Driving Performance Improvement in Ultrasound Guided Peripheral Access: Navigating the Procedure and Process

Rob Dawson
DNP, MSA, APRN, ACNP-BC, CPUI, VA-BC

Vascular Access Consultants, LLC
(VASC)
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Objectives

• Define a short peripheral catheter and a midline
• Explain the Right Triangle Method for sonoguided short catheter insertion
• Describe the 45 degree, 50% rule for sonoguided short catheter insertion
• Describe the implications for patient safety related to sonoguided short catheter insertion
• Describe a framework for vascular access device insertion
What is Vascular Access?

Vascular access can be defined as the practice of assessment, planning, and intervention for the least risk intravascular device insertion and maintenance (Dawson, 2014)
Why Is This Important?

Every patient deserves optimal vascular access care, regardless of: clinician, facility, or time of day!!!

(Dawson, 2011)
Improvement Science Framework

Generalizable Scientific Knowledge + Context of Care
• Purpose
• Patients
• Professionals
• Patterns
• Process

Measured Performance Improvement

(Batlden, 2003)  (Microsystem Academy, 2013)
What is our basic knowledge premise for access?

• Deliver reliable infusion therapy accomplished by reducing venous depletion

• How?
  – Intentional early assessment based on diagnosis, prescribed therapy, and mitigating factors to deliver the device insertion procedure with the least risk and best chance for reliable infusion delivery
Generalizable Knowledge

• Over 90% of admissions require IV access
• One of the least planned for care activities
• Peripheral devices can fail up to 30% of the time before therapy is complete
• Vessel preservation is a key concern
• Sporadic, inconsistent application of evidence is common
  – Effective care variation (Wennberg, 2002)
Generalizable Knowledge?

• Specialized teams reduce risk
• Assessment leads to appropriate device selection and placement
• Early planning maximizes system benefit
  – Less devices and attempts
  – Reduced delays in care
  – Decreased Length of Stay
  – Increases satisfaction
  – Reduced costs
Generalizable Knowledge

• Trauma
  – Ruins access of all kinds

• Prevent trauma
  – Site selection
    • Avoid mechanical trauma from flexion
  – Vein selection
    • Largest, straightest segment
  – Device selection
    • Smallest, shortest device
Knowledge Application

- Fewest number of devices
- Smallest device in the largest vein, out of an area of flexion
- Dilution of infusion preserves veins, and reduces infusion related irritation
- **Right Device, Right Time, Right Patient**
  
  » (Moureau et al., 2012)
Knowledge for Application

- Length of stay > 5 days, plan for midlines and central lines (CDC, 2011)
- Ultrasound reduces risk of central line insertion (CDC, 2011, AHRQ, 2002)
- Diagnosis and Infusion plan predict need and device type (INS, 2011, Moureau et al., 2012)
- Comorbid Mitigators: Age, diabetes, steroid use, renal failure, IV drug use, mastectomy, etc.
Knowledge for Application

• First attempt is your best chance
  – Minimize attempts and trauma to reduce complications
  – Patients do not like pain or needle sticks, this impacts satisfaction
Knowledge Application

• Ultrasound
  – Guides access to Reduce Attempts
  – Allows for Best Vein Selection
  – Allows for Best Site Selection
  – Standardizes care and approach to procedure
  – Can be a skill equalizer
Knowledge Application

• Ultrasound guided access affords the patient the best opportunity for reliable infusion delivery, controlling for mitigating factors...
  • Age
  • Prescribed treatment
  • Body habitus
  • Depleted access
Knowledge Application

• Clinically indicated change (INS, 2011)
  – Extended dwell PIV
  – Is this different than a Midline
  – How does this impact practice
    • Aseptic vs Sterile
    • Device choice
    • Method of Insertion
Vein Preservation

- Veins are a limited, non-renewable resource
  - When evaluating the application of knowledge in practice, with the aim of performance improvement...Keep this as a key point of focus

- Our professional practice aim should be to provide reliable drug infusion by focusing on reducing venous depletion
  - This is your compass!
Approach to Access

Conceptual Framework for Vascular Access: This is a tool to use once you are pointed in the right direction!

