

Neonatal PICCs

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Disclosures

- ▶ University of California Neonatal ICU
- ▶ Associate Professor, Samuel Merritt University
- ▶ Chamberlain University

Objectives

- ▶ Identify line care and maintenance best practices
- ▶ Identify appropriate central tip location for a neonatal PICC
- ▶ Discuss at least 3 current strategies for infection prevention
- ▶ Identify risk factors associated with central lines
- ▶ Describe at least 3 of the best strategies to reduce harm associated with line care
- ▶ Become familiar with recent guidelines and literature

NANN Practice Recommendation

- ▶ Implement complications prevention strategies including central line-associated bloodstream infection prevention
- ▶ Rationale: HRO - A culture of safety, quality and prevention has been successful in minimizing central line-associated bloodstream infection

Impact

- ▶ Increased cost in neonatal population
 - ▶ mean increase in length of stay due to CLABSI is 31 days
 - ▶ Expected increase in cost is approximately \$90,000
- ▶ Length of stay in pediatric population
 - ▶ Mean increase in length of stay due to CLABSI is 19 days
 - ▶ Expected increase in cost is approximately \$55,000


Cavide, A., et al. Attributable cost and length of stay for central line-associated bloodstream infections Pediatrics, 2014, 133(6), p. e125-32.

Risk Factors

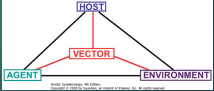
- ▶ Prematurity
- ▶ Immaturity of skin barrier
- ▶ High demands for intravenous therapies:
 - ▶ Extended duration
 - ▶ Multiple breaks in line
 - ▶ Multiple lumen catheters
- ▶ Presence of intra-abdominal pathology in 7 days preceding CLABSI
- ▶ Abdominal surgery in 7 days preceding CLABSI
- ▶ >= 3 heel punctures in the 48 hours preceding CLABSI

Dahan, M., et al. CLABSI Risk Factors in the NICU: Potential for Prevention: A PICNIC Study. Infect Control Hosp Epidemiol, 2016; p. 1-7.

Babies can fall prey to all kinds of organisms:




- ▶ Gastrointestinal bugs
- ▶ Viruses
- ▶ Maternally transmitted
- ▶ Environmental
- ▶ Manifest as: conjunctival cultures, blood cultures, spinal fluid cultures, tracheal cultures, urine cultures, wound cultures, etc.



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The first bundle



- ▶ Institute for Healthcare Improvement (IHI)
- ▶ Hand hygiene
- ▶ Maximum sterile barrier precautions
- ▶ Chlorhexidine for skin antisepsis
- ▶ Optimal catheter site selection (avoiding femoral in adults)
- ▶ Daily review of line necessity and prompt removal when no longer needed

How-to Guide: Prevent Central Line-Associated Bloodstream Infections. Cambridge, MA: Institute for Healthcare Improvement; 2012. (Available at www.ihc.org)

Its all about Nurses!



Newer bundles focus on phases Solutions for Patient Safety Insertion

- ▶ **Standard Elements**
 - ▶ Hand Hygiene
 - ▶ Chlorhexidine gluconate (CHG) scrub
 - ▶ Insertion checklist with staff empowerment to stop non-emergent procedure
 - ▶ Full sterile barrier for providers and patients
 - ▶ Insertion training for all providers
 - ▶ Prepackaged or filled insertion cart, tray or box
 - ▶ No iodine ointment
- ▶ **Standard:** Hospitals **should** implement and measure reliability
- ▶ **Recommended:** Strongly **consider** implementing this element

SPS CLABSI Prevention Bundle, www.solutionsforpatientsafety.org

Solutions for Patient Safety Maintenance

- ▶ **Standard Elements**
 - ▶ Regular assessment of dressing to assure clean/dry/occlusive
 - ▶ Standardized hub access procedure
 - ▶ Standardized dressing, cap and tubing change procedures/timing
 - ▶ Daily discussion of line necessity, functionality & utilization including bedside and medical team members
- ▶ **Recommended Elements**
 - ▶ In-depth multidisciplinary review of all identified CLABSI
 - ▶ Daily CHG bathing and linen changes

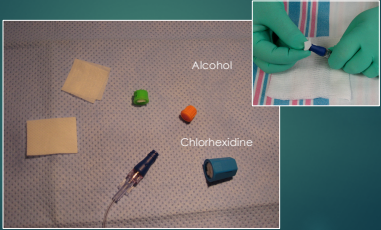
SPS CLABSI Prevention Bundle, www.solutionsforpatientsafety.org

Decreased from 3.9 to 1.7/1000 catheter days

- ▶ Hand hygiene
- ▶ Dedicated specialized PICC team
- ▶ Chlorhexidine for antiseptics > 1 kg or > 2 weeks of age
- ▶ "Hub care" with 3,15% chlorhexidine for 30 seconds, allow to dry
- ▶ Chlorhexidine-impregnated disc for > 1 kg or > 2 weeks of age
- ▶ Masks for dressing change
- ▶ Weekly rounding for monitoring complications

Curry S, et al., Catheter-associated bloodstream infections in the NICU: getting to zero. Neonatal Netw, 2009, 28(3): p. 151

Hub Care: Disinfect the needleless connector and allow to dry



What worked in New York?

