Difficult Vascular Access and Ultrasound-guided Peripheral Intravenous Access

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Introduction

Photos by Carey Rivinius

Objectives

- Discuss difficult vascular access
- Interventions for difficult vascular access
- Ultrasound mechanics
- Identifying vessels with ultrasound
- Technique for Ultrasound-guided Peripheral Intravenous Access (USGPIV)
- Training recommendations

- I have no disclosures

Difficult Vascular Access

Difficult Vascular Access

- Vascular access commonly required in emergency departments
- Certain patient factors cause difficult access
- Challenging even for experienced clinicians
- Patient care delays, staff frustration

(ENA, 2015)

Difficult Vascular Access

- Chronic medical conditions causing difficult vascular access

- *Vascular disease* (Adhikari, Schmier, & Marx, 2015)
- *Sickle cell disease* (Adhikari et al., 2015)
- *Kidney failure* (Adhikari et al., 2015)
- *Organ transplant* (Adhikari et al., 2015)
- *Chronic illness such as cancer* (Stone et al., 2013)
- *Patients who have had repeated venipuncture:* (Stone et al., 2013)
- *IV drug users* (ENA, 2011)
- *Conditions requiring repeated venipuncture* (Stone et al., 2013)

Difficult Vascular Access

- Acute medical conditions causing difficult vascular access
  - *Trauma* (Ismailoglu, Zaybak, Akarca, & Kiyan, 2015)
  - *Burns* (Ismailoglu et al., 2015)
  - *Dehydration* (Arbique et al., 2014)
  - *Shock* (Ismailoglu et al., 2015)
  - *Hypovolemia* (ENA, 2011)
  - *Peripheral edema* (Arbique et al., 2014)
  - *Hypothermia* (Ismailoglu, 2015)

Difficult Vascular Access

- Patient characteristics causing difficult vascular access
  - *Obesity* (Ismailoglu et al., 2015)
  - *Pediatric patients* (Egan et al., 2013)
  - *Elderly patients* (Calderdale & Huddersfield Medical Simulation Team, 2015)

Interventions for Difficult Vascular Access

Evidence

- Emergency Nurses Association Clinical Practice Guidelines:
  - -Ultrasound-guided PIV (USGPIV) access
  - Level A recommendation (ENA, 2015)
- Success rate of USGPIV access
  - -3 studies consistently showed success

  (Egan et al., 2013; Ismailoglu et al., 2015; Stolz et al., 2015)
- Decreased PIV attempts
  - -1 systematic review and meta-analysis (Heinrichs et al., 2013)
- Nurses performing USGPIV access
  - -USGPIV can be completed by nurses (Adhikari, Schmier & Marx, 2015; Veiner et al., 2013)

Considerations

Financial Considerations:

- Ultrasound equipment expensive (Laksonen & Gasiewicz, 2015)
- Expedited patient treatment may decrease costs (Moore, C., 2013)

Political Considerations:

- PIV access delay may harm patient (Arbique, D., Bordelon, M., Dragoo, R., & Huckaby, S., 2014)
- Delayed diagnosis and treatment (Arbique et al., 2014)
- Potential for litigation (Arbique et al., 2014)
- Safer patient care and improved outcome (Moore, C., 2013)

Why Implement USGPIV

- To bring evidence into practice!

Professional Guidelines

- Two sources of professional guidelines for managing patients with difficult peripheral vascular access:

- *Emergency Nurses Association* (ENA, 2011)
- *Infusion Nurses Society* (INS, 2013)

Clinical Practice Guideline Synopsis

Difficult Intravenous Access

December 2012 (Format edited May 2014)

Clinical Question: In emergency department patients with known or suspected difficult intravenous (IV) access does warming, intraosseous, ultrasound-guided, subcutaneous rehydration therapy or infrared methods compared to traditional techniques improve IV access with fewer attempts, less pain, and/or improved patient satisfaction while in the ED?

Problem: Establishing vascular access is one of the most common procedures carried out in the emergency department and is a priority of care for the critically ill and unstable patient. The condition of the patient often plays a role in the likelihood of successfully attaining vascular access. Conditions associated with difficult vascular access include obesity, chronic illness, hypovolemia, IV drug abuse, and vasculopathy (Blavias & Lyon, 2006; Chinnock, Thornton, & Hendey, 2007; Costantino, Parikh, Satz, & Fojtik, 2005; Miles, Salcedo, & Spear, 2011; Nafiu, Burke, Cowan, Tutuo, Maclean, & Tremper, 2010).

