The Impact of Catheter Occlusion in Central Line Associated Bloodstream Infections

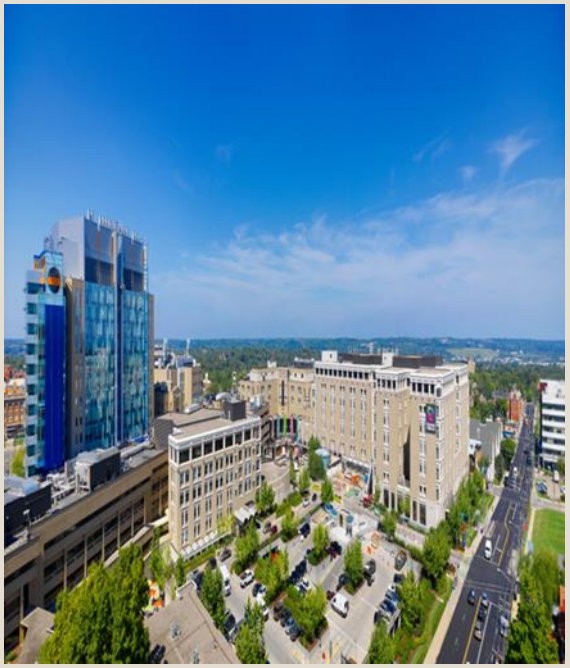
DARCY DOELLMAN MSN, RN, CRNI, VA-BC

MARCH 15, 2017

LOUISVILLE, KENTUCKY

Cincinnati Children's Hospital

- 642 beds
- Rated #3 nationally
- Vascular Access Team (24/7)
  - 37 FTEs
- Services provided:
  - IV access
  - Midline and PICC insertions
  - CVC monitoring and complication management
- Education and research

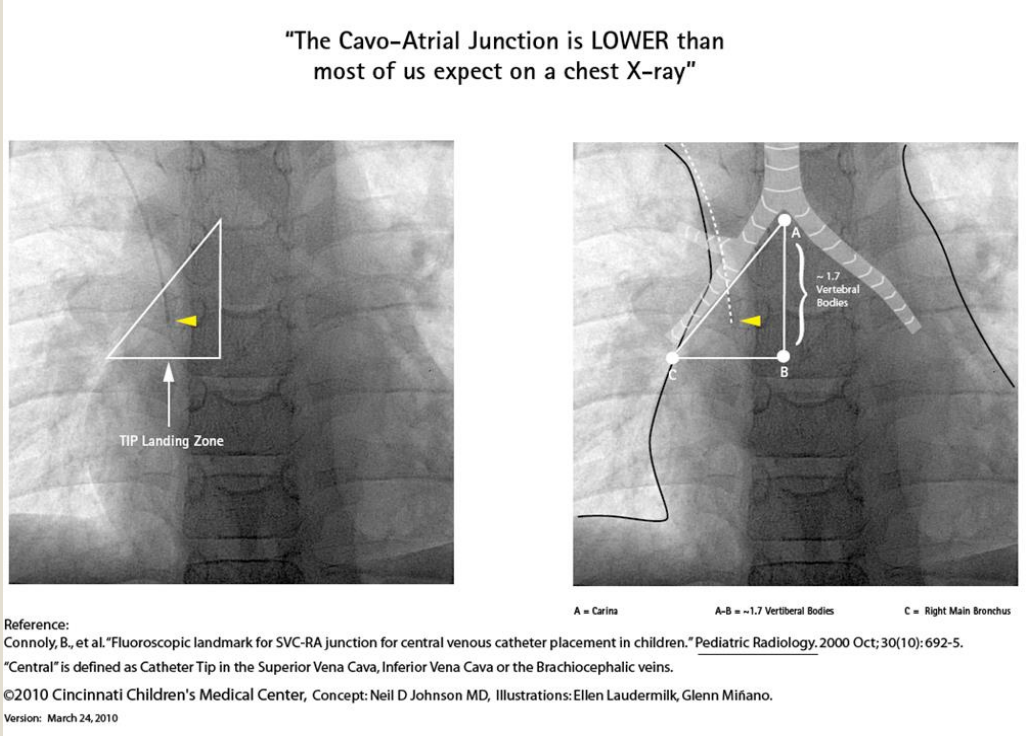


Learning Objectives

- Describe types of catheter occlusion
- Review how to identify, prevent, and manage catheter dysfunction
- Discuss current guidelines and practices for reducing CLABSI rates