(Dawson, 2012)
Application of Framework

• **Purpose**
  – IV Antibiotics – Aztreomyc q 8 hours
  – IV Fluids – Normal Saline

• **Device**
  – Peripheral Access Catheter

• **Location**
  – Forearm

• **Technique or Method**
  – Ultrasound guided, MST
Not all veins are equal

Images courtesy of Rob Dawson
Not all locations are equal

Images courtesy of Rob Dawson
Every patient is different

Images courtesy of Rob Dawson
What stops the most ideal access?

Images courtesy of Rob Dawson
Which would you prefer?

Images courtesy of Rob Dawson
Which Would You Prefer?

Images courtesy of Rob Dawson
Which Would You Prefer?

Images courtesy of Rob Dawson
Approach to Access

Mitigators

✓ Is this the most appropriate vascular access option for this patient at this time

✓ Could this patient possibly require a PICC, Port, or other upper extremity vascular access device

✓ Is the patient cooperative and able to extend arm for assessment and placement
Approach to Access

**Mitigators**

- Current vascular access devices
- Vein limitations of upper extremities
- Chronic renal failure
- History of ultrasound guided PIVs
- History of upper extremity thrombosis
- Policy, Procedure and Staffing
Case Application

- 59 y.o. Male presents with unstable angina
- Admitted Friday evening for planned CABG on Monday morning
- Patient is thin, but reports history of difficult venous access, and “small veins”
- Assessment confirms limited access, but patient needs Reliable Infusion Delivery!
Case Application

• Request made for IV Access:
  – Purpose
  – Device
  – Location
  – Method
  – Mitigator
Case Application

• **Purpose** – IV Heparin gtt, IV fluids
• **Device** – Peripheral Access at this time, although CVC and A-line for surgery
• **Location** – Ideally avoid AC and wrist
• **Method** - Depends on available veins for access
• **Mitigator** - Assessment reveals limited palpable or visible veins, limited to AC area
Case Application

• Ultrasound used for initial access Method after confirming Mitigating factors and considering Purpose and Device,

• Location, Middle forearm Cephalic vein

• Summary: A long PIV 22g, 4.5cm/1.75”, placed in the RLFA Cephalic Vein with Ultrasound Guidance, vein 0.6cm deep, Approximate angle of entry3 30 degrees.
Case Application

Images courtesy of Rob Dawson
US PIV Practice Implications

Where to insert?
- Forearm
- Upper arm

How to insert?
- Landmark / Blind
- Ultrasound

Why to insert?
- Access < 7 days
- Difficult access
- Special procedure
What are Short Catheters?

Short Peripheral Catheter (< 8cm)
- Landmark insertion – 0.5” – 1.5” (Short)
- Sonoguided – 1.5” – 3” (Long)

Midline
- Between 8cm – 10cm (Short)
- Between 10cm – 20cm (Long)

Is this acceptable to define devices?
What is a Midline?

• INS Definition, Standard 35
  – “The midline catheter tip location should be at or below the axillary line” (INS, 2011, p. S45)
  – “…tips terminating in either the basilic, cephalic, or brachial vein, distal to the shoulder. The basilic vein is preferred.” p. S37
What is a Midline?

• INS Standards, Standard 33
  – “Site Selection should be routinely initiated in the region of the antecubital fossa.”

• Certainly not the case anymore
What is a Short PIV?

• “Site selection should be initiated routinely in the distal areas of the upper extremities; subsequent cannulation should be made proximal to the previously cannulated site”.
  
  • (INS, 2011)
Can we define short catheters?

PIV

- Veins of the upper extremity in adults
- Tip terminates peripherally
- No Touch Technique

Midline

- Basilic, Brachial, Cephalic in upper extremity of adults
- Tip terminates distal to shoulder in upper arm at or below axillary line
- Sterile insertion

(INS, 2011)
Can we define short catheters?

PIV

- For duration <1 week
- Avoid areas of flexion and tissue compromise
- Move distal to proximal with subsequent cannulation

Midline

- For duration > 1 week <= 4 weeks
- Initiated in AC veins

(INS, 2011)
Practice Implications

The key difference seem to be: **Tip Position, Dwell Time, Vein Selected, Level of Infection Prevention**

However, it is also clear that that technology of the PIV catheter has limitations when used with Ultrasound to access deeper vessels.