Difficult IV access is defined as multiple attempts and/or the anticipation of special interventions being required to establish and maintain peripheral venous access (Kuensting, DeBoer, Holleran, Shultz, & Steinmann, 2009). Gregg, Murthi, Sisley, Stein, and Scalea, (2010) identifies predictive Predictive factors for difficult IV access include: edema, obesity, and history of IV drug use. While the literature regarding factors associated with difficult venous access in adults is limited, included are chemotherapy, diabetes, and multiple prior hospitalizations(Lapostolle, Catineau, Garrigue, Monmarteau, Houssaye, Vecci, et al., 2007).

Description of Decision Options / Interventions and the Level of Recommendation:		
Warming	Application of heat improves IV success rate and decreases time required to gain access	B
	Dry heat may be more effective than moist heat	C
	For pediatric patients, heat may counteract the vasoconstriction associated with EMLA Cream™	C
	The practice of using forced air warmers without a blanket know as "hosing" is not recommended	NR
Intraosseous (IO)	Intraosseous access is significantly more expeditious than standard IV access and should be considered early when known or suspected difficult venous access exists	A
	In alert patients, pain with intraosseous access insertions is rated as minor	A
	Intraosseous lidocaine administration prior to fluid / medication infusion reduces the pain felt by alert patients	C
Ultrasound Guided	Ultrasound-guided access is a viable option for patients with known difficult access for both adult and pediatric populations	A
	Ultrasound-guided access is a technique that can effectively be performed by physicians, nurses, and ED technicians	A
	Ultrasound-guided techniques may result in improved patient satisfaction	C
	When the external jugular access is not visible, ultrasound-guided peripheral access is significantly more successful than external jugular access	C
SQ	Subcutaneous rehydration therapy is an alternative to peripheral IV insertion for the mildly to moderately dehydrated pediatric and elderly patients	B
Alt	Use of alternative devices such as infrared light, transillumination, and a Vein Entry Indicator Device may be beneficial for pediatric patients whom have difficult IV access or chronic illness, or are dehydrated	C

Overview and Purpose of CPGs: Clinical Practice Guidelines (CPGs) are evidence-based documents that facilitate the application of current evidence into everyday emergency nursing practice. CPGs contain recommendations based on a systematic review and critical analysis of the literature about a clinical question. CPGs are created following the rigorous process described in ENA's Guidelines for the Development of Clinical Practice Guidelines.

For more information on this topic, please go to http://www.ena.org/practice-research/research/CPG/Documents/DifficultIVAccessCPG.pdf

The purpose of CPG's is to positively impact patient care in emergency nursing by bridging the gap between practice and currently available evidence.

Key:

A	Level A (High) Recommendation:	Based on consistent and good quality of evidence; has relevance and applicability to emergency nursing practice.
B	**Level B (Moderate) Recommendation:**	There are some minor inconsistencies in quality evidence; has relevance and applicability to emergency nursing practice.
C	**Level C (Weak) Recommendation:**	There is limited or low-quality patient-oriented evidence; has relevance and applicability to emergency nursing practice.
NR	**Not Recommended:**	Based upon current evidence.
	I/E:	Insufficient evidence upon which to make a recommendation.
	N/E:	No evidence upon which to make a recommendation.

Interventions for Difficult Vascular Access

- Emergency Nurses Association Clinical Guidelines
- Ultrasound-guided peripheral intravenous access (Level A recommendation)
- Intraosseous (Level A recommendation)
- Subcutaneous rehydration therapy (Level B recommendation)
- Warming (Level C recommendation)

(ENA, 2015)

Interventions for Difficult Vascular Access

- Central line
- PICC line
- Risk of complications with central line, PICC not always available

(Meer, 2015)

Advantages of Ultrasound-guided IV

- IV can be placed when veins not visible or palpable
- Avoid central line

(Meer, 2015)

Photos by Carey Rivinius

Indications to Use USGPIV

- Known or suspected difficult vascular access (Adhikari et al., 2015; ENA, 2011)
- Traditional technique fails (Meer, 2015)
- Obesity (Adhikari et al., 2015)
- Edema (Adhikari et al., 2015)
- Multiple hospitalizations Adhikari et al., 2015)
- End-stage renal disease (Adhikari et al., 2015)
- Intravenous drug user or history (Meer, 2015)
- Multiple IV catheters in past (Meer, 2015)
- Burns over IV site (Meer, 2015)
- Severe dehydration (Meer, 2015)
- Pediatric or elderly patients (Calderdale & Huddersfield Medical Simulation Team, 2015)

Ultrasound mechanics

Ultrasound Machine

Ultrasound Machine

- Sonosite m-turbo was used in the training courses attended
- Mentioned in the literature as well (Emme, 2012)
- Various options available
- May vary depending on the facility needs

