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Why All the Interest in Midline Catheters?

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Learning Outcomes

After the session, attendees will be able to describe the indications for midline catheters and the nurse's associated role and responsibilities.

CLABSI

- NHSN- National Healthcare Safety Network- a program administered by the Centers for Disease Control (CDC)

CDC Definitions (2019)

- Primary bloodstream infection (BSI) – A laboratory confirmed bloodstream infection (LCBI) that is not secondary to another infection at another body site.
- Secondary BSI- A BSI that is thought to be seeded from a site-specific infection at another body site.
- Secondary BSI attribution period (SBAP)- The period of time in which a blood specimen must be collected for a secondary BSI to be attributed to a primary site of infection.

CDC Definitions (2019)

Central-line (CL)- An intravascular catheter that terminates at or close to the heart, OR in one of the great vessels that is used for infusion, withdrawal of blood, or hemodynamic monitoring. The great vessels include, the aorta, pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, common iliac veins, femoral veins, external iliac veins.

Arterial catheters, atrial catheters, extracorporeal membrane oxygenation (ECMO), hemodialysis reliable outflow dialysis catheters (HERO), intra-aortic balloon pumps (IABP), ventricular assist devices (VAD), arteriovenous fistulae, arteriovenous grafts, peripheral intravenous lines (IV's) and midlines are not considered CL's for NHSN reporting purposes.

Eligible central line- A CL that has been in place for more than two consecutive calendar days following the first access of the central line in an inpatient location, during the current admission.

These lines are eligible for CLABSI events until the day after they are removed from the body or patient discharge.

Central-line associated blood stream infection (CLABSI)- A laboratory confirmed BSI where an eligible BSI organism (as defined by NHSN) is identified and an eligible CL is present on LCBI DOE (date of event) or one day before. CLABSI is a surveillance definition and likely overestimates actual catheter related infections.



ELSEVIER

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Major Article

Infection free midline catheter implementation at a community hospital (2 years)

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Key Words:

Peripheral
Bacteremia
Surveillance
Intravenous
Extended dwell
CLABSI**Background:** To reduce excess central line use and provide an option for difficult venous access patients through the introduction of a midline catheter.**Methods:** Design included prospective monitoring of the implementation of a quality improvement project. The setting was a 576 bed, urban, community, nonprofit, Magnet recognized, level 3 trauma center serving primarily adult patients. Midline and peripherally inserted central catheters were inserted by a specialty nursing team; care and maintenance of all devices were provided by front line staff.**Results:** Zero midline catheter infections were observed in the 24 months after implementation of the fixed length, power injectable device. Completion of therapy was 80%, the most frequently encountered complication was device dislodgement.**Conclusions:** Adoption of a vascular access nurse led midline catheter program, coupled with device selection algorithms expanded the ability to select the right device for the patient, while decreasing excess central line usage without additional increased risks to the patient.

Vancomycin Administration Through a Novel Midline Catheter: Summary of a 5-Year, 1086-Patient Experience in an Urban Community Hospital



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Abstract

Background: The 2016 Infusion Therapy Standards of Practice no longer require that low pH (<5) medications be administered via central venous access devices. Nevertheless, the practice of placing PICCs for vancomycin administration often persists.

Purpose: To demonstrate the safety and efficacy of intravenous vancomycin administration through a short and long term midline catheter.

Methodology: A retrospective chart review was performed on 1086 patients who received intravenous vancomycin through a midline catheter.

Average dwell time 7.5 days

45% < 6 days

55% 7-14 days

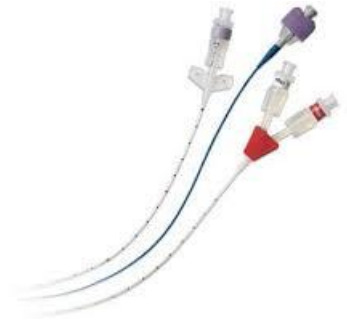
5% 15-25 days

Retrospective chart review looking for the words phlebitis, thrombophlebitis, infiltration, DVT, BSI, or a positive blood culture- or documented symptoms.

