Ultrasound Guided Peripheral IV Teams

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• IVTAGS.com: Owner
• Bard Stock Holder
Published Data:

PIV Insertion Success Rate

Press Ganey: Satisfaction Report
N=1,759,472 patients surveyed
N=1,137 hospitals surveyed

<table>
<thead>
<tr>
<th>How well the staff worked together to care for you (highest)</th>
<th>Skill of nurses</th>
<th>Courtesy of the person who started your IV</th>
<th>Skill of the person who started your IV</th>
<th>Room Temperature (lowest)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.79 mean</td>
<td>.63 mean</td>
<td>.48 mean</td>
<td>.42 mean</td>
<td>.35 mean</td>
</tr>
</tbody>
</table>

Correlations of items with *likelihood of recommending from lowest to highest


Factors Contributing to The Potential for Difficult Venous access

- Some chronic diseases
- Diabetes
- Cancer
- Cardiovascular conditions
- End stage renal disease
- COPD
- Aging population
- Pediatric population
- Mastectomy
- Stroke
- Contractures
- Smoking
- Inactivity
- Major surgery
- Obesity increasing
- Hemophilia
- Rheumatoid arthritis
- Drug abuse
- Crohn's, ulcerative colitis, irritable bowel syndrome
- Dark pigmentation difficult to visualize vascular
- Hypertensive
- Multiple injuries
- History of multiple venous cannulations
- Immunodeficiency
- Long periods of bedrest
- Peripheral venous disease

Hadaway: InfraRed Imaging Systems 2005 pg
**During the past 20 years increase in obesity**

More than 1/3 of US adults (35.7%) are obese

Potentially challenging IV access:
- Non-palpable
- Non-visible


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**Tattoo**

Difficult visualization of veins

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**IV Consults**

- Vancouver General Hospital (1,000 beds)
  - 7 day per week consult service for inpatients with difficult sticks or PIV device complications
  - Consults received from 33 of 37 wards
  - Majority of consults
    - Surgical services (45%)
    - Medical services (41%)
    - Critical care (9%)
    - Other (5%)
  - General surgery wards highest (21%)

Bosma; Journal of Infusion Nursing pg 311 Sept/Oct 2002
### Status of Vein at time of consult

**Vancouver General Hospital: IV Consults**

<table>
<thead>
<tr>
<th>Status of Vein</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viable and good</td>
<td>20%</td>
</tr>
<tr>
<td>Viable and fair</td>
<td>24%</td>
</tr>
<tr>
<td>Viable and poor</td>
<td>39%</td>
</tr>
<tr>
<td>Non visible but palpable</td>
<td>10%</td>
</tr>
<tr>
<td>Non visible non palpable</td>
<td>4%</td>
</tr>
<tr>
<td>Unknown</td>
<td>3%</td>
</tr>
</tbody>
</table>

*Bosma: Journal of Infusion Nursing pg 311 Sept/Oct 2002*

### PIV Insertion success

**Shands at the University of Florida**

- N=371 patients
- **Mean number of IV attempts 2.18**
  - Range 1 – 14 attempts
  - 27% required 3 or more attempts
  - 25% treatment delay for patients requiring IV therapy
  - No visualization technologies utilized

*Barton: J Nurs Care Qual 1998 pg 78*

### INS Recommendations

**Visualization Technologies**

- “consider using visualization technologies that aid in the vein identification and selection” when placing short peripheral catheters
- “The vasculature shall accommodate the gauge and length of the catheter required by the prescribed therapy.”