Image from www.ultrasoundportables.com

Ultrasound Mechanics

- Ultrasound uses sound waves
- Transducer
- Contain piezoelectric material
- Example is lead zirconate titonate
- Sound waves emitted and return to transducer
- Imaging created

(Mayette & Mohabir, 2015)

Ultrasound Mechanics

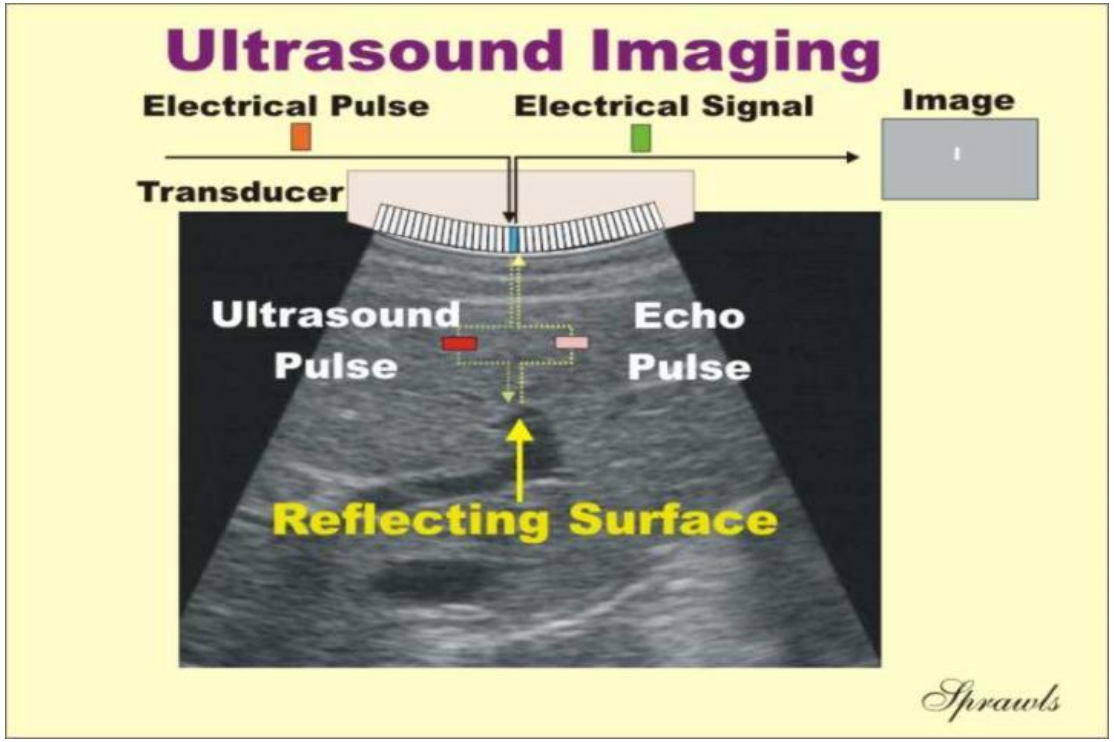
- Frequency ranges from 2 to 18 MHz
- Higher frequency= shorter wavelength
- *Shorter wavelengths have higher resolution*

Penetrate only to shallow depths

- Linear transducer 5 to 10 MHz, superficial structures
- Used for ultrasound-guided peripheral IV access
- Up to 5 cm of depth

(Chiem, 2015)