There may be limits to **Insertion Angle and Vein Depth** as it relates to **Catheter Length and Flexibility**.
Context Assessment

• Context of Care
  – Process and Procedure
  – Patterns
  – Professionals
  – Purpose
  – Patients

  • (https://clinicalmicrosystem.org)
Process

Assess your Process for key Knowledge Principles: 
**Early Assessment, Device Location, Device Selection**

Assess the outcomes that your system of care delivers: 
**Device Failure, Complications**
Context Assessment

• What should be considered when assessing your vascular access program/system?
  – Device failure rate (Short PIV vs. Midline)
  – Successful completion of therapy
Context Assessment

- Device Optimization Ratio (DOR): # of Devices/Hospital Day
  - e.g. 3 device in 2 days = DOR of 1.33
  - vs. 1 device in 4 days = DOR of 0.25
  - One Device per day = DOR of 1

- What does this mean?
  - Application of Knowledge and Process
  - Use of Technology and Skill
Context Assessment

• Observe Process and Procedure to:
  
  – **TRAUMA**
    
    • MECHANICAL
      
      – Site Selection and Technique
    
    • CHEMICAL
      
      – Tip location and Rx Plan
    
    • PSYCHOLOGICAL
      
      – Patient Preference
      
      – Patient Experience may determine future access options
Context Assessment

Process

When, How, and Why is Ultrasound used?

• Some issues:
  – Failure first then US Peripheral would be useful
    – Aponte et al., 2007, AANA Journal/June Vol. 75, No. 3
  – Reduce central line use in non-critically ill emergency department patients
    – Shokoohi et al., 2012, Annals of Emergency Medicine, Vol61, No.2
Context Assessment

• “The nurse should consider using visualization technologies that aid in vein identification and selection” (INS, 2011, p. S41)

OR

• Ultrasound should be considered as a primary assessment tool in determining the most ideal vascular access options, in an effort to reduce trauma and preserve veins for future use
The Procedure

Acceptable Zones for Least Risk Access:
Reduce Attempts, Reduce Trauma by Anatomical Assessment and Procedure Planning
Site Selection System

ZONE INSERTION METHOD (ZIM)

Red Zone
0-7cm

Green Zone
7-14cm

Yellow Zone
14-21cm

Medial Epicondyle

Ideal Zone
Needle Insertion

Axillary Line

Area of Flexion

Target Area

Area of Moisture

Images courtesy of Rob Dawson
Where to Insert, the Upper Arm
Images courtesy of Rob Dawson
Elbow Triangle

Images courtesy of Rob Dawson
Where to Insert, the Forearm

Make an improvement in care!

Image by Rob Dawson
Avoid lateral wrist
4 – 5 inches
Avoid anterior wrist
Avoid areas of flexion
-(INS, 2011)
Planning US PIV Procedure
Vein Assessment and Planning
Planning US PIV Procedure
How to Insert

• INS Standard 35
  – “…non-sterile gloves in conjunction with a no-touch technique for peripheral IV insertion.” p.S44

  – “With no touch technique, the planned IV insertion site is not palpated after skin cleansing unless sterile gloves are worn.” p. S44
How to Insert: 45/50 Rule

In Plane, Long Axis

Angle of Insertion?

How much catheter in before blood flash?

30 degrees

Approx. 70% = 3cm
Why 45/50

- 47% Infiltration within 24 hours for US PIV = 18g into Basiclic or Brachial veins
  – (Dargin, 2009)
45/50 Rule

• No more than, 45 degrees at skin entry
• 50% of the catheter left intravascular
• Why?
  – Material flexibility
  – Limited length
  – Reduce risk for flow occlusion
  – Reduce risk for infiltration
Right Triangle Method

- Needle Angle of Insertion is determined by vein depth and distance from the probe.
Right Triangle Method
Needle Intersect

Constant vein depth means the angle is related to how far the needle is inserted away from the ultrasound wave.
Right Triangle Method

Images by of Rob Dawson
Right Triangle Method

Image by Rob Dawson
# Right Triangle Method

## 1cm Vein Depth, 4.5cm Catheter

<table>
<thead>
<tr>
<th></th>
<th>15 degree Angle</th>
<th>30 degree Angle</th>
<th>45 degree angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needle Distance from US Probe (b)</td>
<td>37.3mm</td>
<td>17.3mm</td>
<td>10mm</td>
</tr>
<tr>
<td>Needle Length to Reach Vein (c)</td>
<td>38.6mm</td>
<td>20mm</td>
<td>14mm</td>
</tr>
<tr>
<td>% Catheter in Vein</td>
<td>12%</td>
<td>55%</td>
<td>68%</td>
</tr>
</tbody>
</table>