*Infusion Nursing Standards of Procedure Volume 34*
Visualization technology: PIV Insertions
Drexel University College of Medicine ER
Temple University School of medicine
N=60 patients

<table>
<thead>
<tr>
<th>Ultrasound Group</th>
<th>Traditional (Landmark) control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>97% success rate</td>
<td>33%</td>
</tr>
<tr>
<td>13 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td>1.7 punctures</td>
<td>3.7 punctures</td>
</tr>
<tr>
<td>8.7 patient satisfaction</td>
<td>5.7 patient satisfaction</td>
</tr>
</tbody>
</table>

Physicians (2) Department of Emergency Medicine
Inclusion Criteria: inability of RN to obtain access after (3) attempts
Candidates: Obesity, IV Drug abuse, chronic medical conditions
Exclusions: Need for central venous access
Greater patient satisfaction with ultrasound group

Costantino: Annals of Emergency Medicine 2005 pg 4.6

Cost and Reimbursement

Costs: PIV Insertion

- Santolucito (OHSU): 2001
  - $32 operational cost successful insertion (2013 = $42.xx)
- Multiple attempts:
  - Additional nursing time
  - Multiple catheters
  - Additional supplies for procedure
- $96 for (3) attempts

Hadaway: Infrared Imaging Systems 2005 pg 1
Reimbursement

Hospital Inpatient
DRG Based for Medicare and Medicaid

CPT 36000 - (Professional Only)

Implementation

Implementation steps

• Hospital needs to develop policy and procedure
  – Equipment IFU’s
• Competency checklist
• Didactic training
• Simulation training
• Proctoring
• Outcome monitoring and evaluation
**Objectives**

- Attendee will be able to define the tools necessary in developing a new U/S Guided program.
- Attendee will be able to illustrate the structure/frequency for beginning an U/S PIV Program
- Attendee will relate to common expected student outcomes, performance, and common pitfalls to avoid.

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**Class Structure/Frequency**

- Suggest maximum of 4 students per instructor
- Didactic: 2 - 3 hrs
- Practicum (on vein blocks): 1 hr

![Practice Veins are Helpful](image)

- Typical day: 8am – noon Didactic/Practicum
  1pm – 4pm Patient Insertions with Preceptor

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**Class Structure/Frequency**

- Models: PICC team, Education Nurse, OR Suite
- Student completion of 3 check off venipunctures with instructor present may take multiple sessions to accommodate everyone.
- In my experience, students average about 5-6 sticks to obtain 3 successful venipunctures.
- First (class) – let all watch other’s venipunctures.
- Students came back for 3 to 4 hour sessions to complete remaining successful sticks
Selecting Students

- RN Candidates selection should demonstrate the following:
  - History of hand/eye coordination activities
    - Playing video games, musical instruments, etc
  - Availability
  - Strong desire to learn this skill
  - Desire to help co-workers
  - Good vision for viewing close objects 😊

Example Program Content

- All Available for download:

Class Content

- Objectives presented to the U/S Guided PIV students:
  - To learn when to utilize ultrasound technology for peripheral IV starts and blood draws
  - To understand peripheral venous anatomy
  - To become familiar with the basics of high frequency-low depth ultrasound machines
  - To be familiar with potential complications
  - To understand vein/catheter selection
  - To learn technique required to cannulate a deep vein
  - To be familiar with common pitfalls
Class Content

- The following slides with "CC:" are course slides for Ultrasound Guided Class and will be in the downloadable PowerPoint Presentation.

- No gloves were worn in images taken for demonstration only purposes.

CC: Ultrasound Guided PIVs

Precision & Solution for the Hidden Veins
You should develop accurate proprioception with practice.

CC: Common Difficult Stick Causes

- Some chronic diseases
- Diabetes
- Cancer
- Cardiovascular conditions
- End stage renal disease
- COPD
- Aging population
- Pediatric population
- Mastectomy
- Stroke
- Contractures
- Smoking
- Inactivity
- Major surgery
- Hematomas
- Obesity increasing
- Hemophilia
- Rheumatoid arthritis
- Drug abuse
- Crohns, ulcerative colitis, intractable bowel syndrome
- Dark pigmentation difficult to visualize vascular
- Hypotensive
- Multiple injuries
- History of multiple venous cannulations
- Immunodeficiency
- Long periods of bedrest
- Peripheral venous disease
CC: Vein Anatomy

Fig. 1  [Image 1]
Fig. 2  [Image 2]