The Dilemma.....

- Midline catheters have been used as a way to “de-escalate” from a CVC in some populations. Because midline catheters do not “count” as a CVC and infections associated with midlines are not reportable, we must resist the temptation to use midlines inappropriately or exchange one set of reportable complications for another set of unreportable complications.
- Cawcutt et. al., 2019

Midline Defined



- “Midlines are defined as vascular access devices inserted in the veins of the upper extremity that terminated in the brachial, basilic or cephalic veins of the arm at or near the axillary line.”
- Chopra et.al., 2019



Variation in use and outcomes related to midline catheters: results from a multicentre pilot study.

Chopra et. al., 2019

- Complete data on 1161 midlines representing 5%-72% of all midlines placed in 12 participating hospitals between 1 January 2017 and 1 March 2018 were available.
- Most (70.8%) midlines were placed in general ward settings for difficult intravenous access (61.4%).
- The median dwell time of midlines across hospitals was 6 days; almost half (49%) were removed within 5 days of insertion.
- A major or minor complication occurred in 10.3% of midlines, with minor complications such as dislodgement, leaking and infiltration accounting for 71% of all adverse events.
- While rates of major complications including occlusion, upper-extremity DVT and BSI were low (2.2%, 1.4% and 0.3%, respectively), they were just as likely to lead to midline removal as minor complications (53.8% vs 52.5%, $p=0.90$).

Comparison of Venous Thrombosis Complications in Midlines Versus Peripherally Inserted Central Catheters: Are Midlines the Safer Option?

Bahl, Caraban, Chu 2019

- A total of 2577 catheters were included in the analysis with 1094 MCs and 1483 PICCs.
- One hundred thirty (11.88%) MCs developed CR thrombosis (deep vein thrombosis [DVT] or superficial venous thrombophlebitis [SVT]) as compared to 112 (6.88%)
- Midline catheters had a 53% greater odds of developing CR DVT than PICCs (7.04% MCs and 4.72% PICCs; OR: 1.53; P = .0126).
- For CR SVT, MCs have a 2.29-fold greater odds of developing CR SVT than PICCs (4.84% MCs and 2.16% PICCs; OR: 2.29; P = .0002).
- Symptomatic CR thrombosis is a serious, life-threatening complication that occurs more frequently in MCs compared to PICCs. Inserters should consider placement of single lumen catheters with the smallest diameter to reduce this risk when a midline is used.

Safety and Utilization of Peripherally Inserted Central Catheters versus Midline Catheters at a Large Academic Medical Center

Xu et. al., 2016

- 200 midlines and 206 PICC's (Jan- May 2015)
- 19.5 % midline complication rate compared to 5.8% complication rate for PICCs
- 10 positive blood cultures- 5 midlines/ 5 PICCs
- Median dwell time 5 days for lines and 12 days for PICCs
- Majority of Midline complications
 - 9 infiltrations, 17 occlusions

A Cluster of Failures of Midline Catheters in a Hospital in the Home Program: A Retrospective Analysis

Dickson et. Al. 2019

- 11 midline catheter failures in a 2 week period-outpatients
- Prompted a 4 month retrospective review
- 38 open tip trimmed midlines in the review
- 65% failure rate (higher with continuous infusions)
- 62% failed due to venous thrombosis
- 38% failed because of dislodgement
- Catheter failure- defined as dwell time shorter than the treatment course
- Expected dwell time 2-4 weeks
- Mean dwell time 13.4 days +/- 11.5 days

2015 Midline Data

June 2015

24 insertions
silicone midlines

7 complications

1 DVT @ 15 days 5.2 mm vein/ DL
2 occlusion @ 2days
2 leaking @ 2 & 6 days
1 positive blood culture- staph @ 4 days
1 dislodged

2 single lumen
26 double lumen

9-20 cm in length
Vein diameter 2.9-6.0 mm
(avg-4.5 mm)

29% overall complication rate

Average dwell time **6.88 days**

August 2015

22 insertions
antithrombogenic- PI midlines

8 complications

3 occlusions @ 6 & 12 days
2 painful @ 2& 3 days
2 leaking @ 14 days
1 phlebitis @3 days