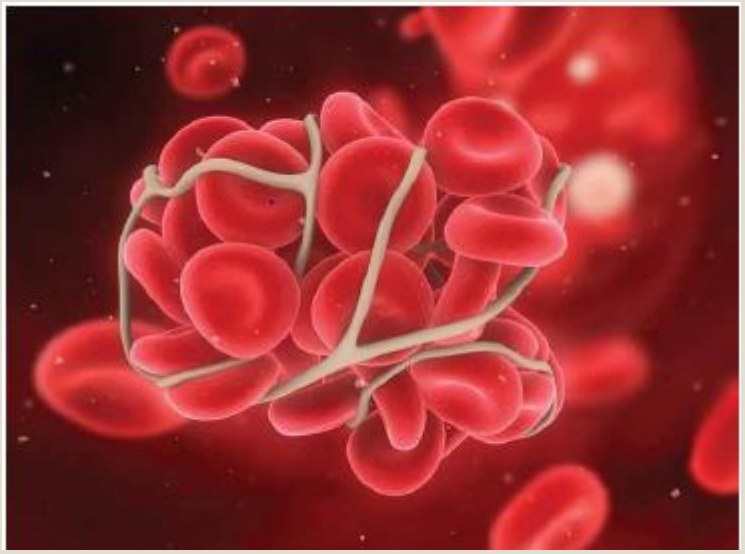
Central Venous Catheters

- Drastic increase in central venous catheters (CVCs) over past 30 years due to:
  - Increase use in TPN
  - Use of chemotherapy
  - Critically ill patients
  - Antibiotic therapy
  - Chronic conditions



Catheter Occlusion

- Up to 25% of CVCs become occluded
- Three types of catheter occlusion
  - Mechanical
  - Nonthrombotic
  - Thrombotic



