Objectives

At the conclusion of the presentation, the participant will:

- Describe two new products/techniques for determining central line tip position
- Describe two techniques to reposition PICC
- List four factors to consider when selecting the appropriate vascular access device for an infant
- List three complications from peripheral and central catheters, including symptoms and management techniques

Matching Vascular Access Needs to Patient & Monitoring Safety

- Survival of infants with chronic health needs
- Long term needs for vascular access
- Multiple devices placed
**Vascular Access Headlines**

- Paraplegia: Complication of Percutaneous Central Venous Line Malposition
- Percutaneous Central Catheters and Peripheral Intravenous Catheters Have Similar Infection Rates in Very Low Birth Weight Infants
- Pericardial Effusion in a Preterm Infant Resulting from Umbilical Venous Catheter Placement

**A New Era of Care**

- Growing awareness of medications and solutions and their impact on venous system.
- Recognition of importance of early assessment for the most appropriate vascular device selection.
- Recognition of importance of integrated team approach.

**Evidence Based Resources**

**Vascular Access Device Choices**

**Short term**
- Peripheral IVs
- PICCs
- Umbilical catheters
- Non-Tunneled CVC

**Long-term**
- Tunneled CVC
- Implanted port
- Multiple lumen catheter
- Commonly used in intensive care

**Accessories Used with Vascular Devices**

- Dressings
- Tubings
- Pumps
- Needleless connectors
- Syringes

**Choosing the Device**

Option 1
- Darn if you do

Option 2
- Darn if you don't

**Is there one best device?**
Guess Who Bears Responsibility for Patient Complications

- Device failure
- Patient
- Undetermined
- Healthcare professional
- Pathologic or physiologic factors

Per FDA data

The Reality: Responsibility for Patient Complications

- 55% Healthcare professional
- 28% Undetermined
- 12% Device failure
- 3% Patient
- 3% Pathologic or physiologic aspects

Per FDA data

Choices: Peripheral or Central Line?

MD doesn’t want to risk patient developing a central line infection or thrombus and decides to infuse dopamine in the PIV....

And, the end result...

Access Challenge

If you only consider the length of treatment when selecting a vascular device, you are living in the past!
The Golden Rule...

- Insert one catheter
- Early in treatment
- To last throughout entire therapy
- Minimize complications

Considerations for Choice

- Patient condition
  - Disease process
  - Lab data
  - Vein condition & history of other device
  - Inability to maintain peripheral IV
  - Vein assessment
- Type of therapy
  - TPN, chemotherapy, antibiotics, transfusions
  - Continuous treatment vs. intermittent treatment
  - Hyperosmolar therapies
  - Solutions with non-physiologic pH
  - Solutions with irritating or necrosing properties
- Length of therapy
  - 3-7 or more days of treatment indication for CVC

PIV & Central Catheter Comparison

**PIV**
- Lasts 1-3 days
- Requires multiple sticks
- No hyperosmolar solutions, pH extremes, vesicants, or irritants
  - Examples: TPN, Vancomycin, Acyclovir
- Cost of 2 PIV = 1 PICC
- More frequent complications
- More pain

**Central Catheter**
- Lasts weeks, months
- Requires few sticks
- All fluids & medications
- More skill to place
- Fewer complications
- Complications more severe
- Increase in cost
- Easier to care for at home

PICCs & Umbilical Lines

- Advantages over other CVCs
  - Low complication profile
  - Lower rates of thrombosis & sepsis
  - Less invasive
  - Placed at bedside
  - Less cost
  - Most removed at end of treatment

Considerations for PICC

- Vein of inadequate size
- Inability to identify an appropriate vein
- Vein needed for other purpose
- Local skin infection, nerve injury, vascular compromise at proposed site
- Coagulopathies
- Infection
- Insertion site infection/excoriation
- High frequency ventilation
- Decreased venous return
- Fractures