9 single lumen
15 double lumen

8-20 cm in length
Vein diameter 3.2-6.4
(avg- 4.1 mm)

4 power injections 3-6 ml per second

36% overall complication rate

Average dwell time **9.0 days**

September 2015

19 insertions
antithrombogenic/ PI midlines

2 complications

1DVT @ 15 days/ 5mm vein/DL
1 infiltrated @ 11 days/4.3 mm vein/DL

9 single lumen
10 double lumen

10-16 cm in length
Vein diameter 2.5-6.9mm
(avg 4.7mm)

2 power injections 3-6 ml per second

10.5% complication rate

Average dwell time **8.68 days**

Current Research Study

- 8 healthy volunteers
- Q 8 hour infusion of Avycaz
(ceftazadime/avibactam) for 7 days
- Experienced inserter- 5fr DL catheters
- Antithrombogenic catheter material
- All but one catheter failed before the 7 day endpoint.
 - Infiltration
 - Phlebitis
 - Loss of blood return

Let's try again....

- New cohort-7 days Avycaz continuous infusion
- 8 healthy volunteers
- Closed tip DL midline with CHG coating
- Tip 2 inches from the axilla
- Multiple dressing changes for bleeding
- 3 of the 8 catheters removed for leaking at the insertion site.
- Multiple catheters maintained blood return only on 1 lumen

Review of Current Product Outcomes

- 4 months of data
 - May-August 2019
- 165 midline catheters
- 102 females/63 males
- Median age 74 (0-93)
- 7-20 cm length
- Overall complication rate 21.1%

Mean Dwell time	8.5 days	Min 1	Max 40
Mean time to loss of blood return	3.89 days	Min 0	Max 33
Percentage of catheters lasting until therapy complete	76.6%	Percentage of catheters failing before therapy completion	23.4%
Leaking (9.7%) Time to failure	Median 8 days	Min 2	Max 17
Occlusion (3.6%) Time to Failure	Mean 2.8 days	Min 1	Max 3
DVT (3.6%) Time to Failure	Mean 14.6	Min2	Max 30
Phlebitis (4.2%) Time to failure	Mean 6.8	Min 1	Max 14
Double lumen	65%	Single lumen	35%
Basilic placement	43%	Brachial placement	41%

Animal Study and Histology

Ryder et.al 2019

- Manufacturer sponsored pre-clinical trial using an ovine model to determine the role of drug/ solution pH, osmolarity, and cytotoxicity as risk factors for infusate related midline catheter failure.
- Evaluating the effects of the drugs on tissue intravascularly and perivascularly macroscopically and histologically.

Animal Study and Histology

- Experimental randomized controlled trial
- 6 study arms
 - Vancomycin 4mg/ml (low cytotoxicity)
 - Vancomycin 10mg/ml (high cytotoxicity)
 - Clinimix 675 mOsm/L (low osmolarity)
 - Clinimix 930 mOsm/L (high osmolarity)
 - Doxycycline 100mg (acidic low pH)
 - Acyclovir 350 mg (basic high pH)

Animal Study and Histology

- 10 cm 18 gauge Powerglide Pro RT Midline
- Test and control catheters bilaterally in each animal's cephalic veins
 - Test catheters received the study drug and the control catheters received normal saline daily
 - Catheter to vein ratio determined by ultrasound
 - 33% vein occupancy- not to exceed 45%
 - Catheters were suture and sterile surgical glue applied to insertion site

Animal Study and Histology

- End points (for two consecutive days)
 - Completion of 14 days of therapy
 - Swelling
 - Pain
 - Leakage from the insertion site
 - Unresolved catheter occlusion- inability to flush or infuse (inability to infuse and withdraw on two attempts met the endpoint)