Regional referral NICU's (19) developed this bundle:

- ▶ Promote hand hygiene with accessible sanitizer at each bedside
- ▶ Use 2 staff members for central line placement
- ▶ Perform IV tubing changes with nurse pairs according to written policy
- ▶ Daily consideration of line removal
- ▶ Grow a culture of collaborative CLABSI prevention
- ▶ Conclusion: Bundles and Checklists had significant impact on CLABSI's

Schümann, J., et al., Statewide NICU central-line-associated bloodstream infection rates decline after bundles and checklists. Pediatrics, 2011, 127(3): p. 436-44.

What worked in North Carolina?

- ▶ North Carolina NICU's (13)
- ▶ Insertion Bundle Checklist
 - ▶ Hand hygiene, Timeout, Face mask within 3 feet of sterile field
 - ▶ Perform skin antiseptics with povidone-iodine, chlorhexidine
 - ▶ Skin preparation agent completely dry before first puncture
 - ▶ Procedure stopped if sterility compromised
- ▶ Maintenance Bundle Checklist
 - ▶ Central line removal when feeds reach 120 ml/kg/day
 - ▶ "Do we need the line today?"
 - ▶ "If no line in place today, would we place one?"
 - ▶ Closed medication administration system
 - ▶ Scrub needleless connector with friction and alcohol or CHG for > 15 seconds
- ▶ **Decreased from 3.94 to 1.16/1000 catheter days**

Fisher, D., et al., Reducing central line-associated bloodstream infections in North Carolina NICUs. Pediatrics, 2013, 132(6): p. e1644-71.

What worked in Ohio?

- ▶ 8 Intensive care nurseries in Ohio
- ▶ Dedicated specially trained PICC team
- ▶ Mandatory central line competency and dressing change training
- ▶ Chlorhexidine skin antiseptics
- ▶ Standardized dressing changes and IV tubing changes
- ▶ Alcohol-based port protectors, neutral needleless connectors
- ▶ CLABSI huddle team review process
- ▶ Chlorhexidine-impregnated disc usage
- ▶ Chlorhexidine baths for > 2 months of age

They decreased from 6 to 1.43/1000 catheter days

Edward G. Shaphert, Tammi J. Kelly, Jos A. Vissel, Dennis J. Cunningham, Erin Keels, Wendy Bousseau, Richard E. McLeod Jr., Significant Reduction of Central-Line Associated Bloodstream Infections in a Network of Diverse Neonatal Nurseries. The Journal of Pediatrics, Volume 167, Issue 1, 2015, 41-46.e3. http://dx.doi.org/10.1016/j.jpeds.2015.03.048

What worked in New Jersey?

- ▶ Staff education on IV tubing change
- ▶ Hand hygiene
- ▶ Hub care disinfection
- ▶ Product changes
- ▶ Institution of IV access competencies

Decreased from 4.4 to 0/1000 catheter days

Dumppa, V., et al., Reduction in Central-Line-Associated Bloodstream Infection Rates After Implementations of Infection Control Measures at a Level 3 Neonatal Intensive Care Unit. Am J Med Qual, 2016, 31(2): p. 133-8

What worked in Texas?

- ▶ Two-Person PICC dressing change
 - ▶ Training for NNP's and RN's
 - ▶ Securement device (if available)
 - ▶ Masks, hats, sterile gowns
- ▶ Daily line rounding
- ▶ Sterile tubing change using 2-person sterile technique
- ▶ 3.15% Chlorhexidine wipe for needleless connector disinfection
- ▶ Sterile hemostatic agent eliminated need for 24 to 48 hour post-insertion dressing changes.
- ▶ **Decreased from 3.9 to 0.3/1000 catheter days**
- ▶ **Decreased length of stay by 17.6 days!**

Wilder, K.A., et al., CLABSI Reduction Strategy: A Systematic Central Line Quality Improvement Initiative Integrating Line-Rounding Principles and a Team Approach. Adv Neonatal Care, 2016, 14(3), p.