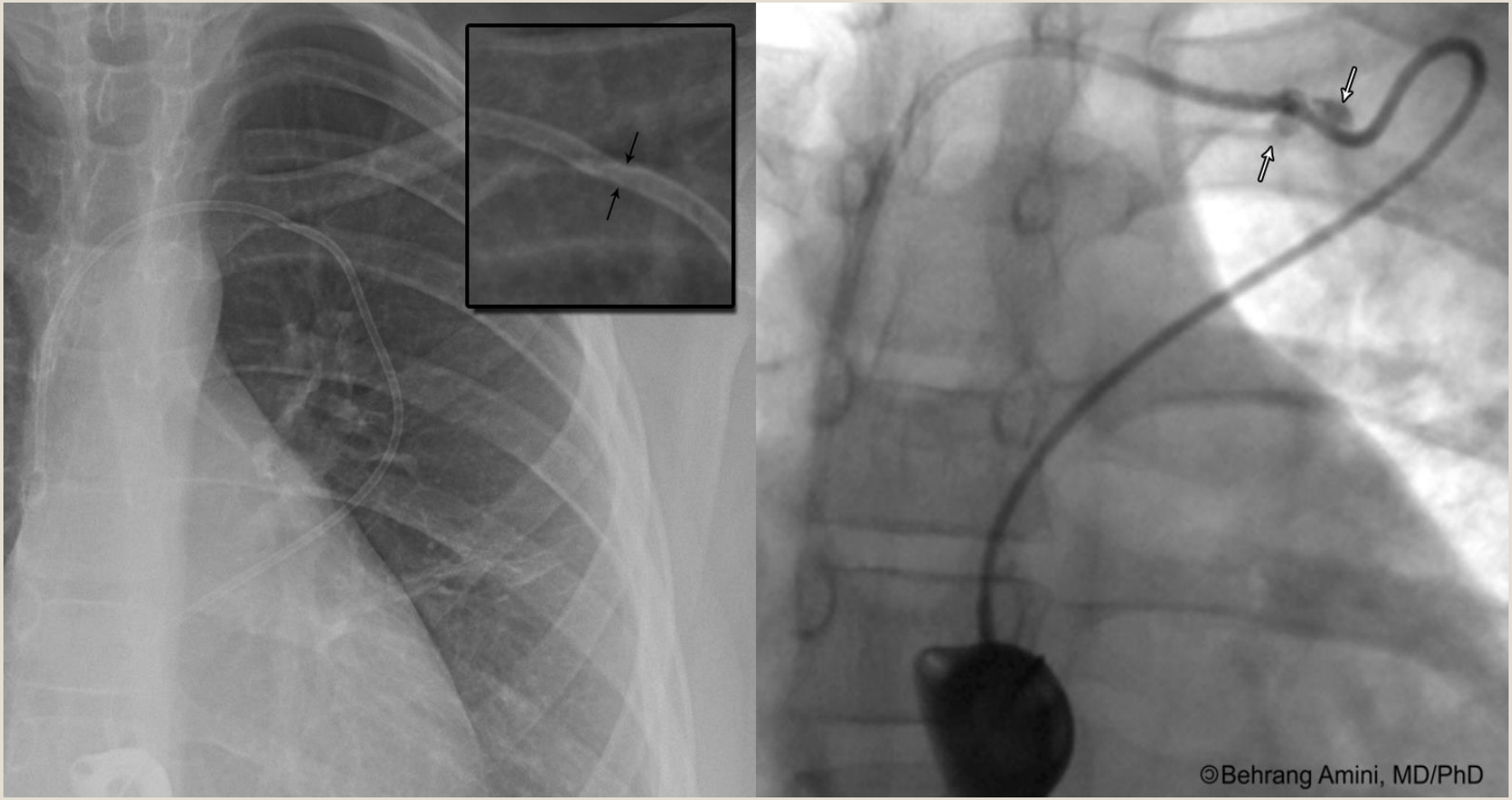
(Baskin 2009)

Mechanical Occlusion

- External
  - Clamped/kinked tubing
  - Position of patient
  - Tight suture around catheter
  - Port needle dislodgement
- Internal
  - Catheter tip malposition
  - Pinch-Off Syndrome
    - Compression of catheter between 1st rib and clavicle
    - Symptom: Flushing stops/starts in a predictable manner
      - Occurs in 1% of patients

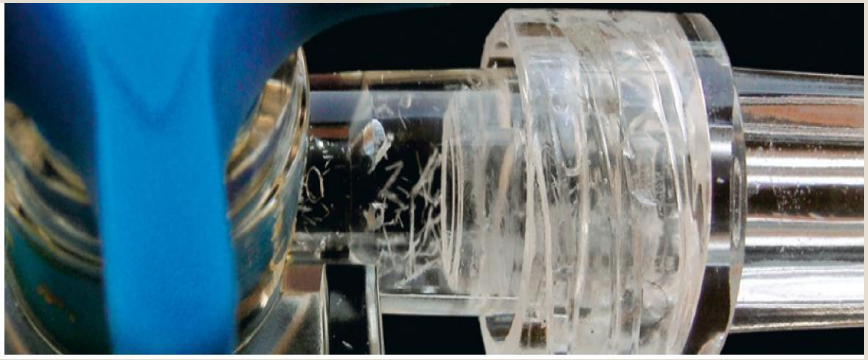
(Dougherty 2006; Gabriel, 2006)

