

SUPPLEMENTAL DIGITAL CONTENT 1. Children's Hospital of Pittsburgh Antimicrobial Lock Therapy Guideline

Antimicrobial Lock Therapy: Guidelines for Antibiotic, Antifungal, and Ethanol Locks

I. PURPOSE:

To improve the effectiveness of IV anti-infective therapy through the use of "Antimicrobial Lock Therapy". Antimicrobial lock therapy involves the instillation of high concentrations of antibiotics such as vancomycin or gentamicin or antifungal agents such as Ambisome® or ethanol lock into central venous catheters (CVC) with prolonged dwell times to eradicate bacterial or fungal organisms that may exist.

Provider specific information can be found in the CHP formulary.

NOTE:

Ethanol 25% lock solutions are used prophylactically in patients with a history of frequent CVC infections after the infection has been eradicated to prevent future infections. This concentration is not used in combination with systemic therapy to treat a CVC-related blood stream infection.

Ethanol lock therapy in polyurethane containing catheters can cause micro-cracks or degeneration of the internal wall of the catheter. NO changes have been observed in silicone catheters.

Any Cook Spectrum™ central venous catheter should not be used for ethanol lock therapy because the ethanol may remove the antimicrobial coating from the catheter and reduce the catheter's antimicrobial efficacy.

II. GUIDELINES AND INFORMATION FOR ANTIMICROBIAL LOCK THERAPY:

1. Prophylactic ethanol 25% locks are used when the affected catheter can be locked for 4-12 hours per day.
2. Ethanol 25% locks are used prophylactically after the CVC blood stream infection has been eradicated.
3. The duration of ethanol 25% lock prophylaxis is indefinite.
4. Antibiotic, Ambisome®, and ethanol 50% lock solutions are used in combination with IV anti-infective therapy to treat existing central line infections.
5. The duration of antibiotic, Ambisome®, and ethanol 50% lock therapy is based upon the patient's response and is generally 10-14 days after the 1st negative blood culture.
6. Antibiotic, Ambisome® and ethanol 50% lock solutions are generally used when the infected CVC can be "locked" (i.e. dedicated to the lock solution and not used for other purposes) for at least 6-12 hours per day for antibiotics, 8-12 hours per day for Ambisome® locks, and 4-12 hours per day for ethanol 50% locks.
7. Antibiotics are prepared in 0.9% sodium chloride; Ambisome® and ethanol locks are prepared in sterile water for injection.

8. Concentrations for antimicrobial lock solutions include: Vancomycin 5 mg/ml in 0.9% sodium chloride
 1. Vancomycin 5 mg/ml in 0.9% sodium chloride
 2. Gentamicin 5 mg/ml in 0.9% sodium chloride
 3. Tobramycin 5 mg/ml in 0.9% sodium chloride
 4. Ceftazidime 2 mg/ml in 0.9% sodium chloride
 5. Amikacin 2 mg/ml in 0.9% sodium chloride
 6. Linezolid 2 mg/ml in 0.9% sodium chloride
 7. Levofloxacin 2mg/ml in 0.9% sodium chloride
 8. Piperacillin/tazobactam 40 mg/ml piperacillin in 0.9% sodium chloride
 9. Ambisome® 2 mg/ml in sterile water for injection
 10. Ethanol 25% locks in sterile water for injection
 11. Ethanol 50% locks in sterile water for injection
 12. Additional antimicrobial locks may be utilized based on culture and sensitivity results and allergy history.
9. All catheters listed in Appendix A are silicone containing unless specifically identified as containing polyurethane.
10. Ethanol lock therapy in polyurethane-containing catheters can cause micro-cracks or degeneration of the internal wall of the catheter. NO changes have been observed in silicone catheters.
11. Any antimicrobial central venous catheter should not be used for ethanol lock therapy because the ethanol may remove the antimicrobial coating from the catheter and reduce the catheter's antimicrobial efficacy.
12. Careful maintenance of the infected CVC is necessary, which includes flushing of the line with 0.9% sodium chloride before and after the antimicrobial lock using the push-pause method and scrubbing each hub for 15 seconds each and allowing to dry for 3-5 seconds.
13. All antimicrobial locks, with the EXCEPTION of Vancomycin, Gentamicin and Ambisome®, require ID approval. Nearly all uses of antimicrobial lock therapy will be limited to tunneled or long-term catheters.
14. Monitoring of trough blood levels for gentamicin or tobramycin is necessary when gentamicin or tobramycin locks are used more than once daily or when multiple lines or lumens are involved.
15. Ethanol 70% locks are not permitted due to the potential for line occlusion and potential clot formation.