Daily Line Rounding

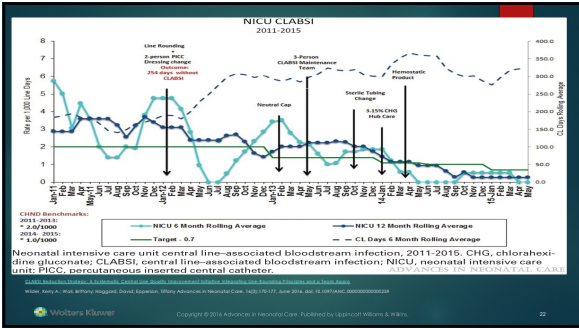
- ▶ ALL or NOTHING Rounding Components
 - ▶ Assessed line necessity
 - ▶ Tubing dated accurately
 - ▶ Dressing dated accurately
 - ▶ Dressing clean, dry and intact
 - ▶ Tubing up and away from potential contamination
 - ▶ Protective overlay correctly placed if needed
 - ▶ PICC securement device present and beneath dressing

All or Nothing Line Rounding

NICU	Insertion	Assessed line necessity	COMPLIANCE WITH MAINTENANCE PRINCIPLE						PICC Securement (device present & beneath dressing)	AON	No. of Maintenance Rounds	CLABSI
			Tubing dated and data's correct	Dressing dated and data's correct	Tubing up and away from potential contamination	Protective overlay present	PICC securement device present & beneath dressing	PICC Securement (device present & beneath dressing)				
NICU1	20%	100%	100%	95%	100%	100%	100%	100%	100%	112	0.00%	
NICU2	100%	100%	100%	98%	100%	100%	100%	100%	100%	124	1.59%	
NICU3	80-90%	100%	100%	100%	95%	100%	100%	100%	100%	214	10%-15%	
NICU4											0.0%	
NICU5											0.0%	
NICU6											0.0%	
NICU7											0.0%	
NICU8											0.0%	
NICU9											0.0%	
NICU10											0.0%	

Compliance with line rounding, AON, "All Or Nothing" Principle; NICU, neonatal intensive care unit central line; PICC, percutaneous inserted central catheter.

- ▶ [CLABSI Reduction Strategy: A Systematic Central Line Quality Improvement Initiative Integrating Line-Rounding Principles and a Team Approach](#)
- ▶ Wilder, Kerry A.; Wall, Brittany; Haggard, David; Epperson, Tiffany
- ▶ Advances in Neonatal Care, 16(3):170-177, June 2016. doi: 10.1097/ANC.0000000000000259



Does catheter type matter?

- ▶ N = 2986 neonates with 656 catheters
- ▶ Femoral (FVC) 12.3 per 1000 catheter days
- ▶ Umbilical (UVC) 10.6 per 1000 catheter days
- ▶ PICC 5.3 per 1000 catheter days
- ▶ Risk factors identified:
 - ▶ parenteral nutrition
 - ▶ male gender
 - ▶ higher birthweight

Antibiotic treatment at birth was associated with a decreased risk of CLABSI

Dubbink-Verheij et al. Frontiers in Pediatrics, June 20, 2017

Does dwell time matter?

- ▶ N = 13,327 infants with 15,567 catheters in 141 NICUs
- ▶ Median postmenstrual age 29 weeks
- ▶ Median dwell time 11 days (PICCs) vs 25 days (tunneled)
- ▶ **CLABSI 2.4 times as high for tunneled catheters as for PICCs**
- ▶ CLABSI rate 0.93 per 1000 catheter days
- ▶ Increased dwell time not associated with increased CLABSI

Greenberg et al. Pediatrics, 2015

Does dwell time matter?

- ▶ N = 3985 infants in 10 regional NICU's in Australia
- ▶ Group 1 – infants with UVC only
- ▶ Group 2 – infants with PICC only
- ▶ Group 3 – infants with both UVC and PICC

UVC CLABSI rate increased to 42 per 1000 UVC-days by Day 10 with highest in Group 3 at 85 per 1000 UVC days.

UVC had a higher adjusted CLABSI risk, controlled for dwell time.

Replacing UVC before Day 4 may trend lower CLABSI risk.

Consider early UVC removal and replacement by PICC before Day 4

Sanderson et al. Journal of Hospital Infection, AOP 8/1/17

What worked nationally?

Quality Improvement Collaborative of 17 Centers

- ▶ Hand hygiene
- ▶ Central line insertion, maintenance
- ▶ Root Cause Analysis
- ▶ Sterile tubing changes (mask, sterile gloves, sterile barrier) should decrease CLABSI rates by 0.51 per 1000 catheter days
- ▶ Adding hub care (30 seconds scrub-30 seconds dry time) should decrease CLABSI rates by 1.25 per 1000 catheter days

Decreased from 1.33 to 1.07/1000 catheter days

Piazza AJ, Brazański B, Provost L et al. SUG Bug Quality Improvement with Orchestrated Testing Leads to NICU CLABSI Reduction. Pediatrics. 2016; 137(1): e20143642.

What worked in the United Kingdom?

- ▶ Aseptic no-touch technique (ANTT)
- ▶ Vascular access nurse specialist
- ▶ Standardized chlorhexidine from 0.5% and 2% to only 2% concentration
- ▶ Hub care with 2% chlorhexidine
- ▶ Ongoing monitoring audits

Decreased from 31.6 to 4.3/1000 catheter days

Shihai, A.K., et al., Prevention of Late Onset Sepsis and Central-line Associated Blood Stream Infection in Preterm Infants. Pediatr Infect Dis J, 2016; 35(4): p. 401-6.