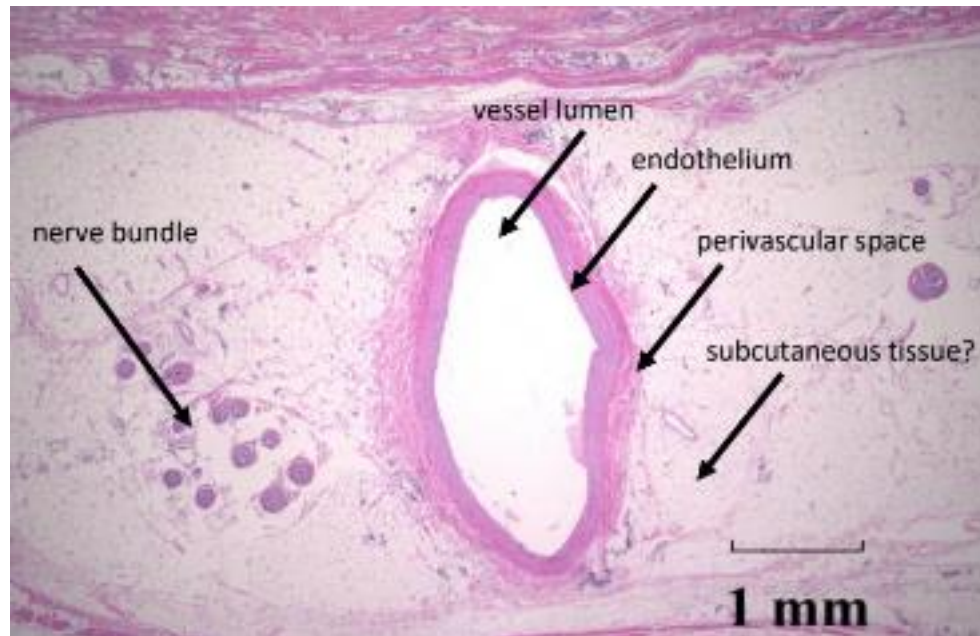
Animal Study and Histology

- Histology Representing Vessel Injury
 - Inflammation
 - Mural thrombus
 - Necrosis
 - Perivascular reaction (5mm radius around the vein)
 - Scale (pathologist blinded to test, control and drug)
 - 0- feature absent
 - 1= presence minimal
 - 2= presence mild
 - 3= presence moderate
 - 4 = severe
 - Aggregate measure = vessel injury score (VIS)

Results

- 24 animals total- 4 excluded from analysis
- 95 % of the test catheters failed
 - median of 7.5 days
- The test catheters always had worse VIS scores than the controls.
- All clinical symptoms were associated with thrombotic events
- In every arm, large adherent fibrin sheaths were noted around the test catheters.
- 40% had occlusive venous thrombosis
- 42% lost blood return and all of these had a mural thrombus beyond the tip
- Mean time to loss of blood return was 3.8 days

- Vancomycin 4mg/ml
 - 3 of 4 failed by day 14
- Vancomycin 10mg/ml
 - all failed- 7 day average
- Clinimix 930
 - all failed- 6.3 day average
- Clinimix 675
 - all failed – 7.3 days average
- Doycycline 100
 - all failed- 7 days average
- Acyclovir 350
 - all failed- 9.7 days average