Special Considerations

- Catheter sizes
  - 2.8, 3.5, 5.5, 8 Fr
- Number of lumens
  - Single
  - Double
  - Triple

Umbilical Vein Catheter

- Advantages/Benefits
  - Easy to insert in newborn
  - Can remain in place 7-14 days
  - Accepts most medications, fluids & blood
  - Blood sampling
  - CVP monitoring
  - Multiple sizes & lumens

- Catheter sizes
  - 2.8, 3.5, 5.5, 8 Fr
- Number of lumens
  - Single
  - Double
  - Triple
Umbilical Artery Catheter

Advantages/Benefits
- Easy to insert in newborn
- Can remain in place 7-14 days
- Accepts most medications, fluids & blood
- Restrictions to use:
  - Vasconstrictive agents
  - Blood sampling
  - CVP monitoring
  - Multiple sizes & lumens

Catheter sizes
- 2.8, 3.5, 5, 6.5, 8 Fr

Number of lumens
- Single
- Double
- Triple

Non-Tunneled Central Venous Catheter

Advantage/Benefits
- Catheter inserted from subclavian, internal jugular, or femoral veins into central vein
- Rare use in neonates
- Common in pediatric ICU

Advantage/Benefits
- Easy to place
- Multiple sizes & lumens
- Allows infusion of all solutions, medications, & blood
- Allows blood sampling

Disadvantage
- Short-term
- Increase risk of catheter associated bloodstream infection

Common sizes:
- Single Lumen: 3FR
- Dual Lumen: 4FR
- Triple Lumen: 5FR

Coated catheters that reduce risk of infection:
- Minocyclin Rifampin and CHG/silver reduce time to central line infections

Non-Tunneled Central Venous Catheter

Account for the majority of central line infections (CDC, 2011)

Short-term use: < 6 days

Common sizes:
- Single Lumen: 3FR
- Dual Lumen: 4FR
- Triple Lumen: 5FR

Coated catheters that reduce risk of infection:
- Minocyclin Rifampin and CHG/silver reduce time to central line infections

Tunneled Catheter

Placement
- Chest, scalp, abdomen
- Tunneled into locations where children can’t reach

Common sizes:
- Single Lumen: 2.7 FR to 4.2FR
- Dual Lumen: 7 FR

Advantages/Benefits
- Intermediate to long-term therapies: > 2 months
- Lower risk of central line associated bloodstream infection
- Can infuse most solutions, medications & blood
- Blood sampling
- Less risk of dislodgement
- Easy to care for - especially at home

Disadvantages
- Surgical procedure
- Cost

Preventing Adverse Events
Understanding Anatomy & Impact of Catheter Tip Location

Veins and X-Rays

Preferred Central Catheter Tip Locations

Pediatric Tip Location

Cincinnati Children's CVC Location Map
Uses magnetic stylet within PICC

Advantages:
- Accurate to within 1 cm
- Fewer x-rays
- Decrease time for insertion

Disadvantages:
- Costs
- Limits in pediatrics
- Evidence
- Sizes
**P-Wave Morphology**

- Allows confirmation of tip location by evaluating height of P wave.

**EKG Guided PICC Placement**

- Allows confirmation of tip location by evaluating height of P wave.
- Methods:
  - Guidewire
  - Saline
- Advantages:
  - Rapid identification of tip
- Disadvantages:
  - Availability
  - Competency
  - Costs

**Non-Radiographic Assessment Findings of Malposition**

- May be asymptomatic
- Symptoms related to position:
  - Cardiovascular
  - Pulmonary
  - GI
  - Neurologic
  - *Soft tissue swelling
  - *Pain
  - Other
- Change in catheter function
- Infusion pump occlusion alarm
- Change in external length of catheter

**Risk Factors: Insertion Related Catheter Malposition**

- Insertion site
- Anatomy
- Catheter
- Insertion technique

**Malposition**

“To conclude, CVC using single orifice catheter through arm veins in pediatric patients is easy to perform, but the proper catheter tip placement is highly unreliable, particularly in younger children 1 to 5 years of age.”