Quality Improvement and Checklists

- ▶ 54-bed NICU
- ▶ May 2013 to May 2015
- ▶ Checklists
 - ▶ Insertion
 - ▶ Maintenance
 - ▶ Line Access

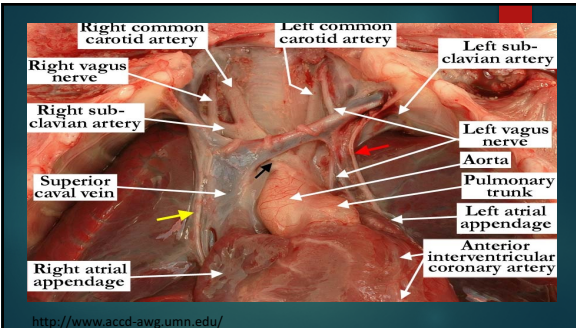
Decreased from 13.8/1000 catheter days to 7.8/1000 catheter days

Taylor, McDonald, Earnest, Bulfinch, Fusinato, Hovenden, Wallace & Tan. A quality improvement initiative to reduce central line infections in neonates using checklists. Eur J Pediatr 2017.

Site selection and complications

- ▶ N = 827 patients, mean gestational age 28.8 weeks
- ▶ 593 in upper extremity (72%)
- ▶ 234 in lower extremity (28%)
- ▶ **Complications**
 - ▶ **Infiltration occurred more in upper extremity** (15% v 6.4%)
 - ▶ Odds ratio 2.4, p < 0.003
 - ▶ **Occlusion occurred more in lower extremity** (13.2% v 8.7%)
 - ▶ CLABSI 4.7/1000 days in upper v. 3.3/1000 days in lower
 - ▶ Phlebitis similar 3.5% in upper v 3.8% in lower

Bashir, Swarnam, Vayalthirikkovai, Yee & Sarosham. Amer J Perinatol 2016



Chlorhexidine bathing

- ▶ NICU Patients with central venous catheters 28 weeks and >
 - ▶ If < 28 weeks, included once > 14 days of age
- ▶ 2% chlorhexidine gluconate wipes were used 3x/weekly.
- ▶ Results:
 - ▶ CLABSI rates decreased from **3.55**/1000 device days in 2015 to **0.24** /1000 device days in 2016

Green Hines, A et al. Abstract 9189. Presented at The Society for Healthcare Epidemiology of America (SHEA) spring conference, March 29-31, 2017; St. Louis, MO

Summary of best strategies

- ▶ Insertion
 - ▶ Specially trained dedicated PICC teams
 - ▶ Maximum sterile barriers
 - ▶ Skin disinfection with Chlorhexidine or povidone-iodine, allowing the antiseptic to completely dry
 - ▶ Chlorhexidine for minimum 30 seconds, up to 2 minutes
 - ▶ Or Povidone-iodine for 2 minutes
 - ▶ Consider use of an extension set between the catheter and needleless connector to reduce catheter manipulation
 - ▶ Consider a 2-person procedure

Wyckoff, M, and E. Sharpe, *Peripherally Inserted Central Catheters: Guideline for Practice*, 3rd ed, ed. N.A.o.N. Nurses, 2015, Chicago IL: National Association of Neonatal Nurses.
INS, *Intravenous Nursing Standards of Practice*, 1st Society, Editor, 2016, Wolters Kluwer Lippincott Williams & Wilkins: Norwood MA.

Summary of best strategies

- ▶ Maintenance
 - ▶ Hub Care with alcohol or chlorhexidine for vigorous minimum 15-second scrub time with each subsequent entry
 - ▶ Allow the agent to dry before access
 - ▶ Change needleless connectors no more frequently than every 96 hours, or if blood or debris present, or prior to drawing blood for culture.
 - ▶ Standardize IV tubing changes with sterile technique and 2-persons
 - ▶ Change intravenous administration set no more frequently than every 96 hours
 - ▶ Minimize add-on devices
 - ▶ Consider fluid and medication filtration (0.2 micron for clears, 1.2 micron for intralipids)

INS, *Intravenous Nursing Standards of Practice*, 1st Society, Editor, 2016, Wolters Kluwer Lippincott Williams & Wilkins: Norwood MA.

Summary of best strategies

- ▶ Ongoing and Outcomes Monitoring/Surveillance
 - ▶ Line rounding by dedicated PICC team
 - ▶ Procedural checklists
 - ▶ Bedside audits
- ▶ Collaborative Action
 - ▶ Stakeholder engagement increases accountability
 - ▶ Ongoing discussion and education
 - ▶ Reporting compliance is associated with lower CLABSI rates
 - ▶ State-based alliances
 - ▶ Solutions for Patient Safety
 - ▶ Wyckoff, M, and E. Sharpe, *Peripherally Inserted Central Catheters: Guideline for Practice*, 3rd ed, ed. N.A.o.N. Nurses, 2015, Chicago IL: National Association of Neonatal Nurses.

Line Care in the NICU Summary

What are Best Practices?