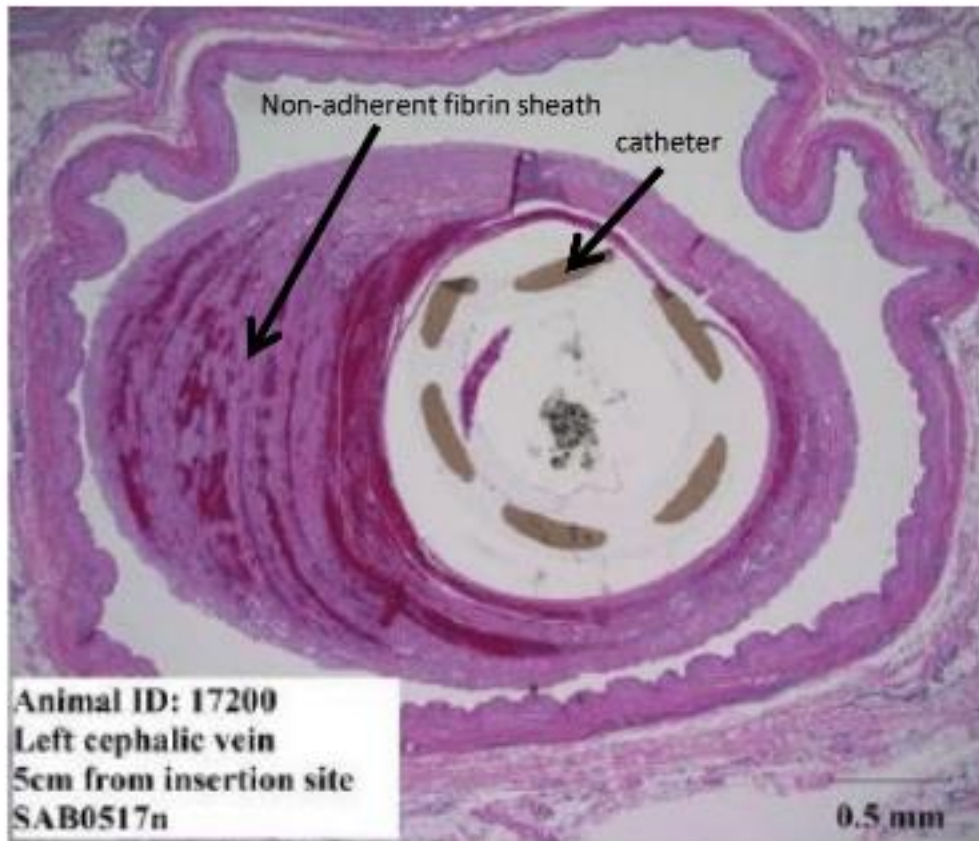


Fig. Moderate sized, non-adherent fibrin pericatheter sheath. Control - VIS 1 - 9 DTF – pain