CC: Arm Vein Anatomy

CC: Upper Arm Vein Anatomy
CC: Ultrasound View – Upper Arm

- Veins
- Basilic
- Brachials
- Artery
- Brachial

CC: Ultrasound View – Upper Arm

- Nerve Bundle

CC: Typical Sizes & Flow Rates

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Diameter (mm)</th>
<th>Blood Flow (ml/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cephalic</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Basilic</td>
<td>8</td>
<td>150 - 200</td>
</tr>
<tr>
<td>Axillary</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Subclavian</td>
<td>6-19</td>
<td></td>
</tr>
<tr>
<td>Superior Vena Cava</td>
<td>20 to 30</td>
<td>2000 - 2500</td>
</tr>
</tbody>
</table>

CC: “Rule of Thumb”

- Be patient
- Look for sites that will have the best possible success
- Use warm packs if extremities are cold to touch
- Avoid areas of flexion
- Use good judgment
- Evaluate and avoid sticking nerve bundles

CC: “Rule of Thumb”

- Assess entire arm
- Start distal and work up
  - Ulnar, Radial, Cephalic
- Then upper arm superficial
  - Cephalic
- Avoid upper arm and forearm in patients with Chronic Kidney Disease
  - Basilic, Brachial

CC: Example Ultrasound Equipment

Educate your students where to locate the ultrasound equipment and utilize a log book for tracking use.
CC: Ultrasound Technology

- Ultrasound has a high frequency >20KHz, outside the range of human hearing.
- Interacts with tissues as it propagates and returns
- Reflections from blood are weak compared with those from solid tissues.


CC: Ultrasound Machines

- Always plug in power adapter
- Battery life is unpredictable
- Machine must be signed out in log book located at respective nursing station
- Clean before and after use
- Please take careful care in handling equipment
- Very expensive… $15,000 - $25,000
- Replacement probe… $3,500 + (don’t drop it)

CC: Ultrasound Machines

- Avoid tilting the probe (too much)
CC: Ultrasound – Maximize Your Image

- Depth
  - The lumen should be large enough to be easily seen on the ultrasound screen.¹
- Optional settings typically available
  - gain, focus, etc

- Fluid filled vessels should appear (anechoic) black, void of echoes ²

¹ (Goldstein, Israeli Journal of Emergency Medicine, 2006, pg 50)

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CC: Selecting the Vein

- Depress vessels to differentiate veins from arteries ¹
- Vein will stay depressed. ¹
- Arteries will “pulsate” ¹
  NOTE: Patients with low BP may not pulsate.
- Trace vein with probe to find a straight section of the vein ¹
- Mark endpoints to visualize vein path ²
- Vein depth discussed later...

¹ (Goldstein, Israeli Journal of Emergency Medicine, 2006, pg 50)
² (Meer, Medscape, 2011, pg 5)

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CC: Selecting the Catheter

- Catheter size selection should reflect choosing the smallest device to accommodate the prescribed therapy. ¹

- ------ Implement a guideline ------
- Typical guideline: Catheter length should be adequate to ensure that ½ of the catheter will reside in the lumen of the vessel. Be sure to take the angle of approach into consideration when determining vessel depth (depth scale available on US screen).

¹ (Policies and Procedures for Infusion Nursing, 4th ed. INS. Pg 56)
CC: Vein Depth | Stick Angle | Catheter Length

- This chart represents the catheter lengths needed just to reach the vein.
- The length to reach the vein should not be more than one-half of your catheter length.