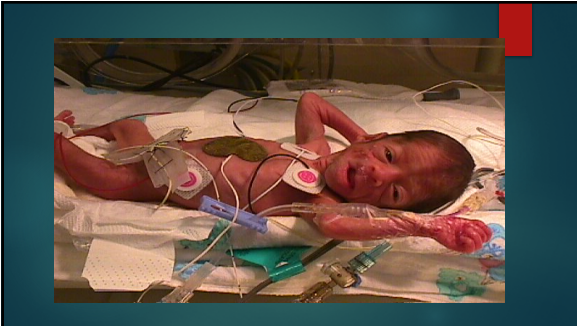
Best Practices

- Hand Hygiene
- Maximum sterile barriers
- Site antiseptics with drying time
- Hub disinfection prior to line entry
- Teams, education & standardization
- Daily review of line necessity

When best is not enough, what could be better?

Better?

- Passive disinfection devices
- Chlorhexidine-impregnated dressing
- Sterile hemostatic agents
- Chlorhexidine bathing



NANN Practice Recommendations

- ▶ Maintain the catheter tip in a central tip location in SVC/IVC
- ▶ Maintain the extremity where catheter is inserted in a consistent position for accurate radiographic confirmation
- ▶ Consider noninvasive catheter repositioning strategies to correct catheter tip malposition
- ▶ Obtain follow-up imaging subsequent to catheter repositioning
- ▶ Consider chlorhexidine gluconate or povidone iodine as disinfectant agents for skin antisepsis
- ▶ Consider the right saphenous vein in initial assessment for catheter placement unless gastroschisis is present

▶ Wyckoff, M. and E. Sharpe. *Peripherally Inserted Central Catheters: Guideline for Practice*. 3rd ed. ed. N.A.o.N. Nurses. 2015, Chicago IL: National Association of Neonatal Nurses.

NANN Practice Recommendations

- ▶ Limit use of contrast media to situations where the catheter tip is unable to be visualized
- ▶ Implement complications prevention strategies including central line-associated bloodstream infection prevention
- ▶ Perform dressing change as needed per patient or external indications.
- ▶ Utilize air embolism preventive measures upon catheter removal
- ▶ Provide initial, ongoing, and consistent education for providers who insert and care for PICCs
- ▶ Consider incorporating new technology and equipment to enhance practice as appropriate to specific patient needs

▶ Wyckoff, M. and E. Sharpe. *Peripherally Inserted Central Catheters: Guideline for Practice*. 3rd ed. ed. N.A.o.N. Nurses. 2015, Chicago IL: National Association of Neonatal Nurses.

NANN Practice Recommendation


- ▶ Maintain the catheter tip in a central tip location in SVC/IVC
- ▶ Rationale: Placement of the catheter tip in the superior vena cava or inferior vena cava is associated with lower risk of complications

NANN Practice Recommendation

- ▶ Maintain the extremity where catheter is inserted in a consistent position for accurate radiographic confirmation
- ▶ Rationale: Consistent patient positioning of the extremity of catheter insertion supports accurate and consistent confirmation of the catheter tip location. Changes in patient position impact catheter tip location and depth

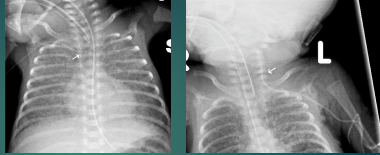
Internal dynamics can make a difference

When should the dressing be changed?



Policy	Product	Patient
<ul style="list-style-type: none"> Hospital protocol Bundle component 	<ul style="list-style-type: none"> If chemically-impregnated disc/dressing Follow manufacturers' recommendations 	<ul style="list-style-type: none"> Soiled, bleeding Moisture Non-occlusive Loss of security

NANN Practice Recommendation



- Consider noninvasive catheter repositioning strategies to correct catheter tip malposition
- Rationale: Noninvasive repositioning facilitates central catheter tip location while posing less trauma to the skin and patient associated with catheter withdrawal or replacement and dressing removal

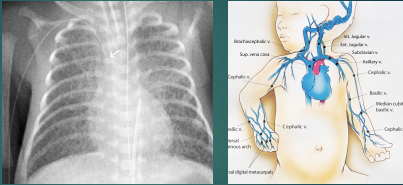


Flush catheter with 1 ml flush in 10 ml syringe


Promote gravity and flow

Gently extend the extremity

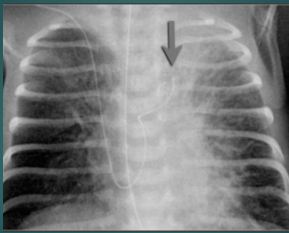
Gravity + Flow = Optimal tip location in the SVC!