III. PROCEDURE

1. The order for antibiotic lock therapy is entered in the e-record by utilizing the Antibiotic Lock Therapy Order Set.
2. When dispensed, Pharmacy will affix a red-colored "NOT FOR INJECTION" sticker to each syringe.
3. Fill volume:

1. The volume of the antimicrobial lock solution to be instilled in the central line can be found Appendix A. This volume includes catheter fill volume PLUS 0.1ml needleless connector fill volume.
2. If the line is not listed, the volume is determined by adding 0.1 mL (for the volume of the needleless connector) to the volume of the central venous catheter usually printed on the external portion of the lumen of the catheter or documented in the line insertion note in the e-record (e.g, if the printed volume on the lumen is 0.7 mL, add 0.1 mL for the volume of the needleless connector and the total lock volume is 0.8 mL).
3. The volume of the antimicrobial lock solution to be instilled in the port requires a calculation. Refer to Appendix A to calculate the volume of each of these port segments.
 - a. Volume to be administered = Catheter Length (cm) x Catheter Volume per cm + Port Volume (ml) + port needle priming amount (0.3ml) + Needleless Connector amount (0.1ml)
4. The usual sequence for flushing with 0.9% sodium chloride, instilling the antimicrobial lock solution, and flushing with heparin is:
 1. Check for potential patient allergy to ordered lock solution
 2. If line is not currently locked:
 - a. Instill 10 mL of 0.9% sodium chloride flush using the recommend push/pause flush method to clear the line (if patient is not fluid restricted).
 - b. Aspirate to check for blood return. If no blood return is present, refer to policy PTCMDIV802 Central Venous Catheter Clearance Using Alteplase or Hydrochloric Acid.
 - c. Once the line is determined to have a good blood return, continue with the locking process.
 3. Locking Process:
 - a. Instill 10 mL of 0.9% sodium chloride flush using the recommend push/pause flush method to clear the line (if patient is not fluid restricted) and should occur prior to checking for blood return.
 - NOTE: If Ambisome® lock is being used, follow the saline flush with D5W in a sufficient volume to clear the saline (10 mL), due to saline's incompatibility with ambisome.
 - b. Instill antimicrobial lock per provider order. If line has a slide clamp, engage the clamp
 4. If the line is currently locked:
 - a. Remove antimicrobial lock after appropriate dwell time.
 - b. Aspirate the antimicrobial lock medication ensuring that blood return only enters the lumen and does not go through the cap.
 - In some cases, the entire lock volume may not be retrievable. As long as the attempt was made to remove the lock solution, it is acceptable to proceed with flushing if no contraindications (The volume remaining will not harm the patient).

- NOTE: Notify the primary service of any issue with retrieving the full volume of the lock as changes to therapy may be needed.
 - c. If no blood return is present, refer to policy PTCMDIV802 Central Venous Catheter Clearance Using Alteplase or Hydrochloric Acid.
 - d. Once the line is determined to have a good blood return, continue with the locking process.
5. Once lock therapy is completed and the lock has been aspirated:
- a. Instill 0.9% sodium chloride flush (or D5W followed by saline for Ambisome®) in sufficient volume to fully clear the catheter (10 ml) using the push-pause method.
 - Instill heparin flush per policy PTCMDIV818 (Central Venous Access Device Care) using the push-pause method.
 - NOTE: When continuous IV fluids are administered after the antimicrobial lock is removed, the heparin flush may not be required. The lock solution should always be preceded and followed by a saline (or D5W flush for Ambisome®) to prevent the solution from coming into contact with other medications including heparin. The use of heparin to prevent clot formation is required (Note: Since heparin has limited compatibility with these anti-infectives, it is not mixed with antimicrobial lock solutions but is administered separately as an IV flush according to the sequence above).
5. IV lines that are locked will be identified with an ancillary brightly colored label attached near the IV cap describing the lock, e.g., "This line locked with vancomycin."
6. All infected lumens of a central line must be locked unless it is not logistically possible (e.g., other IV fluids and medication are required to be administered preventing the infected lumen to be locked). In this case, all attempts should be made to infuse medical therapies through the most distal lumen of the catheter to prevent the lock solution from coming into contact with other medications. Lumen locks may be rotated at the service's discretion.
7. The recommended dwell time for antibiotic lock therapy is 6-12 hours per day for antimicrobial locks; 8-12 hours per day for Ambisome®, and 4-12 hours per day for both 25% and 50% ethanol locks. However, shorter and more frequent periods are permitted with provider order. (Note: efficacy may be reduced when dwell time is less than recommended.)