Pinch-Off Syndrome



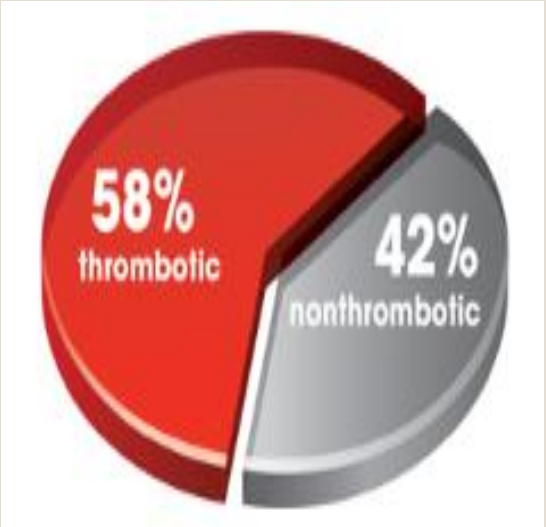
Nonthrombotic Occlusion

- Precipitate
  - Extreme pH, calcium phosphate crystals, or lipid deposits
  - Crystallization of TPN
  - Drug precipitation
    - Diazepam, aminoglycosides, phenytoin



Thrombotic Occlusion

- Most common type of catheter occlusion
- Four types:
  - Intraluminal
  - Fibrin sheath
  - Fibrin tail
  - Mural thrombus



(Stephens 1999)

Fibrin Formation

- CVCs are considered a foreign body in situ
  - After placement, CVCs become covered with plasma proteins and fibrin
  - Within 24 hours, platelets and WBCs adhere to protein and allows for colonization of bacteria

Intraluminal Occlusion

- Occurs when blood refluxes inside CVC lumen
- Causes of reflux:
  - Patient coughing, emesis
  - Inadequate amount of flush after blood draws
- Leads to sluggish lumen or total occlusion

Fibrin Sheath

- Fibrin adheres to catheter surface
- May completely cover the opening of the catheter tip, like a sock
- Causes: injury to tunica intima
- A complete fibrin sheath may lead to infiltration or extravasation

(Gabriel 2006)

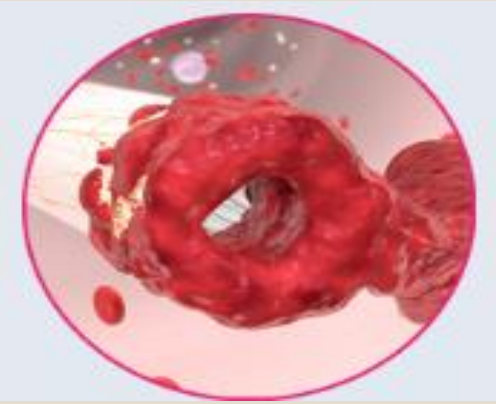
Fibrin Tail

- Tail extends from CVC tip
- Upon aspiration, fibrin tail blocks catheter lumen
- Results in an ability to infuse fluids but an inability to withdraw blood

- Leads to partial occlusion

Mural Thrombus

- Forms where the catheter touches the vein
- Can occur anywhere along the catheter path
  - Common with catheter tip malposition
- May lead to catheter thrombosis



Identification of Catheter Occlusion

- Routinely assess catheter for patency with flushing of CVC
- Patency: ability to flush and aspirate blood without resistance

- Sluggish lumen
- May be first symptom of a catheter occlusion
- May lead to a partial (withdraw) or complete occlusion
- Assess CVC further if catheter is sluggish

Rule Out Mechanical Factors

- Begin at infusion pump or catheter hub
- Assess for closed clamps, kinked tubing or catheter
- Is patient laying on the catheter?
- Has PICC migrated out?
- Change in port needle location?
- Is needleless connector clotted?
- Review MAR profile, is there a concern for precipitation?
- Has mechanical factors been resolved or ruled out?