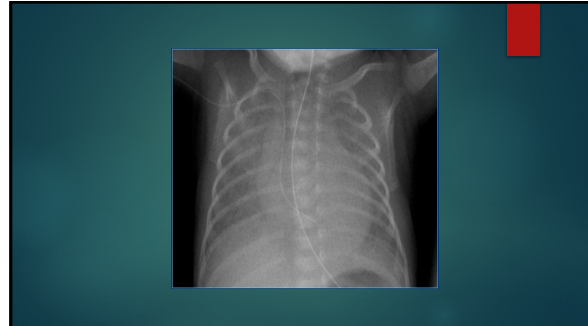
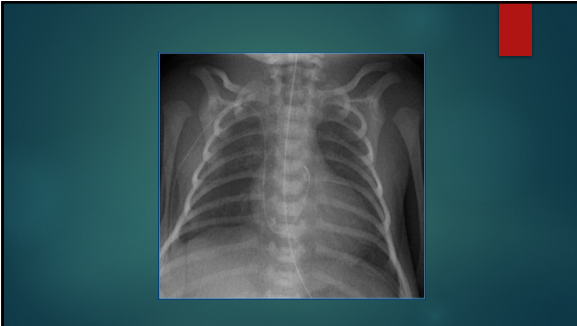


NANN Practice Recommendation



- Obtain follow-up imaging subsequent to catheter repositioning
- Rationale: Catheter tip position should be verified following all repositioning efforts
- Accurate information about the catheter tip location supports minimizing complications



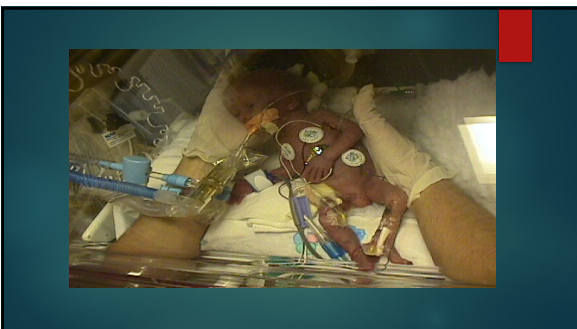


NANN Practice Recommendation

- ▶ Consider chlorhexidine gluconate or povidone iodine as disinfectant agents for skin antisepsis
- ▶ Remove povidone iodine prior to dressing application
- ▶ Rationale: Removing povidone iodine minimizes the risk for tissue damage, absorption and thyroid suppression

NANN Practice Recommendation

- ▶ Consider the right saphenous vein in initial assessment for catheter placement unless gastroschisis is present
- ▶ Rationale: Lower extremity vessels are associated with lower complications rates
- ▶ Right saphenous vein is associated with lower malposition rates



NANN Practice Recommendation

- ▶ Limit use of contrast media to situations where the catheter tip is unable to be visualized
- ▶ Rationale: Use of contrast does not guarantee precise visualization of the catheter tip in all situations

What you need to know about contrast media in babies

- ▶ LOCA's: Low osmolar contrast agents
- ▶ Minimum needed, attempt to withdraw
- ▶ Technique: burst vs. instillation
- ▶ Adverse effects are rare:
 - ▶ hypotension, renal
- ▶ Non-ionic agents recommended in < 1 yr
 - ▶ Iodixanol (Visipaque)
 - ▶ Iopamidol (Isovue)
 - ▶ Ioversol (Optiray)

Costa, J Inf Nsg, 2004

PICC with contrast



NANN Practice Recommendation



- ▶ Perform dressing change as needed per patient or external indications
- ▶ Rationale: The needs, risks and benefits of dressing changes should be considered as the procedure is not without risk and may cause discomfort or trauma to fragile skin

PIVs and PICCs should be assessed every hour

Dressing

- ▶ External length of catheter
- ▶ Kinks, bends, tension
- ▶ Correlate with most recent documentation
- ▶ Erythema, edema, drainage, bleeding
- ▶ Evaluate entire extremity along vein track

Catheter Site

- ▶ Occlusive at perimeter as well as insertion site
- ▶ Secures catheter to prevent migration
- ▶ No portion of catheter is exposed
- ▶ Moisture or bleeding at the site

Dressing change points for practice

How?

- ▶ Sterile technique
- ▶ Hat, mask at minimum
- ▶ Consider a two-person procedure
- ▶ Cleanse with an antimicrobial agent
- ▶ Replace securement devices
- ▶ Replace transparent dressing

When?

- ▶ When no longer adhere to catheter or are damp or soiled
- ▶ Fluid or bleeding at the site
- ▶ If tape and/or gauze is used, should be changed every 48 hrs
CDC, NANN, INS

What is the correct syringe size for flushing?

Syringe Size	Pressure Generated
1 ml	> 300 PSI
3 ml	110 PSI
5 ml	57 PSI
10 ml	< 40 PSI

- ▶ Larger barrel size syringes generate less pressure when flushing
- ▶ Smaller syringes create less pressure when used to withdraw

Macklin, JVAN, Vol. 3, No 1, Winter 1993, pp11-17.

