Dealing with Difficult Vascular Access in Children

Don't worry, I'll find a good site soon!

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Disclosures

No off label use

Consultant for Bard, Christie Medical, B. Braun, Teleflex
Learning Objectives

• Discuss the use of ultrasound to obtain peripheral venous access
• Discuss the use of intraosseous catheters to obtain vascular access
• Identify advantages of NIR technology for peripheral venous access
• Review peripheral vascular access adjunct techniques
Workshop Setup

- 6 Stations: US, IO, EZ IO, Adjuncts, 2-NIR
- 30 minute presentation / overview
- Break up into groups by number
- Rotate clockwise every 20 minutes
- Additional 30 minutes available at end for additional training as needed.
Why this is so Important

• It helps put you in charge
• Allows you to see what your eyes and fingers can’t find
• May help improve efficiency
• DVA is common
• Patient Satisfaction
• Professional Satisfaction
Difficult Vascular Access
Difficult Vascular Access
DVA

• Could be Peripheral, Central, Arterial
• Dependent on factors and dynamic
  – Patient Condition
  – Clinician’s Skill & Luck
  – Equipment Availability
• Easier to describe than define
Why is DVA Growing?

- Hospitalized patients sicker
- People living longer
- Increased use of Vancomycin
- Failure to prospectively manage vascular access
- Knowledge gap
DVA PEDIATRICS

• < 6 months
• < 2 - 3 years of age
• Obesity in children
• Dark skin tones
• Edema
• Inability to cooperate
Principles of Ultrasound
Developing U/S Skills

• Patience
• Practice
• Position
• Probe
• Conductive media
Patience

• It takes time to achieve proficiency
• To understand ultrasound anatomy
• To develop manual dexterity
Sonographic Anatomy

- Hyperechoic –“white”
  - Vessel wall
  - Nerve
  - Fascia
  - Bone borders
- Hypoechoic –“Black”
  - Fluid (blood)
- Below bone is shadow
Practice

• Use routinely—not just in difficult IV access
  – Start with easier: older children or adult

• Develop efficiency:
  – Develop a rapid access to US machine
  – Have all equipment at stand-by
  – Anticipate needing the machine
  – Pre-scan to find best before you sterilize the site(s)
Optimal Position

• Patient
  – Immobilize or support extremity
  – Make sure comfortable
  – Make sure sustainable

• Screen
  – Operator face the screen neutral position
**Optimal Position**

- **Operator**
  - Do: Arm/hand rest on the patient/bed
    - **US barely touching skin**
  - Do not: bear your weight on the US probe
Probe Selection

**Curvilinear**
- Low frequency probe
- Deep structures

**Linear-array**
- High frequency probe
- Shallow structures
Probe Selection

Wide footprint useful for wider anatomical view
Sonographic Anatomy

- Hyperechoic –“white”
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Gel & Acoustic Impedance

• Resistance of medium to the sound waves

• Each tissue has own unique AI
  • Fat 1.38, Water 1.5, Muscle 1.7, Bone 7.8

• Image is created by the differences in impedance
  • Differences in impedance affects energy reflected

• [http://www.mrcophth.com/commonultrasoundcases/principlesofultrasound.html](http://www.mrcophth.com/commonultrasoundcases/principlesofultrasound.html) Section 4
Why is Acoustic Impedance important?

• Suboptimal contact with skin affects impedance, which affects image quality

• Air bubble in cover disrupts acoustic energy

• Insufficient gel: Poor probe--skin contact
Thick layer of gel may help reduce compression of superficial vessels

But is a mess when trying to secure a PIV after gaining access
When using a sterile sleeve

- Thick layer of gel inside & outside of sterile sleeves
- Remove wrinkle & bubbles
Out-of-Plane vs. In-Plane
“Out of Plane”

Needle is \textit{perpendicular} to footprint of probe
In-Plane

Needle is *parallel* to footprint of probe
Which is better?
Problems with In-Plane

-Vessels are not always straight
-Difficult to keep in line with vessel and probe
-Requires a steady hand and subject

Radial artery
Problems with Out-of-Plane

-Hard to know where the needle tip is
-Can’t tell needle alignment with vessel
-Requires 3-D planning and reaction

Radial artery
Probe Movements
Probe Movements

- Slide to find needle
- Too much pressure might flatten vessel
- Firm pressure needed for deep structures
Probe Movements

- **Angling** – Out-of-plane
  - Improves view of cross-sectional target
- **Tilting** – In-plane
  - Help visualize the needle
Optimal Probe Position