## 2cm Vein Depth, 4.5cm Catheter

<table>
<thead>
<tr>
<th></th>
<th>15 degree Angle</th>
<th>30 degree Angle</th>
<th>45 degree angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needle Distance from US Probe (b)</td>
<td>74.6mm</td>
<td>34.6mm</td>
<td>20mm</td>
</tr>
<tr>
<td>Needle Length to Reach Vein (c)</td>
<td>77.3mm</td>
<td>40mm</td>
<td>28.3mm</td>
</tr>
<tr>
<td>% Catheter in Vein</td>
<td>0% Does Not Reach</td>
<td>9%</td>
<td>36%</td>
</tr>
</tbody>
</table>
Right Triangle Method

30 Degree Angle of Entry, 2.5 inch Catheter (6.4cm)

<table>
<thead>
<tr>
<th>Vein Depth</th>
<th>Catheter Length to Reach Vein</th>
<th>% Catheter in Vein</th>
<th>Distance from Probe at Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1cm</td>
<td>2cm</td>
<td>69%</td>
<td>1.7cm</td>
</tr>
<tr>
<td>2cm</td>
<td>4cm</td>
<td>38%</td>
<td>3.5cm</td>
</tr>
</tbody>
</table>
# Right Triangle Method

45 Degree Angle of Entry, 2.5 inch Catheter (6.4cm)

<table>
<thead>
<tr>
<th>Vein Depth</th>
<th>Catheter Length to Reach Vein</th>
<th>% Catheter in Vein</th>
<th>Distance from Probe at Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1cm</td>
<td>1.4cm</td>
<td>78%</td>
<td>1cm</td>
</tr>
<tr>
<td>2cm</td>
<td>2.8cm</td>
<td>56%</td>
<td>2cm</td>
</tr>
</tbody>
</table>
## 45 Degree Angle of Entry, 8 cm Catheter

<table>
<thead>
<tr>
<th>Vein Depth</th>
<th>Catheter Length to Reach Vein</th>
<th>% in Vein</th>
<th>Distance from Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 cm</td>
<td>2.8 cm</td>
<td>65%</td>
<td>2 cm</td>
</tr>
<tr>
<td>2.5 cm</td>
<td>3.5 cm</td>
<td>56%</td>
<td>2.5 cm</td>
</tr>
</tbody>
</table>
### 30 Degree Angle of Entry, 8 cm Catheter

<table>
<thead>
<tr>
<th>Vein Depth</th>
<th>Catheter Length to Reach Vein</th>
<th>% in Vein</th>
<th>Distance from Probe</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 cm</td>
<td>4 cm</td>
<td>50%</td>
<td>3.5 cm</td>
</tr>
<tr>
<td>2.5 cm</td>
<td>5 cm</td>
<td>38%</td>
<td>4.3 cm</td>
</tr>
</tbody>
</table>
Procedure Example 1

Video by Rob Dawson
Mitigators Change Your Plan

Upper arm unlikely to work for midline

Forearm vein too deep for PIV
Case Application

Before
• 3 devices, 2 days
• Device Optimization Ratio = 1.33
• 2 missed ABX doses by > 3 hours
• 9 attempts
• Phlebotomy

After
• 1 Device, 4 days
• Device Optimization Ratio = 0.25
• 1 attempt
• No missed ABX doses
• Reduced phlebotomy
Summary

• Avoid unnecessary use of central lines
• Difficult vascular access (DVA)

**Ideal vascular access**

– Matching device, purpose, and method to reduce trauma and risk
– Make ultrasound routine, not just for difficult vascular access (DVA)
– One device per admission
Summary

- **Warning signs for your practice**
  - multiple unsuccessful peripheral sticks
  - numerous peripheral IV restarts
  - Device Optimization Ratio for LOS > 3 days

- **Patient assessment signs**
  - history of difficulty obtaining IV access
  - limited vascular options
  - large gauge access needed
  - central line contraindicated or unsuccessful
Procedure Example 2

Video by Rob Dawson
Thank you!

RBDAWSON@ME.COM
TWITTER: @DRROBERTDAWSON