<table>
<thead>
<tr>
<th>Stick Angle (degrees from skin)</th>
<th>Vein Depth</th>
<th>Units = cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°</td>
<td>0.5 cm</td>
<td>1.0, 0.7, 0.5</td>
</tr>
<tr>
<td>45°</td>
<td>1.0 cm</td>
<td>2.0, 1.4, 1.0</td>
</tr>
<tr>
<td>75°</td>
<td>1.5 cm</td>
<td>3.0, 2.1, 1.6</td>
</tr>
<tr>
<td></td>
<td>2.0 cm</td>
<td>4.0, 2.8, 2.1</td>
</tr>
<tr>
<td></td>
<td>2.5 cm</td>
<td>5.0, 3.5, 2.6</td>
</tr>
</tbody>
</table>

Catheter Length = Vein Depth / [Sin(Stick Angle x (π/180))] Units = cm

CC: Selecting the Catheter

- Floor Stock [Insert your model]
  - 1.00, 1.25 inch etc.
  - 18, 20, 22, 24 gauge

- U/S Insertions Stock [Insert your model]
  - 1.75 in | 45 mm
  - 20 gauge
  - This will require adding tubing

- One handed vs two handed
CC: Stick Technique

- Clasp probe with a “C” grip close to the skin… holding the probe far from the end will allow too much movement.

Gripping with a “C” allows use of your pinky finger and/or butt of your hand to stabilize your hand against patient arm.


CC: Stick Technique

- Stabilize your hand holding probe with one finger or wrist against patient’s arm.

- For users that place the machine on the same side of the bed, it is recommended to wrap the ultrasound cord around arm to prevent dropping probe.

- Keep ultrasound perpendicular to skin for a better image 1

- Use on-screen guide to align center. 2

2 Goldstein, Israeli Journal of Emergency Medicine, 2006, pg 50

CC: Site Prep

- Mark endpoints to visualize vein path and insertion area 1

- Impressions will stay for a while and not rub off in prep.

1 Goldstein, Israeli Journal of Emergency Medicine, 2006, pg 50
**CC: Site Prep**

- Using friction, scrub the selected site about three inches in diameter for 30 sec and allow to dry¹
  
  **NOTE:** Do not blot or wipe on site to speed drying.

- Aseptic vs sterile technique is inconsistent in the literature but minimizing contact of the needle with gel is intuitive but difficult for novice users.²

- Apply sterile gel to the probe or above selected insertion site³

- Alternate techniques: covers, gel caps, etc.

¹ ChloraPrep One-Step FREPP Applicator, CareFusion, 2010
² Goldstein, Ultrasound-Guided Peripheral Venous Access, 2006 pg 49
³ Meer, Ultrasonography Assisted Peripheral Line Placement, 2011 pg 6

**CC: Stick Technique**

- AGAIN: Consider the concept of catheter length vs. angle of insertion. It is important to balance the two.

- Use on-screen guide to measure depth of vein and direction. Each dot = ½ cm (on most machines).

- Veins with a diameter of at least 0.4 cm and a depth no greater than 1.5 cm should yield better success.¹

- Sticks will be easier with a higher angle of insertion, but this must be balanced with the catheter’s ability to bend.

- Avoid kinking the catheter.

¹ Meer, Ultrasonography Assisted Peripheral Line Placement, 2011 pg 6

**CC: Stick Technique**

- Center the vessel on the ultrasound probe¹

- Use a needle approach angle of 45 degrees perpendicular to the skin¹

¹ Meer, Ultrasonography Assisted Peripheral Line Placement, 2011 pg 6


¹ Meer, Ultrasonography Assisted Peripheral Line Placement, 2011 pg 6
CC: Stick Technique

• In general it is easier to visualize your needle if you stick in the 45 (to 65) degrees range from the skin. Then lower your angle to thread the catheter.

Fig. 1

Fig. 2

Fig. 1  Image created by Kevin Arnold, RN, BSN. kev1999@gmail.com

Fig. 2

1 Meer, Ultrasonography Assisted Peripheral Line Placement, 2011, pg 7


CC: Stick Technique

• Scan probe to view needle tip by moving probe to and from insertion site.
• You may inadvertently stick through both sides of vein wall. If so, you may see and feel the vein wall “pop” into place when retracting the needle out of the deeper side of the vein wall.
• You should have excellent blood flow when tip is in the middle of the vein.
• After visualizing tip of needle in center of vein, it is okay to lessen the angle of the needle as you begin to thread the catheter.