NANN Practice Recommendation

- ▶ Utilize air embolism preventive measures upon catheter removal
- ▶ Rationale: Air embolism can occur due to air inadvertently entering the venous system upon dislocation of the catheter

Air Embolism

Risks <ul style="list-style-type: none"> ▶ Disconnections or changes of tubing ▶ Inadequate priming of infusion tubing ▶ Barotrauma ▶ Removal of catheter ▶ A 14-g catheter can allow 100 ml of air to enter per second 	Prevention <ul style="list-style-type: none"> ▶ Use luer-lock connections ▶ Prime infusion tubing ▶ Keep clamps closed when tubing not in use ▶ Do not keep tubing connected to patient when not in use
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Air embolism can occur when air enters the pulmonary vein or air bubbles cross the patent foramen ovale into the arterial circulation.

Foramen Ovale

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Air embolism

Management

- ▶ Place patient left-sided down
- ▶ Administer oxygen
- ▶ Attempt to aspirate air
- ▶ Occlude entry if possible
- ▶ Monitor vital signs
- ▶ Notify provider

Qazi AQ, Haider ZA, Najam Y. Fatal Systemic Air Embolism in a Neonate after Cardiopulmonary Resuscitation. APSP Journal of Case Reports. 2015;4(1):11.

Diaphragmatic Palsy

- ▶ 800-gram 26 weeks
- ▶ On day of life 11, increased from NCPAP to HFOV due to right pleural effusion
- ▶ X-ray shows asymmetrical diaphragmatic elevation
- ▶ Monitored and normalized by day of life 101.

Hobson, C. et al. "A Rare Complication of Central Venous Catheter Extravasation in a Preterm Neonate: Hemidiaphragmatic Paralysis." AJP Reports 7.2 (2017): e65-e67. PMC Web. 18 Apr. 2017.

Pericardial effusion

Qazi AQ, Haider ZA, Najam Y. Fatal Systemic Air Embolism in a Neonate after Cardiopulmonary Resuscitation. APSP Journal of Case Reports. 2015;4(1):11.


Neonatal PICC1 Survey

- ▶ Electronic survey invitation via MyNANN electronic community
- ▶ 156 respondents in 6-week survey period
- ▶ 115 qualified if placed PICCs as part of daily practice
- ▶ Results
 - ▶ 97.1% had written PICC policies
 - ▶ 61% reported that dressing changes were done by specially trained
 - ▶ 53.6% PICC insertions by specially trained nurses
- ▶ Catheter migration may be more common than infection as a PICC-related complication
- ▶ Systems need to be developed to gather and produce meaningful data related to neonatal PICCs and patient outcomes
- ▶ Neonatal providers are using less heparin for flushing for increased patient safety

Sharpe, Kuhn, Ratz, Krein & Chopra, Advances in Neonatal Care, 2017

Catheter migration may be more common than infection as a PICC-related complication

- ▶ 67.1% stated that they did not use securement devices.



Most common PICC-related complications

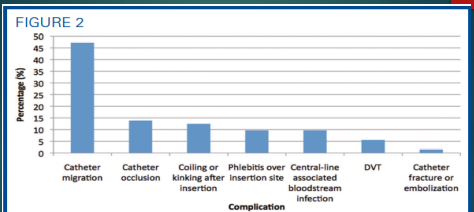
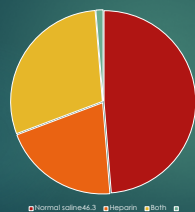


FIGURE 2

Most commonly reported PICC-related complications (n = 72). DVT indicates deep vein thrombosis; PICC, peripherally inserted central catheter.

Sharpe, Kuhn, Ratz, Krein & Chopra, Advances in Neonatal Care, 2017

Neonatal providers are using less heparin for flushing for increased patient safety



- ▶ Normal saline only 46.3%
- ▶ Heparin only 19.5%
- ▶ Both heparin and saline 28.0%
- ▶ (based on device or patient characteristics)

Variability in Flushing frequency

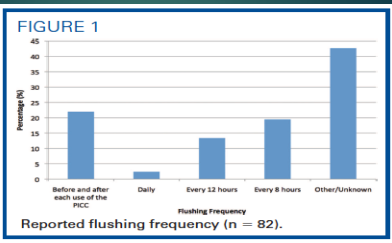


FIGURE 1

Reported flushing frequency (n = 82).

Sharpe, Kuhn, Ratz, Krein & Chopra, Advances in Neonatal Care, 2017

NANN Practice Recommendation

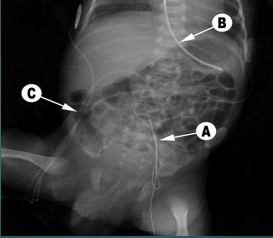


- ▶ Consider incorporating new technology and equipment to enhance practice as appropriate to specific patient needs
- ▶ Rationale: Evolving technology enables new procedures that may help meet specific patient needs and improve outcomes

NANN Practice Recommendation

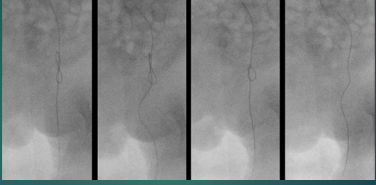
- ▶ Provide initial, ongoing, and consistent education for providers who insert and care for PICCs
- ▶ Rationale: Appropriate and timely education for those placing and caring for PICCs has been integral to preventing central line-associated bloodstream infection, and is critical to minimizing risks of other complications

Not a bundle, just a knot...