Management of Occlusion

- Preferred approach is catheter salvage
- Manage as thrombotic occlusion if unable to determine type of occlusion
- Do not leave an occluded lumen untreated because another lumen is functional

Symptoms

- Resistance when flushing
- Sluggish flow
- Inability to infuse fluids
- Frequent occlusion alarm on infusion pump

Treatment for Thrombotic Occlusion

- Alteplase (thrombolytic)
  - 2mg/2mL sterile water
  - Can instill alteplase up to 2 doses
    - Adults: 2 mg/2mL
    - Pediatrics: 110% of the catheter priming volume
  - Dosing: Allow 1st dose to dwell for up to 2 hours
    If occlusion persists, instill 2nd dose
  - Efficacy: Adults: 88% patency after 2 doses
    75% patency after 1 dose
    Pediatrics: 83% patency after 2 doses

Treat all types of thrombotic occlusions

Thrombolytic Therapy

- Urokinase
  - 15,000 iu/1.5mL normal saline
  - 2nd dose 20,000 iu/2mL normal saline
- Overall efficacy: 70%
- Reteplase:
  - .4 U
- Efficacy: Up to 74% after 40 min
  Overall: 90%
- Tenectaplase
  - Small sample studies

(Baskin et al, 2012)

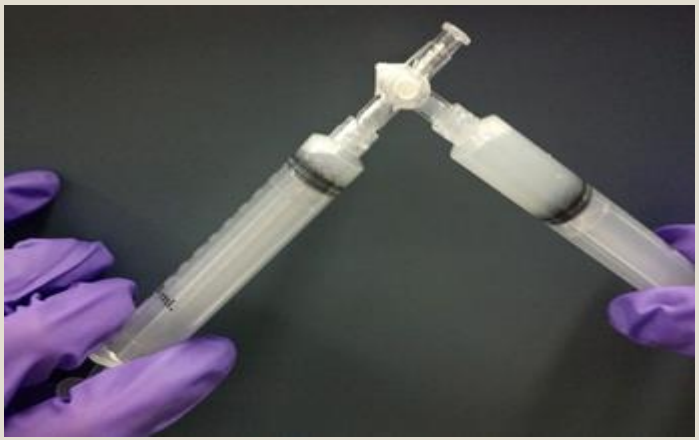
Treatment for Precipitation

- 1% HCL acid: Precipitation of medications with a low pH and calcium phosphate crystals
- $NaHCO_3$ can be treated with high pH infusate precipitations
- 70% ethanol for lipid residue

- Resolve chemical precipitate by instillation of clearing agent(s) recognized to dissolve precipitate
- All clearing agents dwell for 1 hour using catheter priming volume