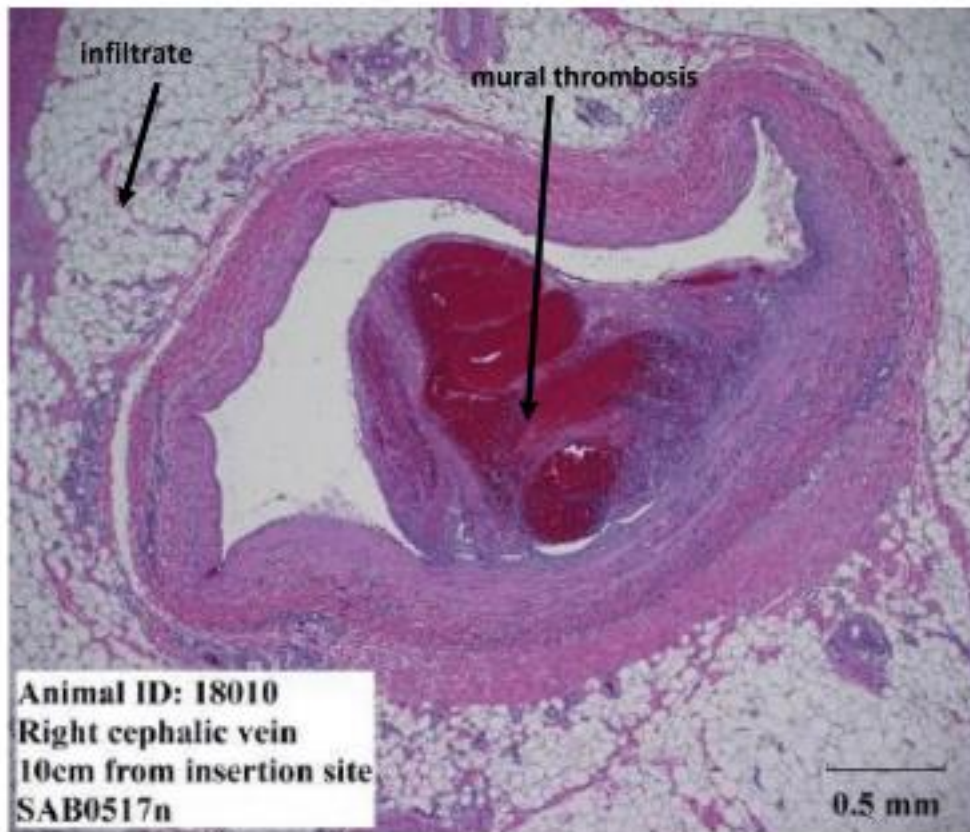
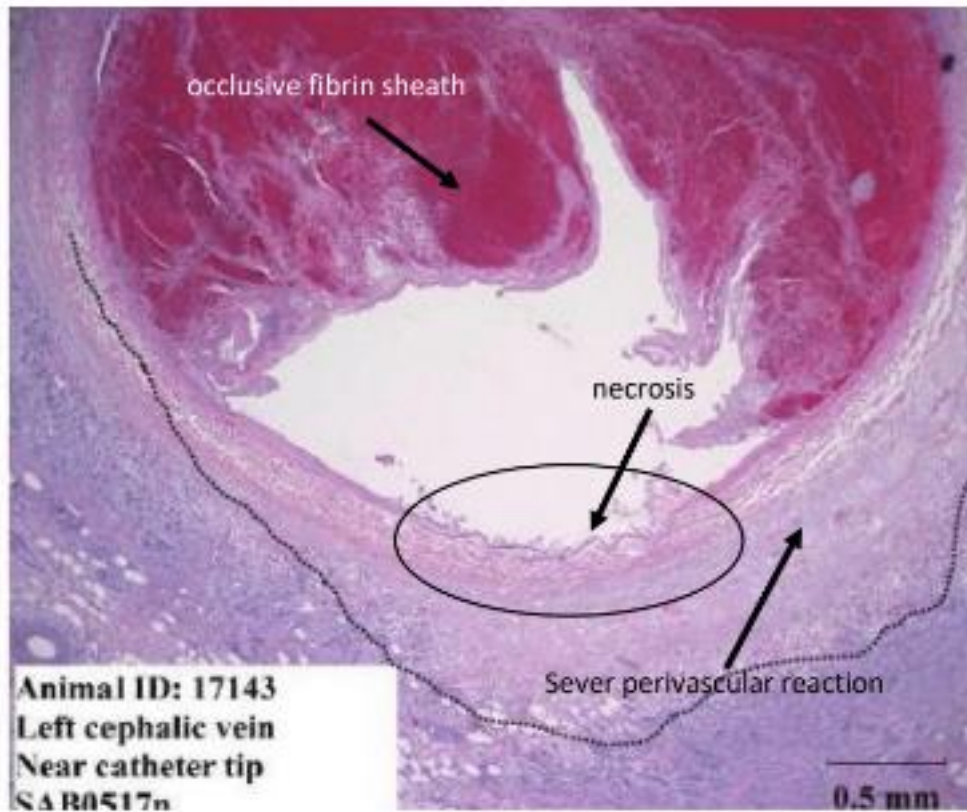