Fig. 1  Image created by Kevin Arnold, RN, BSN. kev1999@gmail.com

Fig. 2  Image created by Kevin Arnold, RN, BSN. kev1999@gmail.com

Fig. 1

Fig. 2

1 Meer, Ultrasonography Assisted Peripheral Line Placement, 2011, pg 7

CC: Stick Technique Confirmation

• Needle entering and visible in vein

Fig. 1  http://www.bluephantom.com/product_thumbs/t_basilic_vein_ultrasound_needle_cannulation_PICC_training.jpg

Fig. 2  http://img.medscape.com/pi/emed/ckb/clinical_procedures/79926-104340-1433943-1464756.jpg

Fig. 1

Fig. 2
CC: Stick Technique-Confirmation

• Side View (Horizontal Plane)

[Image]

http://www.bluephantom.com/product_thumbs/t_brachial_vein_ultrasound_needle_insertion_model.jpg

CC: Stick Technique-Video 1

[Video]

Video created by Kevin Arnold, RN, BSN. kev1999@gmail.com

CC: Stick Technique-Video 2

[Video]

Video created by Kevin Arnold, RN, BSN. kev1999@gmail.com
CC: Potential Complications

- Arterial puncture
- Adjacent nerve irritation
- Infiltration
- Potential UE DVT
- Injury to vessel preventing arteriovenous fistulas sites for renal patients

CC: Common Pitfalls

- Beware of threading in the “sidewall” of the vein.
- It is common to get some blood return after threading through part of the sidewall. It is very important to visualize the needle tip in the center of the vein opening.

CC: Common Pitfalls

My needle is under the skin but I can’t see the tip?
- Make sure the needle is directly underneath the face of the transducer
- Move the transducer closer to the site of skin entry.
- You may be too deep. Look for movement below vein

I buried my needle and I still can’t reach the vein?
- Retract and advance at a steeper angle, but make sure to allow sufficient catheter length left for in the vein. Infiltration is likely if catheter is too short.
CC: Common Reminders

- You will constantly have to remind students:
  - Keep your eyes on the screen...not the insertion area.
  - Stick steeper...45 degrees is steeper than their usual.
  - Don’t hover over patient with needle...just stick quickly through skin and then use the screen to guide the needle into the vein.
  - Use your wrist/finger to stabilize your probe hand...free handing the probe will allow too much movement. Use a "C" grip.

CC: Institution Documentation

- Document IV site location and preparation, gauge of catheter, number of attempts, and type of dressing in the medical record.
- Use of ultrasound for guidance should be included in note.

Student/Patient Outcomes

- Barton and Danneck Average Stick Rate
  - Mean num of IV attempts 2.18
  - Poor patient satisfaction
- Hard Stick without U/S
  - ???
- Hard Stick with U/S
  - My experience... as good as 1.10 = approx 90%

1 Barton, Journal of Nursing Care Quality, 1998, pg 79
Student Outcomes

- In my experience, most students gain competency in 5 to 10 insertions but do obtain best insertion performance until 20 to 40.
- A few never gain competency
  - Obstacles: Lack of Coordination, Time, Desire
- Recommendation: start small.

Typical Learning Curve

Average Sticks by New Ultrasound Users Post Check Off Insertions

Data generalized from speaker’s experience of typical outcomes.

Patient Outcomes

- Common patient comments:
  - (new patients) “Why don’t they use that every time?”
  - (previous patients) “Please use the ultrasound, they had to use it last time and it was great.”
- Effect on central line placements
  - ???
References

- Dychter SE: (March/April 2012) “Intravenous Therapy: A Review of Complications and Economic Considerations of Peripheral Access, 35(2) 84-91
- MC—PP-628
- Policies and Procedures for Infusion Nursing: Infusion Nurses Society, 4th Ed. 2011, pg 1-162
- Ryder MA, Peripheral Access Options, Surgical Oncology Clinics of North America; 4(3) pp 395-427

Questions?