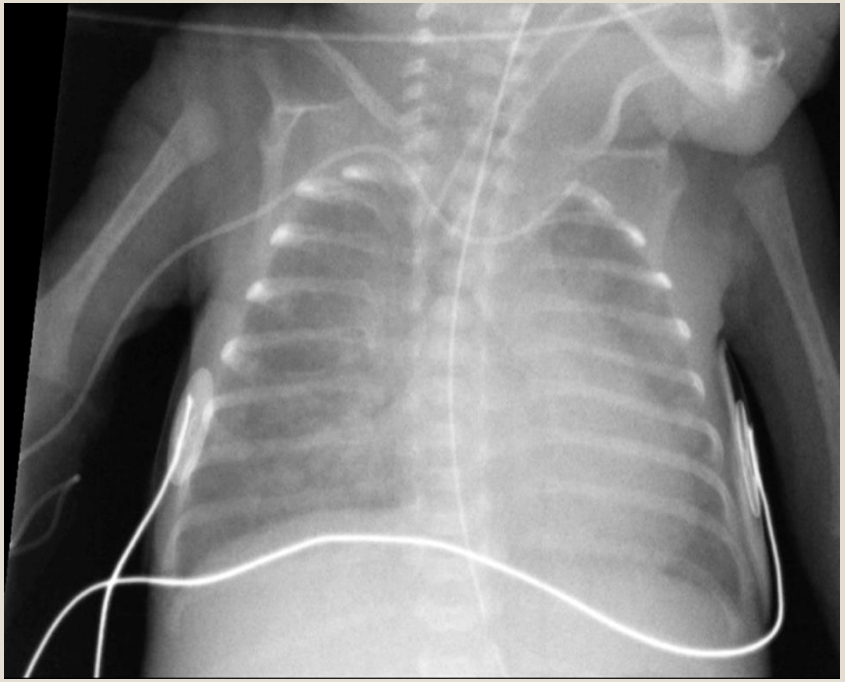
Administration of Thrombolytic

- Thrombolytic therapy:
  - Instill alteplase by a 10mL sryinge or stopcock method
  - Never flush catheter against resistance
- Allow adequate dwell time



Persistent Occlusion

- If clearing agent does not resolve catheter occlusion, consider chest xray or contrast study to assess catheter tip malposition



Persistent Partial (Withdraw) Occlusion

- If CVC remains dysfunctional (unable to obtain blood return)
- Do not continue to use CVC
  - In rare cases, consider transfemoral approach to pull off fibrin

Risks for Catheter Occlusion

- Catheter tip malposition
- Number of CVC lumens
- Large catheter to vessel ratio
- PICCs are prone to occlusion by a factor of >2 in comparison with other CVADs

- Ports have less catheter occlusion as compared to Broviac and Hickman catheters

(Moureau & Chopra, 2016)

Prevention

- Proper flushing technique
  - Volume of flush
  - Type of flush
    - Normal saline vs heparinized saline
  - Frequency of flush
  - Routine flushing and after blood draw
  - Push-pause flushing
  - Use 10mL syringe for flushing
  - Flush unused lumens per protocol

(Goosens 2014)

Prevention

- Ensure optimal CVC tip placement
- Minimizing catheter occlusions requires the tip placement for CVADs to be in the lower one-third of the superior vena cava near the junction of the right atrium

Prevention

- Review institutional data on CVC complications
- Use of valved PICCs
- Needleless connector
- Education of the nursing staff
  - Occlusion rate decreased in a 6-month period from 29% down to 8.5%
- Dedicated PICC team
  - Occlusion rate decreased from 32 to 15 occlusions

(Bartock 2010;Ngo, 2005)

Patient Family Experience

- Delays in therapy
  - At risk for suboptimal therapy
- Delays in procedures
- Delays in discharge
- Increased cost

Complications

- 14 -36% complication rate within 2 years of CVC placement
- Increase cost
- Increase LOS

Link Between CLABSI and Occlusion

- In animal studies, fibrin sheath formation around CVCs promoted
  - Colonization
  - Infection
  - Persistent bacteremia

(Mehall et al, 2004)

PICCs

- Retrospective study of hospital ortho patients
- 180 PICCs in 136 patients
  - Mean dwell: 21 days
- 36/180 (20%) removed due to complications
  - CLABSI: 8/180 (14%)
  - Occlusion: 11/180 (8%)

Two risk factors for CLABSI:
> 70 years of age
Two lumens or greater

(Valbouquet Schneider et al 2015)

PICCs in Oncology Patients

- Prospective study on 291 PICCs in oncology patients
- Total # of PICC complications 70 (24.7%)
- 44 (15.1%) removed due to complications
  - CLABSI: 12 (4.1%)
  - Occlusion 7 (2.4%)

15% failure rate in patients receiving chemotherapy

(Bertoglio, 2016)

PICCs in Oncology Patients

- Prospective, multicenter, cohort study
- N= 477 patients
- 81 (17%) experienced complications
- 36 (7.5%) removed due to complications
  - 3.4% due to occlusions
  - 6 (1.7%) due to CLABSI

Patients with a BMI > 25 were more likely to have a PICC complication

(Kang et al, 2017)