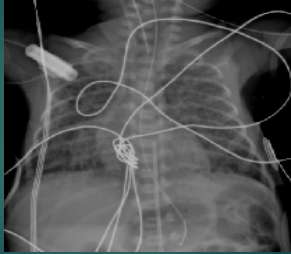


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Unlooping with a guidewire




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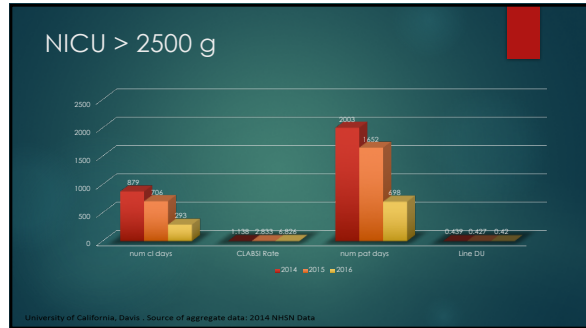
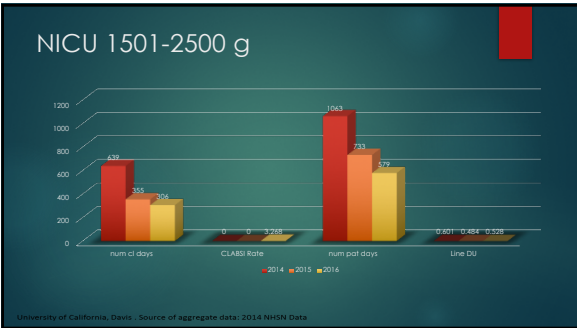
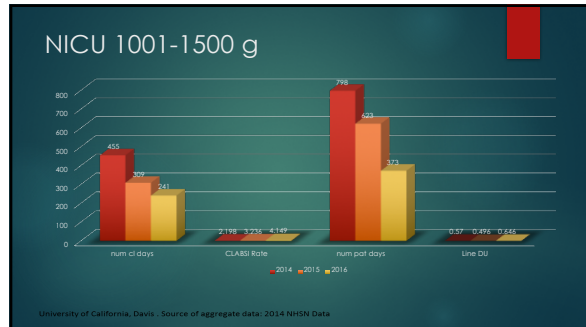
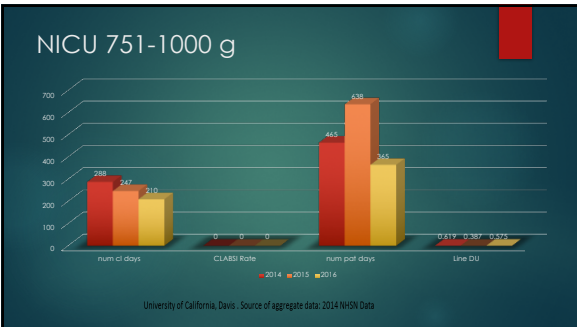
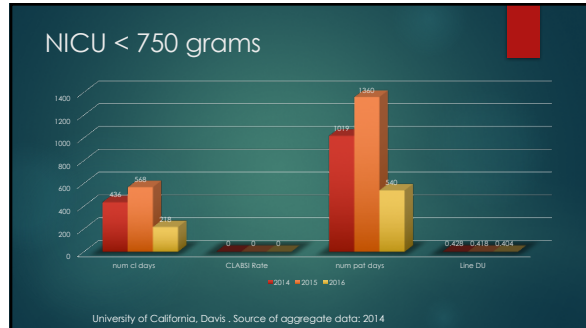
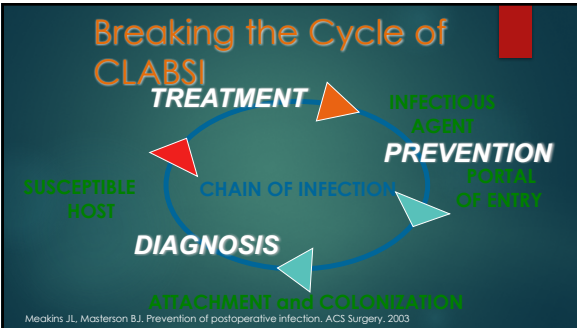
Pearls for PICC Placement

- ▶ Premeditate to medicate?
- ▶ Coordinate with planned extubation or ventilatory support changes
- ▶ Coordinate with volume expansion, after fluid status optimized
- ▶ Coordinate after blood products support (PRBCs, platelets)
- ▶ Place before anticipated surgery
- ▶ Place before hypothermia protocol initiated
- ▶ Timing is everything!

Every day ask the question...



Can the catheter be removed?





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