Malposition: Post-insertion Factors

- Patient position/Movement
- Catheter dislodgment
- Dressing security
- Change in intrathoracic pressure
  - Coughing
  - Vomiting
  - High frequency ventilation
- Other forces

Complications Associated with Malpositioned Catheters

- NONE
- UNKNOWN
- Respiratory
  - Effusions
  - Paralysis
  - Hiccoughs
- Cardiac
  - Dysrhythmias
  - Effusion/tamponade
- Vascular
  - Tissue
- Neurologic
  - Seizures
  - Altered exam
  - Renal
  - Other

When it Isn't Right

Passive Techniques: Repositioning Catheters

- Wandering catheter: It it changed once, it can change again
- Gravity
- Venous return
- Time
- Luck

Correction of Malpositioned PICCs

- Timing
- Insertion
- During dwell
- What’s correctable?
  - Ven
  - Type & size of catheter
  - Patient specifics
  - Time in location
- Techniques
  - Assisted
  - Spontaneous
- Outcomes

Effect of Body Movement on Peripherally Inserted CVC Tip Location

<table>
<thead>
<tr>
<th>Site</th>
<th>Abduction</th>
<th>Adduction</th>
<th>Flexion</th>
<th>Extension</th>
<th>Head Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm - Basilic</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>↑</td>
<td>-</td>
</tr>
<tr>
<td>Arm - Axillary</td>
<td>↑</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Arm - Cephalic</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
<td>-</td>
</tr>
<tr>
<td>Scalp/ Jugular</td>
<td>-</td>
<td>-</td>
<td>↓</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Leg</td>
<td>-</td>
<td>-</td>
<td>↑</td>
<td>↓</td>
<td>-</td>
</tr>
</tbody>
</table>
**Active Techniques: Repositioning Catheters**

**Bedside Techniques**
- Reposition patient to utilize gravity
- Arm & leg - extremity manipulation
- Flushing – gentle vs power
- Infusion of fluids
- Venous return
- Time
- Imaging to confirm correction
- Other – IR approaches

**Repositioning Left Arm to Jugular**

If catheter in basilic vein travels to jugular:
1. Abduct arm at shoulder
2. Extend elbow to retract catheter
3. Adduct arm
4. Flex elbow to advance catheter

If catheter in cephalic vein travels to jugular or axilla:
- Adduct the arm
- Extend the elbow to withdraw catheter
- Abduct the arm
- Flex the elbow to re-advance catheter

**Tip in Contralateral Brachiocephalic Vein Repositioning**

- Reposition patient to utilize gravity
  - Sit upright - jugular tip location
  - Place on ipsilateral side if catheter has crossed midline to contralateral side
- Dynamic forces:
  - Gentle flushing
  - Infusion of fluids
  - Venous return to heart
  - Reconfirm catheter position radiographically
  - Length of efforts

**When Unable to Achieve Vena Cava Tip Position**

- Assess risk vs. benefit of location, consider infusates & length of treatment
- Brachiocephalic & subclavian tips
- ??Lower IVC tips
- Midline tips

**Thrombosis Resulting From Incorrect Tip Position**

Is it ok to leave in this position
Real Time Safety Dilemmas

Case

Peripheral Venous Infusion Risk

Risk derived from available evidence, CCHMC data and CCHMC expert opinion. Subject to review and change as further evidence becomes available.

This does not apply to situations of emergency medical treatment.

If a medication is not on this list, please refer to the CCHMC formulary or contact pharmacy (6-4291) for information.