CLABSI Prevention

- Two phases:
  - Insertion
    - Insertion checklist
    - Use of ultrasound
    - Credentialing of clinician
    - Standardized CVC insertion kits
    - Maximal sterile barrier/chlorhexidine skin antisepsis
  - Maintenance
    - Dressing changes
    - Needleless connector antisepsis
    - Tubing changes
    - Chlorhexidine bathing

Avoid the Femoral Vein

- Increases infection risk and deep venous thrombosis in adults
- Emergent situations only

(Lorente, Henry, Martin, et al, 2005)

Hand Hygiene

- Using alcohol-based waterless product or antiseptic soap and water
- Compliance measurements can be obtained by actual observation

Curlej & Katrancha 2016

CVC Insertion

- Insertion Checklist
- Credentialing of clinician
- Standardized CVC insertion kits
- Maximal sterile barrier
- Chlorhexidine skin antisepsis

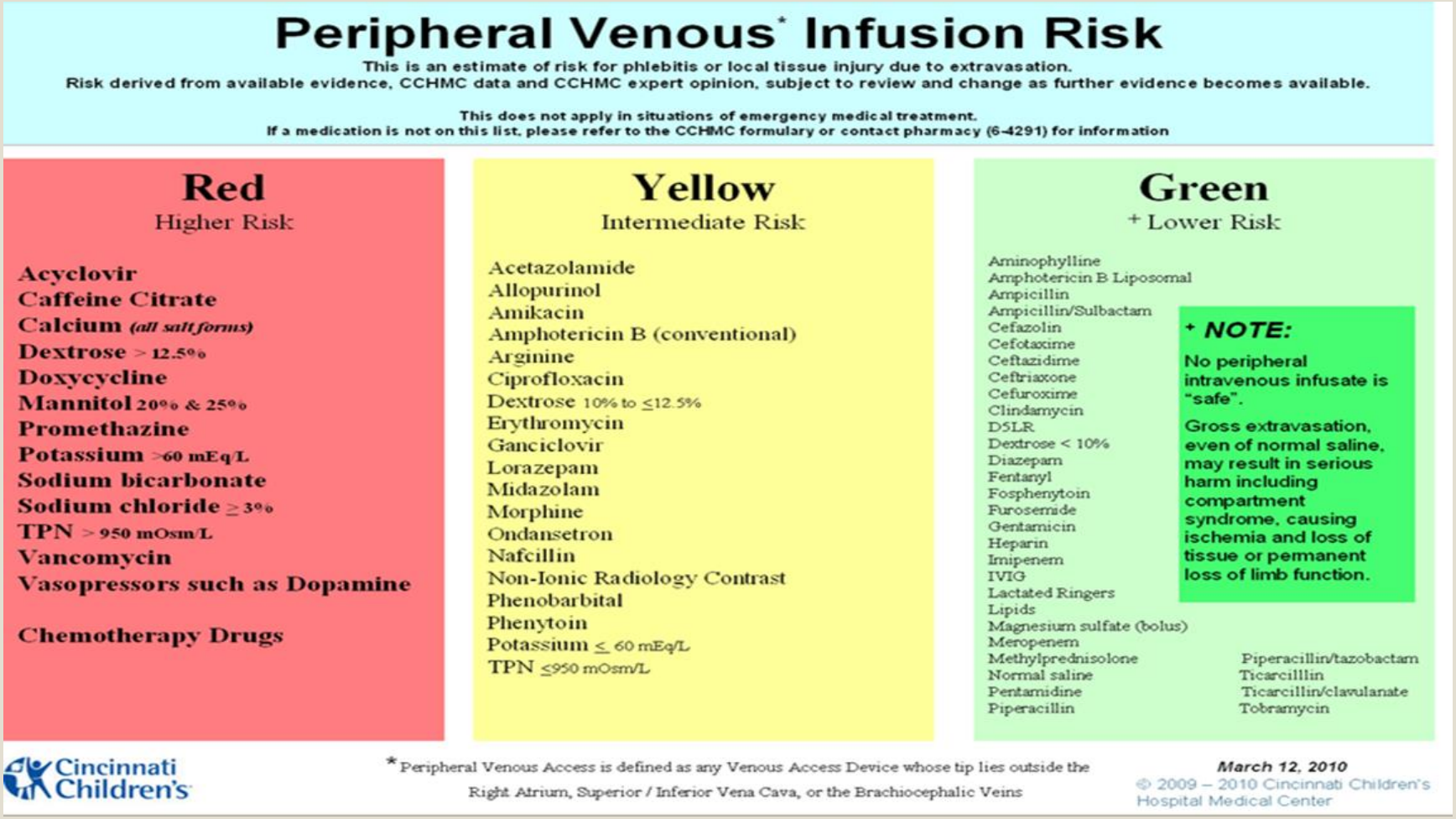
Device Selection

- CVADs carry significant risk to patients
- Apply evidence-based guidelines for selection
- Avoid overuse of PICCs

- Vascular Access Teams can assist with difficult IV access, failed attempts, or specific patient conditions:
- Obesity
- Diabetes

(Moureau & Chopra, 2016)

Red/Yellow/Green List



CLABSI Reduction

- Reduce the # of CVCs inserted
- Alternative devices include:
  - Ultrasound guided IV insertion
  - Midline catheter insertion
- Assess daily need for CVC
- Promptly remove catheters that are not being used

MAGIC Guidelines/INS

Device Type	Proposed Duration of Infusion			
	≤5 d	6–14 d	15–30 d	≥31 d
Peripheral IV catheter	No preference between peripheral IV and US-guided peripheral IV catheters for use ≤5 d			
US-guided peripheral IV catheter	US-guided peripheral IV catheter preferred to peripheral IV catheter if proposed duration is 6–14 d			
Nontunneled/acute central venous catheter	Central venous catheter preferred in critically ill patients or if hemodynamic monitoring is needed for 6–14 d			