REFERENCES

Cook Medical (2013). *Cook Spectrum® Silicone Cuffed Central Venous Catheter*. Retrieved from <https://ifu.cookmedical.com/ifuPub/searchIfu.jsf>

McGhee W, Howrie D, Schmitt C, et al. *Pediatric Drug Therapy Handbook & Formulary*. 8th ed. Hudson, OH: Lexi-Comp Inc.; 2020.

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APPENDIX A

Each volume listed is the total amount to be administered.
This includes catheter fill volume *PLUS* 0.1ml needleless connector fill volume (*except implanted ports*)

Cook Spectrum® (Antimicrobial) Hyperalimentation System Catheter (HAS – long-term cuffed)				
French Size	Description	Small Lumen #1 Volume (ml)	Small Lumen #2 Volume (ml)	Large Lumen Volume (ml)
4.0	Cook Spectrum® Hyperalimentation System Catheter 25cm.	0.2		
5.0	Cook Spectrum® Hyperalimentation System Catheter 25cm.	0.3		
7.0 D	Cook Spectrum® Hyperalimentation System Catheter 20cm. & 25 cm.	0.2		0.2
9.0 D	Cook Spectrum® Hyperalimentation System Catheter 25cm.	1.1		1.2
8.0 T	Cook Spectrum® Hyperalimentation System Catheter 25cm.	(Red) 1.0	(Blue) 1.0	(Yellow) 1.2
Cook™ Central Venous TPN Catheters *Catheter Discontinued but may still be in patient population (Tunneled and Cuffed)				
French Size	Description	Small Lumen #1 Volume (ml)	Small Lumen #2 Volume (ml)	Large Lumen Volume (ml)
3.0	TPN Single Lumen Catheter*	0.5		
4.0	TPN Single Lumen Catheter*	0.6		
5.0	TPN Single Lumen Catheter*	0.8		
5.0 D	Double Lumen TPN Catheter	0.6		0.6
6.0 D	Double Lumen TPN Catheter	0.7		0.8
6.5	TPN Single Lumen Catheter*	1.2		
7.0 D	Double Lumen TPN Catheter	0.8		1.0
9.5	TPN Single Lumen Catheter*	2.3		

9.0 D	Double Lumen TPN Catheter*	1.7		2.2
10.0 D	Double Lumen TPN Catheter*	1.8		1.8
12.0 D	Double Lumen TPN Catheter*	2.1		2.8
8.0 T	Triple Lumen TPN Catheter*	1.3	1.3	1.9
Cook™ Central Venous Catheters (Nontunneled and Noncuffed)				
French Size	Description	Distal Lumen Volume (ml)	Mid Lumen Volume (ml)	Proximal Lumen Volume (ml)
3.0	<u>Polyurethane</u> Central Venous Catheter (5cm & 8cm)	20G- 0.2		
4.0 D	<u>Polyurethane</u> Antimicrobial Coated Catheter	20G - 0.3		22G - 0.3
4.0 D	<u>Polyurethane</u> Central Venous Catheter (5cm and 8cm)	20G - 0.3		23G - 0.3
5.0 D	<u>Polyurethane</u> Central Venous Catheter (5cm and 8cm)	20G - 0.3		20G - 0.3
5.0 T	<u>Polyurethane</u> Antimicrobial Coated Catheter	18 G- 0.4	23 G- 0.3	23G- 0.3
5.0 T	<u>Polyurethane</u> Central Venous Catheter (12cm)	18G - 0.4	23G - 0.3	23G - 0.3
7.0 T	<u>Polyurethane</u> Antimicrobial Coated Catheter	16 G- 0.6	18 G- 0.7	18 G- 0.7
7.0 T	<u>Polyurethane</u> Central Venous Catheter (15cm)	16G - 0.6	18G – 0.4	18G – 0.4