Green & Lower Risk

Aminophylline
Amphotericin B Liposomal
Ampicillin
Ampicillin/Sulbactam
Cefazolin
Cefotaxime
Ceftazidime
Ceftriaxone
Cefuroxime
Clindamycin
D5LR
Dextrose < 10%
Diazepam
Fentanyl
Fosphenytoin
Furosemide
Gentamicin
Heparin
Imipenem
IVIG
Lactated Ringers
Lipids
Magnesium sulfate (bolus)
Meropenem
Methylprednisolone
Piperacillin/tazobactam
Normal saline
Pentamidine
Piperacillin
Ticcarilllin
Pentamidine
Ticcarilllin/clavulanate
Piperacillin
Tobramycin
Yellow & Intermediate Risk

Acetazolamide
Allopurinol
Amikacin
Amphotericin B (conventional)
Arginine
Ciprofloxacin
Dextrose 10% to <12.5%
Erythromycin
Ganciclovir
Lorazepam
Midazolam
Morphine
Ondansetron
Nafcillin
Non-Ionic Radiology Contrast
Phenobarbital
Phenytoin
Potassium <60 mEq/L
TPN < 950 mOsm/L
Vancomycin

Red & Higher Risk

Acyclovir
Caffeine Citrate
Calcium (all salt forms)
Dextrose > 12.5%
Doxycycline
Mannitol 20% & 25%
Promethazine
Potassium > 60 mEq/L
Sodium bicarbonate
Sodium chloride >3%
TPN > 950 mOsm/L
Vasopressors such as Dopamine
Chemotherapy Drugs

History

A PIV was used to infuse epinephrine & during my beginning of shift assessment I discovered...

Peripheral Venous Access is defined as any Venous Access Device whose tip lies outside the Right Atrium, Superior / Inferior Vena Cava, or the Brachiocephalic Veins

June 1, 2011

* NOTE: No peripheral intravenous infusate is “safe”. Gross extravasation, even of normal saline, may result in serious harm including compartment syndrome, causing ischemia and loss of tissue or permanent loss of limb function.

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Real Time Safety Dilemmas

Case

History

The infusion pump had an occlusion alarm. The fellow flushed the PICC and it worked fine. Several days later we discovered...
Case

When we removed the PAL after not being able to get blood return, we noticed this at the insertion site...

Real Time Safety Dilemma

My baby had a seizure!!

We did a LP to rule out sepsis and drained TPN!!

Arterial Catheter Complications

History

When we removed the PAL after not being able to get blood return, we noticed this at the insertion site...

History

My baby had a seizure!!

We did a LP to rule out sepsis and drained TPN!!
Azygous & Hemzygous Systems

- Left sided insertion most common
  - fails to cross midline
  - appears to overlay spine
- Subtle, lateral deviation (hump) of catheter at L4-5 for left sided insertions
- Curl in catheter in inguinal region
- Investigation
  - Skill in interpretation
  - Lateral radiograph
  - X-ray with contrast

Normal Inferior Vena Cava (IVC) Tip Placement

PICC in Ascending Lumbar Vein

Azygous Catheter Location

Scalp insertion

*Courtesy of Tim Royer*
The PICC looked different on the chest x-ray...

Redundant/Persistent Left Superior Vena Cava

Left Sided Vena Cava

Real Time Safety Dilemma
History
While doing my beginning of shift assessment, I noticed the fingers on the right left hand were dusky and cool...

or

Post PICC insertion, The arm turned blue!

Can you always identify when an insertion is arterial?
True or false

Arterial vs Venous Anatomy
- Distinction clearer in adults
- Artery crosses over clavicle vs under
- Left sided insertion does not cross midline
- Right sided insertion crosses over sternum & to left
- Leg insertion - joins aorta to left of midline

Arterial Cannulation
Arteries
- Arm
  - Brachial
  - Axillary
- Scalp
- Temporal
- Leg
  - Popliteal
  - Dorsalis Pedis

Evaluation
- Radiographic
- Physical features
- Laboratory studies
- Transduce
- Visual evaluation
  - Blood flow
  - Color
- ? Aberrant anatomy

Arterial Insertion
Arterial Insertion

Real Time Safety Dilemma

Case

I think my patient has NEC...