Ultrasound mechanics



http://www.sprawls.org/ppmi2/USPRO/

Transducers

Linear for ultrasound-guided IV

10-5 MHz
38-mm
linear array

10-5 MHz
25-mm
linear array

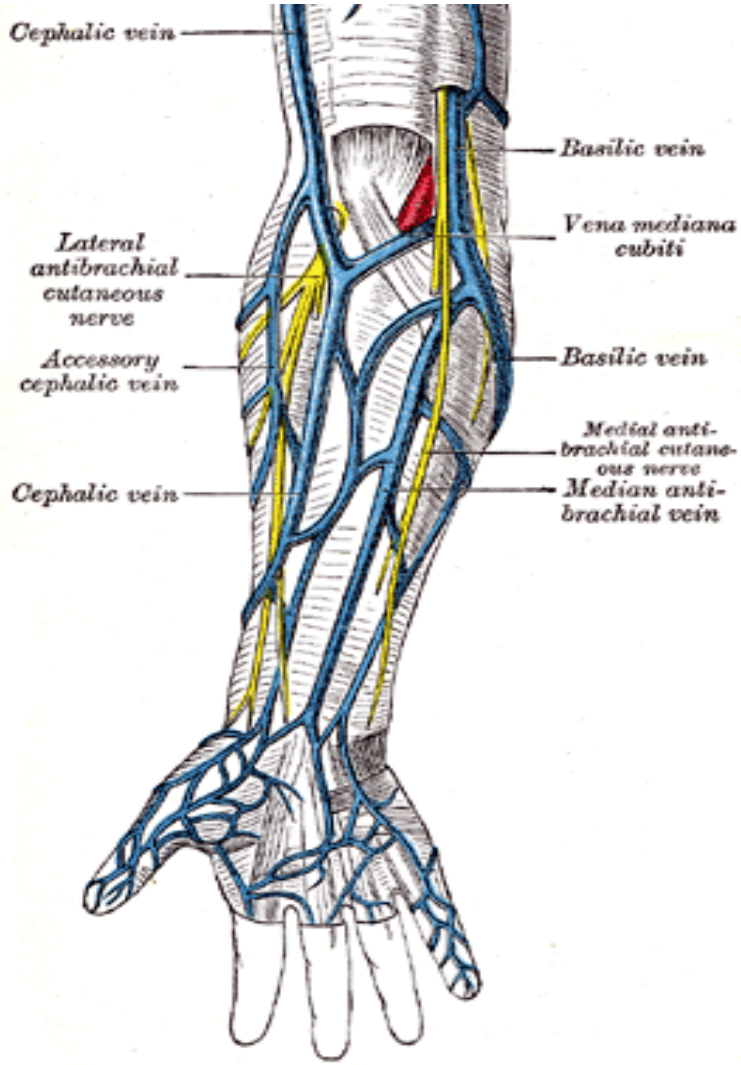
7-4 MHz
11-mm
curved array

5-2 MHz
60-mm
curved array

http://www.usra.ca/transducer.php

Vasculature

Vein anatomy



https://groups.diigo.com/group/kingtusutccric68/content/left-arm-veins-6909971

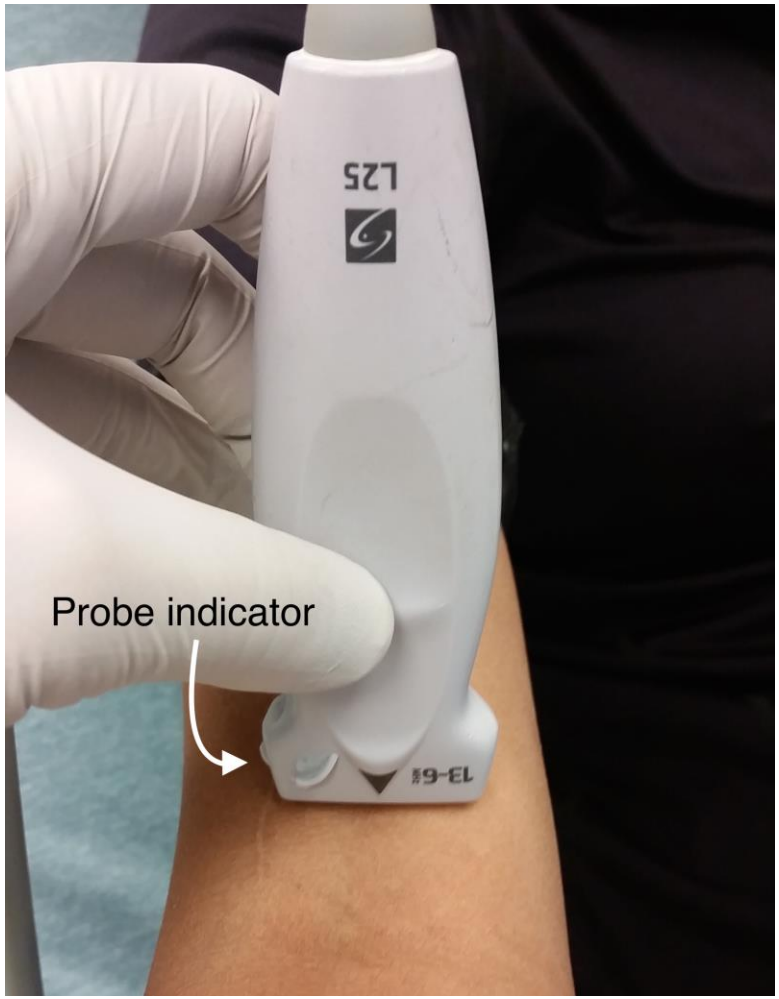
USGPIV Technique

Key components

- Use US machine to visualize veins
- Linear transducer/probe, notch on patient's left
- Identify arteries vs. veins
- Short axis and long axis technique
- 1.88 inch or longer IV catheter
- 45 degree angle of IV catheter
- Target sign