Midline catheter	Midline catheter preferred to PICC if proposed duration is ≤14 d			
PICC		PICC preferred to midline catheter if proposed duration of infusion is ≥15 d		
Tunneled catheter				PICC preferred to tunneled catheter and ports for infusion 15–30 d
Port				

Antibiotic Coated Catheters

- 240 community hospital in California
  - Control group: 257 patients, 8 CLABSIs with an infection rate of 4.18/1,000 line
  - Study group: 260 patients, 1 CLABSI with an infection rate of 0.47/1,000 line days.

(Rutkoff, 2014)

CLABSI

- The estimated mortality rate associated with CLABSI is 23.8%, with an average increase LOS up to 21 days and an estimated cost of $29,156 per patient

Single Lumen vs Multi-lumen CVCs

- In the absence of indications for a multilumen PICC, use a single-lumen PICC of the smallest gauge
- Insert the smallest catheter french size with the lowest number of lumens

Criteria for a Multi-lumen CVC

- Continuous vesicant or irritant chemotherapy with additional lumen needs
- Need for vasopressors
- Milrinone
- Need for simultaneous administration of multiple incompatible medications
- TPN plus additional lumen needs

Senior Leadership

- Senior leadership can help reduce CLABSI rates by:
  - Driving the implementation of best practices and technologies
  - Promoting compliance with nursing staff
  - Support of staff for continuing education (conferences, certification)
  - Invest in EMRs that align with data collection and reporting
  - CLABSI task force member

Summary

- Catheter occlusion is a common complication of CVCs
- Assess CVC patency with routine flushing, medication administration, and blood sampling
- Prevention and prompt treatment of occlusions is vital for CVCs
- Choose the most appropriate VAD based on the patient's type and length of therapy
- Avoid unnecessary CVCs
- Follow current CVC bundles for reducing CLABSI

Thank You

- Darcy.doellman@fuse.net

Thank You