Superficial Abdominal Vein

Real Time Safety Dilemmas

Case

History

Our rate of CLABSI is too high. What can we do?

Infection Related to Length of Dwell

- Greater rate if PICC in >21 days
- Greater risk if CVC in >22 days
- Greater risk if PICC in >35 days
- Greater risk if CVC in >31 days (median)
- Umbilical lines left in for 28 days have the same infection rate compared with the practice of removal at 7 days followed by placement of a PICC line for 21 days
- Repeat study 2006-09
  - Long term UVC & PICC 4.6/1000 CD
  - Short term UVC & PICC 3.0/1000 CD
  - PICC-related CLABSI rate stable after 7 days while UVC CLABSI rate increased (p<0.001)

Central Line Bundles: Advances

- Hub antisepsis
- Skin antisepsis
- Ensuring consistent practices
- Monitoring care processes

CCS CLABSI Prevention Bundle Elements

- Insertion
- Maintenance
- Leadership
- Diagnosis

Go to website for information about bundle
http://www.dhcs.ca.gov/ProvGovPart/initiatives/nqi/Pages/default.aspx

Agents & Methods for Disinfection of Needleless Connectors

- 3% don't clean!
- Alcohol
- CHG/Alcohol

Marshall, Mermel, Cassan, Arias, Potgorny & Yokoe, 2008
Line Insertion Checklist

Tubing Change Checklist

STERILE TUBING CHANGE CHECKLIST

1. Hand hygiene.
2. Don exam gloves and other appropriate PPE
3. Remove tracing device and new tubing (if present) and place in sharps container
4. Remove patient identification band.
5. Secure catheter securely to skin.
6. Perform hand hygiene and don sterile gloves
7. Remove sterile gloves and place in sharps container
8. Don sterile gloves and perform hand hygiene
9. Remove and discard catheter
10. Open sterile tubing kit
11. Identify patient and verify tubing and catheter
12. Gently pull catheter out of the skin
13. Secure new tubing securely to skin
14. Perform hand hygiene and remove PPE
15. Remove used equipment and place in sharps container
16. Document completion of procedure

Needless Connector Checklist

Monitoring Staff Performance

Line Set-Up Auditing

Catheter Entry Auditing

Developed by CCS CLABSI Prevention Collaborative

Developed by CCS CLABSI Prevention Collaborative
Concerns Associated with Skin Antiseptic Agents

<table>
<thead>
<tr>
<th>Agent</th>
<th>Effect</th>
<th>Alliteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>Chemical burns</td>
<td>Unknown</td>
</tr>
<tr>
<td>Povidone Iodine</td>
<td>Absorption with iodine causing thyroid suppression Skin reactions</td>
<td>Remove from skin</td>
</tr>
<tr>
<td>CHG/Alcohol</td>
<td>Minimal absorption Toxicity not reported Skin reactions</td>
<td>No recommendation to remove</td>
</tr>
<tr>
<td>CHG/Aqueous</td>
<td>Minimal absorption Toxicity not reported Skin reactions</td>
<td>Remove with sterile water following the procedure (aqueous CHG will not dry due to its soapy consistency)</td>
</tr>
</tbody>
</table>

Pettit & Wyckoff, 2007; Land, Bailly, Raines, Eckerly, Archambault, & O’Halloran, 2007

History of CHG Use in Neonates

- More than 40 years
  - Use in bathing the newborn, umbilical cord cleansing, and wiping the skin to reduce infection
  - Few reports of significant adverse effects
  - Trace blood levels of CHG identified in premature newborns subjected to a variety of concentrations and repeated use.
- Blood levels due to skin contamination rather than percutaneous absorption.
- Skin irritation in infants <1000 grams, regardless of alcohol or aqueous base.
  - 2% CHG/aqueous
  - 2% CHG/Alcohol
  - PI irritation double that of CHG/Alcohol

