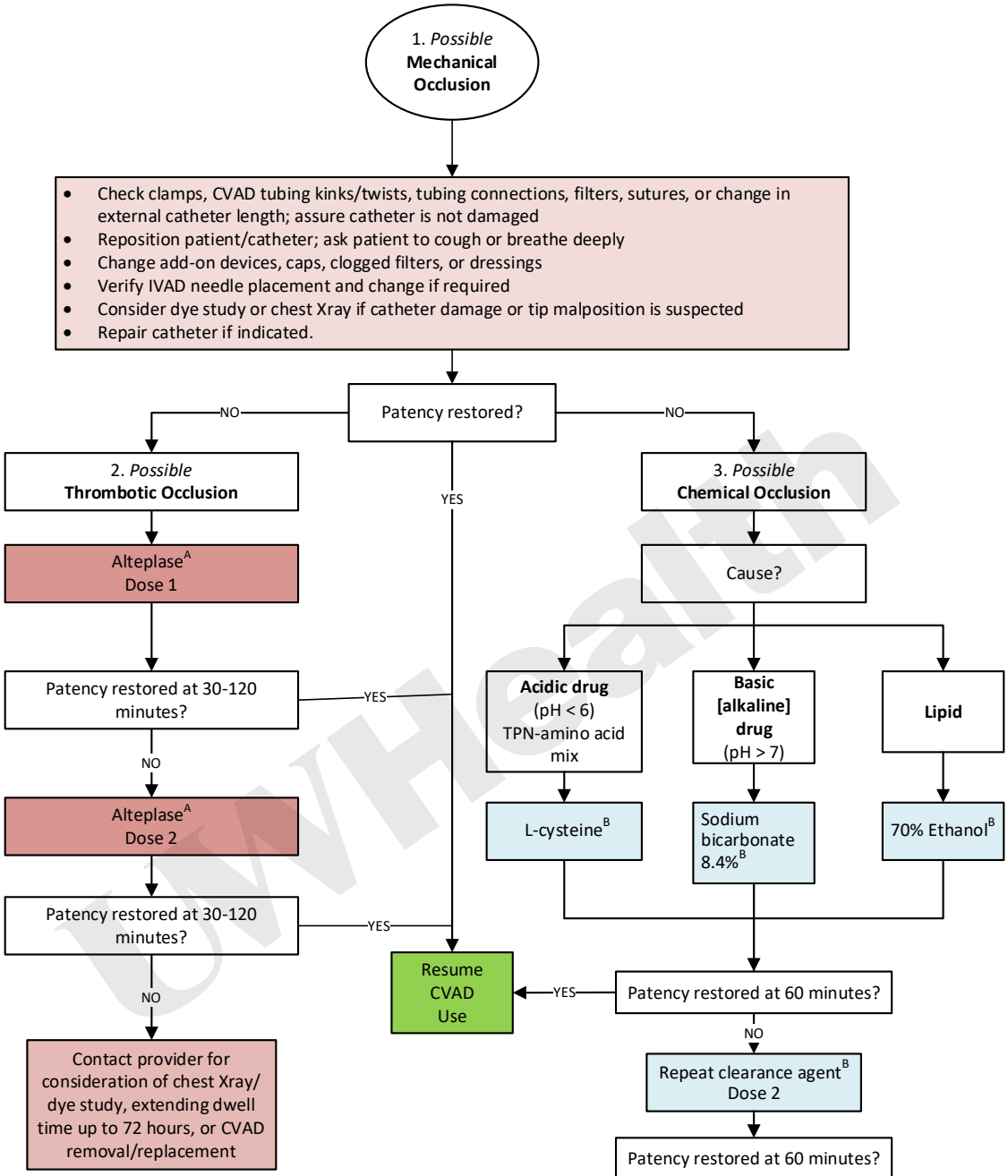
Neonatal PICC's *Volumes listed below do not include microclave volume (0.05 mL). Best practice: attach syringe directly to the catheter hub to instill alteplase

Line Size	**1.0 French** Single Lumen	**1.4 French** Single Lumen	**1.9 French** Single Lumen	**1.9 French** Single Lumen	**1.9 French** Single Lumen	**1.9 French** Single Lumen	**2.6 French** Double Lumen
Total Length	20 cm	30 cm	30 cm	30 cm	50 cm	50 cm	50 cm
Brand	Vygon 	Footprint Polyurethane 	Footprint Silicone 	Argon / L-Cath 	Argon/ First PICC 	Medcomp 	Medcomp 
Uncut Volume	0.09 mL	0.14 mL	0.12	0.1 mL	0.13 mL	0.21 mL	0.22 mL
Cut Length	*Volumes for Cut Lines 110% Lumen Priming Volume (mL)						
10-15 cm	0.07	0.08	0.07	0.06	0.04	0.07	0.07
16-20 cm	0.10	0.10	0.09	0.07	0.06	0.09	0.1
21-30 cm	-	0.15	0.13	0.11	0.09	0.14	0.15
31-40 cm	-	-	-	-	0.12	0.18	0.19
41-50 cm	-	-	-	-	0.14	0.23	0.24

Pediatric PICC's

Line Size	**3 French** Single Lumen	**4 French** Single Lumen	**4 French** Double Lumen
Total Length	45 cm	55 cm	55 cm
Brand	Bard PowerPICC	Bard PowerPICC	Bard PowerPICC
Uncut Volume	0.53 mL	0.67 mL	0.52 mL
Cut Length	*Volumes for Cut Lines 110% Lumen Priming Volume (mL)		
10-15 cm	0.19	0.20	0.16
16-25 cm	0.32	0.34	0.26
26-35 cm	0.45	0.47	0.36
36-45 cm	0.58	0.60	0.47
46-55 cm	-	0.75	0.57

Appendix B. CVAD Occlusion Management Algorithm



[A]Alteplase Dose

Patient Weight	Alteplase Dose
30 kg or greater	2 mg/2 mL
10 – 30 kg	1 mg/1 mL
Less than 10 kg	See Appendix A for volume
Implanted port	2 mg/2 mL regardless of weight or age

Dose may not exceed 2 mg/2 mL

[B]Chemical Clearance Agent Dose: fill volume of lumen

Broadhurst D, Cernusca C, Cook C, et al. CVAA Occlusion Management Guideline for Central Venous Access Devices. *Vascular Access*. 2019;13(1):1-30.
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Collateral Tools & Resources

Delegation Protocols
[16] – Central venous access device clearance – adult/pediatric/neonatal

Order Sets & Smart Sets
[3600] – IP/OP - Catheter Clearance – Supplemental Order Set

Policies
UWHC Nursing and Patient Care Policy1.56 AP Central Vascular Access Device Use, Maintenance, and Removal (Adult and Pediatric)

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