Fig Mural thrombus
D100: Control - VIS 5 - 7 DTF – swelling



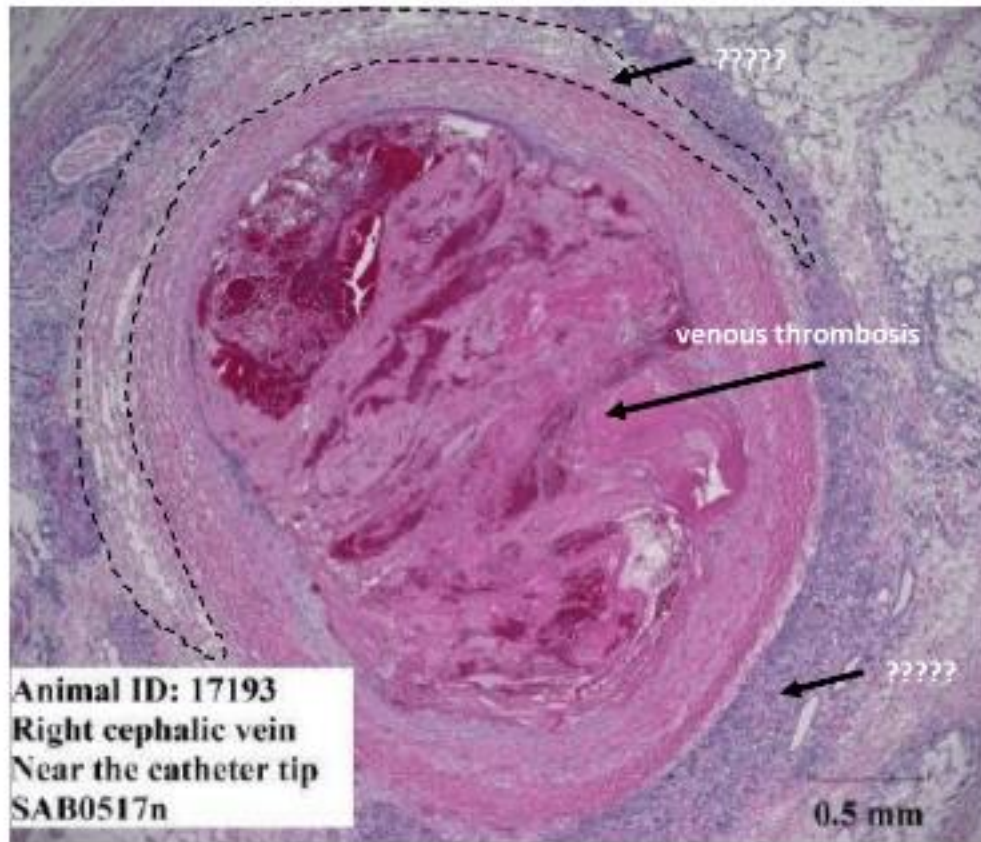


Fig Occlusive venous thrombosis proximal to tip
V10: Test catheter - VIS 12 – 8 DTF – pain and swelling

So--- what does that mean for me?