Adopting Evidence-Based Use of CHG/Alcohol in the NICU

- Barriers
  - Previous product labeling restricted use if < 2 months of age.
  - Updated product labeling January 2012: Use with care in premature infants or infants under 2 months of age. These products may cause irritation or chemical burns.
  - Skin reactions
  - Absorption
  - Fear of the unknown

- Facilitators
  - Emerging evidence
  - Improved CLABSI reduction
  - Minimal reactions
  - Adjusting use based on gestation & chronologic age
  - No toxicity associated with the minimal absorption
  - Realization that all skin antiseptics problematic
  - More than half of NICUs in the U.S are using.

Survey of Neonatal CHG Use

- Survey of Neonatology Fellowship Directors in the United States
  - CHG use 61%
  - 5% of users limited use on basis of birth weight, gestational age, or chronological age.
  - Skin reactions (erythema, erosions, burns) occurring primarily in those weighing <1500 grams were reported by 55%.
  - No difference in adverse events between the alcoholic or aqueous CHG preparations.

- Survey of nurses inserting PICC in U.S.
  - CHG use 54%

Can & Should CHG/Alcohol Be Removed From the Skin?

- Can it be removed?
  - Unknown

- Should it be removed?
  - Reduces persistent effect of antiseptic
  - Not linked to prevention of skin reactions
  - No studies on transcutaneous absorption following attempts to remove

There is no evidence to support removal & it may defeat the proven benefits of CHG with an ↑ in CLABSI

Summarizing the Debate About Chlorhexidine/Alcohol

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual antimicrobial effects of both CHG/ alcohol discourages colonization for up to 7 days</td>
<td>Potential skin irritant</td>
</tr>
<tr>
<td>Not inactivated by blood or body fluids as is povidone iodine</td>
<td>Probably population based</td>
</tr>
<tr>
<td>Increasing body of evidence to support safe, effective use</td>
<td>Low proven risk of topical absorption</td>
</tr>
<tr>
<td>Updated product labeling for those &lt; 2 months of age</td>
<td>No toxic effects identified</td>
</tr>
<tr>
<td></td>
<td>Attempts at CHG/alcohol removal may be detrimental</td>
</tr>
</tbody>
</table>
Survey of CHG/alcohol Use & Removal During PICC Insertion

- Pre-Survey - 21 questions
- 7 questions – Demographics
- 3 questions - Qualifying questions
- 7 questions – Knowledge of CHG/alcohol use
- 2 questions - Reasoning for method of use of CHG/alcohol, including source of knowledge about product use
- 2 questions - Assessment of attitude regarding CHG/alcohol use
- Post-Survey – 22 questions
  - 1 question – Program evaluation

Clinical Significance of Findings

- Significant lack of information or misinformation
- Risk to patients
- Knowledge can be changed through use of a targeted education program

Responses to Knowledge Questions

CHG Question 1

How does the manufacturer recommend applying chlorhexidine/alcohol?
- Using a circular motion
- Back and forth, side to side motion
- I do not know the manufacturer’s recommendation

CHG Question 2

The manufacturer does not recommend removal of chlorhexidine/alcohol from the skin following a procedure.
- True
- False
- I do not know the manufacturer's recommendation

CHG Question 3

When applying chlorhexidine/alcohol, if erythema results it is a normal response to the alcohol.
- True
- False
- I do not know
Both chlorhexidine in a water or an alcohol-base have been linked to skin irritation in neonates.

A. True
B. False
C. I do not know

Chlorhexidine can be easily removed from the skin using water or saline.

A. True
B. False
C. I do not know

Chlorhexidine is inactivated in the presence of blood and other body fluids.

A. True
B. False
C. I do not know

When left on the skin, chlorhexidine imparts persistent antiseptic action for at least two days.

A. True
B. False
C. I do not know

Do you feel that leaving chlorhexidine on the skin protects the neonate from infection?

A. Yes
B. No
C. I am unsure

Summary
References