Cook™ Peripherally Inserted Central Catheters (PICCs)				
French Size	Description	Distal Lumen Volume (ml)	Mid Lumen Volume (ml)	Proximal Lumen Volume (ml)
3.0	Spectrum <u>Polyurethane</u> Turbo-Ject Antimicrobial Catheter	19G- 0.62		
4.0	Spectrum <u>Polyurethane</u> Turbo-Ject Antimicrobial Catheter	17 G- 0.86		
4.0 D	Spectrum <u>Polyurethane</u> Turbo-Ject Antimicrobial Catheter	22G- 0.71		24G- 0.56
5.0	Spectrum <u>Polyurethane</u> Turbo-Ject Antimicrobial Catheter	17G- 1.1		
5 D	Spectrum <u>Polyurethane</u> Turbo-Ject Antimicrobial Catheter	18G- 0.82		18G- 0.82
6 T	Spectrum <u>Polyurethane</u> Turbo-Ject Antimicrobial Catheter	17G- 1.14	19G- 0.83	19G- 0.83

BARD™ Central Venous Catheters (Tunneled and Cuffed)				
French Size	Description	White Lumen	Red Lumen	Blue Lumen
2.7	Broviac™ Single Lumen Catheter (silicone)	0.3		
4.2	Broviac™ Single Lumen Catheter (silicone)	0.4		
6.6	Broviac™ Single Lumen Catheter (silicone)	0.8		
7.0 D	Hickman™ Dual Lumen Catheter (silicone)	0.7	0.9	
9.0 D	Hickman™ Dual Lumen Catheter (silicone)	0.7	1.2	

9.6	Hickman™ Single Lumen Catheter (silicone)	1.9		
12.0 D	Hickman™ Dual Lumen Catheter (silicone)	1.9	1.9	
10.0 T	Hickman™ Triple Lumen Catheter (silicone)	1.5	0.9	0.9
12.5 T	Hickman™ Triple Lumen Catheter (silicone)	1.7	0.8	0.8
10.0 D	Leonard™ Dual Lumen Catheter (silicone)	1.4	1.4	
4.0	Hohn™ Single Lumen Catheter (silicone)	0.3		
5.0	Hohn™ Single Lumen Catheter (silicone)	0.4		
5.0	Hohn™ Single Lumen Catheter with VitaCuff® Antimicrobial Cuff (silicone)	0.4		
7.0 D	Hohn™ Dual Lumen Catheter (silicone)	0.3	0.4	
7.0 D	Hohn™ Double Lumen Catheter with VitaCuff™ Antimicrobial Cuff (silicone)	0.3	0.4	
BARD™ PowerPICC				
French Size	Description	Lumen 1 (ml)	Lumen 2 (ml)	
3F	Provena Polyurethane Catheter Single Lumen	0.63		
3F	SV Polyurethane Catheter Single Lumen	0.47		
4F	Polyurethane Catheter Single Lumen	0.77		
4F D	Provena Polyurethane Catheter Dual Lumen	(18G) 0.62	(18G) 0.62	
4F D	SV Polyurethane Catheter Dual Lumen	(19G) 0.61	(21G) 0.48	
5F	Polyurethane Catheter Single Lumen	0.76		
5F D	FT Polyurethane Catheter Dual Lumen	(18G) 0.66	(18G) 0.66	
5F D	Polyurethane Catheter Dual Lumen	(18G) 0.67	(18G) 0.67	
5F T	HF PowerPICC Polyurethane Catheter	(18G) 0.86	(19G) 0.54	(19G) 0.54
6F D	Polyurethane Catheter Dual Lumen	(18G) 0.72	(18G) 0.72	
6F T	Polyurethane Catheter Triple Lumen	(17G) 0.86	(19G) 0.57	(19G) 0.57
BARD™ PowerPICC SOLO Catheter (polyurethane)				
French Size	Description	Lumen 1 (ml)	Lumen 2 (ml)	Lumen 3 (ml)
3Fr	PowerPICC Provena Catheter with SOLO Valve - Single Lumen	0.68 ml		
4Fr	PowerPICC SOLO Catheter - Single Lumen	0.83 ml		
4Fr	PowerPICC Provena Catheter with SOLO - Dual Lumen	0.66 ml	0.66 ml	
5Fr	PowerPICC SOLO Catheter - Triple Lumen	Red 0.81ml	Gray 0.57ml	White 0.57ml
Argon™ Central Venous Catheters				
French Size	Description	Lumen 1 (ml)		
1.9	Single Lumen Silicone PICC Catheter	0.23		