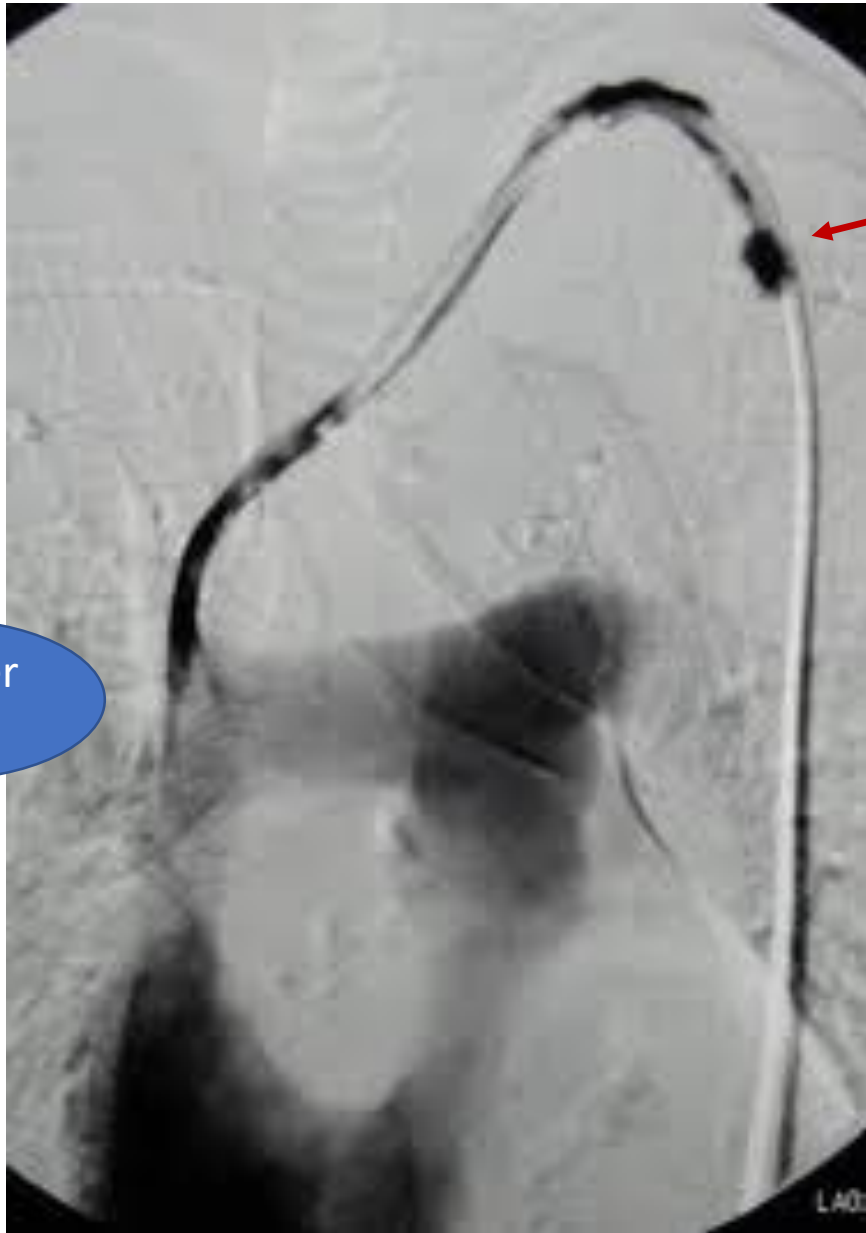


2016 Midline SOP 52

- Choose a midline catheter as follows:
 1. Consider infusate characteristics in conjunction with anticipated duration of treatment (eg. 1-4 weeks)
 2. Consider a midline catheter for medications and solutions such as antimicrobials, fluid replacement, and analgesics with characteristics that are well tolerated by peripheral veins.
 3. Do not use midlines for continuous vesicant therapy, parenteral nutrition, or infusates with an osmolality of greater than 900mOsm/L
 4. Use caution with intermittent vesicant administration due to risk of undetected extravasation
 5. Avoid midline use for history of thrombosis, hypercoagulability, decreased venous flow to the extremities, or end- stage renal disease requiring vein preservation

Does a Blood Return Matter?

- “ During the initial flush, slowly aspirate the VAD for blood return that is the color and consistency of whole blood, which is an important component of assessing catheter function prior to administration of medications and solutions” INS SOP 40



Catheter
tip

Drug
infuses
here



Bad Medicine

- “A midline will often fail to present a blood return after several days of dwell time. This alone may not be a reason to remove and replace the line if it is otherwise flushing adequately without patient discomfort and there are no signs of complications such as phlebitis or infiltration.”
- Opinion of Caprara, 2017

MAGIC Guidelines

- Treatment involves peripherally appropriate solutions that will likely exceed 6 days
Preferred for patients requiring infusions of up to 14 days
- Patients with difficult intravenous access (DIVA) despite ultrasound-guided peripheral catheter attempts
- Single-lumen midline is placed unless specific indication for dual lumen with compatible infusions

• Chopra et.al 2015

“With rejuvenated interest in utilization of MCs, consideration should be given to further studies aimed at clearly defining the indications, contraindications, and patient selection for their placement. ”

Adams et.al, 2016

Conclusions

- Based on the histology and failure rates in the animal study :
- Infusion of drugs or solutions with the properties tested in this study resulted in severe vascular injury and premature midline catheter failure and should not be infused via midlines.
 - Vancomycin 4mg and 10 mg per milliliter
 - Clinimix 675/930 mOsm/L
 - Acyclovir 350mg
 - Doyxcycline100mg
- Best practice is to limit peripheral administration of Vancomycin 4mg in a short peripheral catheters to 72-96 hours while awaiting blood culture results and under careful monitoring.
- Consideration should be given to limiting midline catheter use to therapies less than 6 days duration to preserve vascular health.
- Midline catheters without a blood return should not be considered functional.

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