Angle of Incidence
= the angle at which US beam strikes target

• Max energy reflected when Incidence = 90°

Best Image

Poor Image
Needle angle of approach
Peripheral Vein

~30°
Likely to go through vein

~10°
Easier to thread catheter
30-45 degree
5-15 degree
### Table 2  Ultrasonography-guided peripheral IV catheter survival data

<table>
<thead>
<tr>
<th>Catheter survival rates, n (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall survival</td>
<td>42 (56)</td>
</tr>
<tr>
<td>Survived &lt;24 h</td>
<td>35 (47)</td>
</tr>
<tr>
<td>Survived &lt;48 h, &gt;24 h</td>
<td>12 (16)</td>
</tr>
<tr>
<td>Survived &lt;72 h, &gt;48 h</td>
<td>14 (19)</td>
</tr>
<tr>
<td>Survived ≥72 h</td>
<td>14 (19)</td>
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</table>

<table>
<thead>
<tr>
<th>Reason for IV removal, n (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheters that survived</td>
<td></td>
</tr>
<tr>
<td>Treatment completed</td>
<td>30 (40)</td>
</tr>
<tr>
<td>Not removed 4 d after placement</td>
<td>7 (9)</td>
</tr>
<tr>
<td>Changed per routine</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Patient removed catheter</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Catheters that failed</td>
<td></td>
</tr>
<tr>
<td>Infiltrated</td>
<td>21 (28)</td>
</tr>
<tr>
<td>Inadvertent dislodgement</td>
<td>8 (11)</td>
</tr>
<tr>
<td>Phlebitis</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Occluded</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Infection requiring antibiotics</td>
<td>0 (0)</td>
</tr>
<tr>
<td>DVT</td>
<td>0 (0)</td>
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</table>
Use of Intraosseous for Difficult IV Access
Intraosseous Access

• Have it readily available
• Know where it is
• Be comfortable using it
• Think about when
• Practice its use
Intraosseous Line

- Tibial tuberosity
- Anterior border
- 90° to medial surface
Intraosseous Lines

- Make sure in marrow
- Syringe with saline
- Elevate slightly
- Pressure bag
- Reassess leg
15 mm 3-39 Kg
25 mm >39 Kg
45 mm >39 Kg
Recommendations for the Use of Intraosseous Vascular Access for Emergent and Nonemergent Situations in Various Health Care Settings: A Consensus Paper

L. Phillips, J of Pediatric Nursing, 2011, 26: 85-90
Efficacy of the EZ-IO® needle driver for out-of-hospital intraosseous access - a preliminary, observational, multicenter study

Richard Schalk¹, Uwe Schweigkofler², Gösta Lotz¹, Kai Zacharowski¹, Leo Latasch³ and Christian Byhahn¹∗
IO Summary

• IO very easy, rapid access
• Great for urgent, emergent access in any age range
• Forgotten simple skill
• Not just for pre-hospital
Near Infrared

Wavelength (nm)

oxy Hb
deoxy Hb

Near Infrared
How it works

NIR Generating LEDs

Skin
How it works
HOW IT WORKS

VeinViewer

Visable Light

Skin

AccuVein

Laser
Improving Contrast

Lost
What are the Advantages?

Improving Contrast - Reduce Lost Veins
What are the Clinical Data?


<table>
<thead>
<tr>
<th></th>
<th>Traditional Method</th>
<th>Vein Viewer Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Patients</td>
<td>150</td>
<td>91</td>
</tr>
<tr>
<td>First Attempt Success</td>
<td>49.3%</td>
<td>80%</td>
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<tr>
<td>(p &lt; 0.001)</td>
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<td></td>
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<tr>
<td>Mean Number of Attempts Per IV</td>
<td>1.97</td>
<td>1.29</td>
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<tr>
<td>(p &lt; 0.001)</td>
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<tr>
<td>IV’s in &lt; 15 min</td>
<td>52.8%</td>
<td>86.7%</td>
</tr>
<tr>
<td>(p &lt; 0.001)</td>
<td></td>
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</tbody>
</table>
Picking an Optimal Access Site

What You Can’t See

What You Can’t See

What You Can’t See

What You Can’t See
Near Infrared

More Options Than Sight and Touch

Pilot Study Shows a 310% Increase In Potential Venous Access Targets
What are the Advantages?
What are the Advantages?

Getting PIV Access
What are the Advantages?

Post-Access Venous Integrity
What are the Advantages?

Post-Access Venous Integrity
What are the Limitations?

- Depth of Visualization
- Vein Widening
- False Images
- Limited PRT
Summary

- Technology – More Options
- U/S - Available, Learning Curve
- I/O - Not Just for Pre-hospital
- NIR – Very promising
Thank You