MedCOMP™ PICC				
French Size	Description	Lumen White 23G (ml)	Lumen Red 21G (ml)	
2.6 20cm	Vascu PICC silicone	0.27	0.27	
2.6 50cm	Vascu PICC silicone	0.28	0.32	
MedCOMP™ Central Venous Catheters (Cuffed and Tunneled)				
French Size	Description	Lumen 1 (ml)	Lumen 2 (ml)	Lumen 3 (ml)
5F	Single Lumen MedCOMP CT CVC <u>Polyurethane</u> Proline Catheter	0.9		
5F D	Dual Lumen MedCOMP CT CVC <u>Polyurethane</u> Proline Catheter	0.7	0.7	
6F	Single Lumen MedCOMP CT CVC <u>Polyurethane</u> Proline Catheter	1.2		
6F D	Dual Lumen MedCOMP CT CVC <u>Polyurethane</u> Proline Catheter	0.8	0.8	
7F	Single Lumen MedCOMP CT CVC <u>Polyurethane</u> Proline Catheter	1.5		
7F D	Dual Lumen MedCOMP CT CVC <u>Polyurethane</u> Proline Catheter	0.9	0.9	

IMPLANTABLE PORTS

Must Utilize the following equation to determine the appropriate volume for implanted ports

$$\text{Volume to be administered} = \text{Catheter Length (cm)} \times \text{Catheter Volume per cm} + \text{Port Volume (ml)} + \text{port needle priming amount (0.3ml)} + \text{Needleless Connector amount (0.1ml)}$$

****Catheter lengths will need to be noted to ensure accurate volumes to instill.**

****Catheter volume per cm in the tables below.**

****Port volume is listed in the tables below.**

**** All implantable port needles have a 0.3ml priming volume**

Bard PowerPorts®				
CATHETER VOLUMES PER CM				
Bard ®	6Fr	8Fr	9.5Fr	9.6Fr
	0.014mL/cm	0.02 mL/cm	0.02 mL/cm	0.02 mL/cm
Bard PowerPorts®				
Port Volumes (mL)				
Bard PowerPorts®		Volume (mL)		
PowerPorts® ClearVUE isp implantable port		0.6		
PowerPorts® ClearVUE Slim implantable port		0.4		
PowerPorts® Isp MRI implantable port		0.6		
PowerPorts® MRI implantable port		0.6		
PowerPorts® Duo MRI Implantable port (dual lumen)		0.6 / 0.6		
PowerPorts® Isp implantable port		0.6		
PowerPorts® Slim implantable port		0.5		
PowerPorts® Implantable Port		0.6		
PowerPorts® VUE implantable Port		0.6		
PowerPorts® VUE MRI implantable Port		0.5		

MedCOMP ® Implantable Ports				
CATHETER VOLUMES PER CM				
MedCOMP®	5Fr	6.6Fr	8Fr	9.6Fr
	0.011 (ml/cm)	0.014 (ml/cm)	0.017 (ml/cm)	0.020 (ml/cm)
PORT VOLUMES (ml)				
MedCOMP®	Titanium Mini Profile CT Port* (contains polyurethane)	Low Profile CT Port* (contains polyurethane)	Mid- size CT Port* (contains polyurethane)	
	0.43 mL	0.43 mL	0.47 mL	