(Emme, 2012)

Linear Probe



https://cdemcurriculum.files.wordpress.com/2016/04/venous-access-image-3.jpg

Visualizing veins

Identify vessels using US to scan

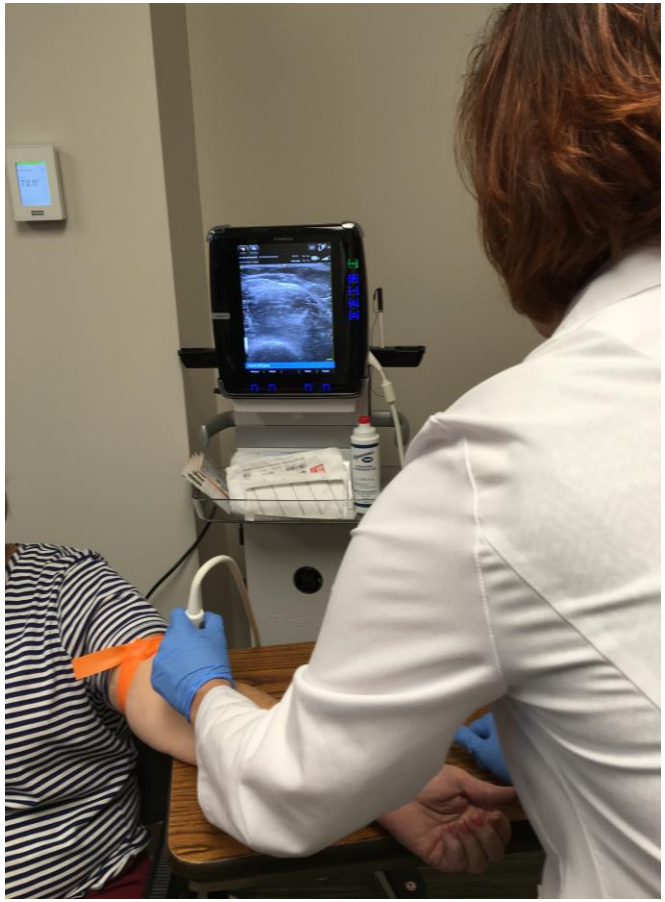


Photo by Carey Rivinius

Visualizing veins

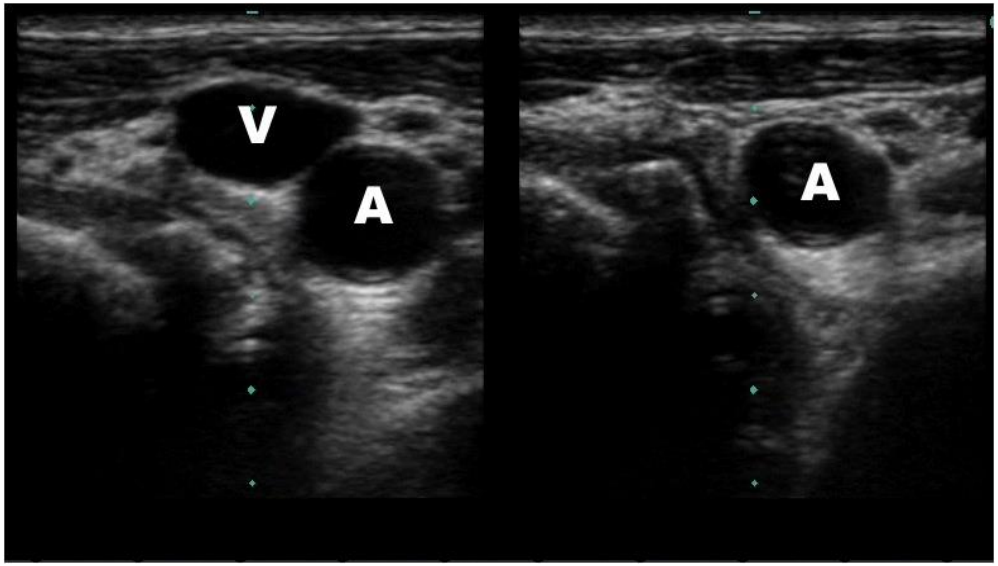
Image by Carey Rivinius

Visualizing veins

- Differentiate between arteries and veins

- Veins are compressible, thinner wall
- Arteries not compressible, they pulsate, thicker wall

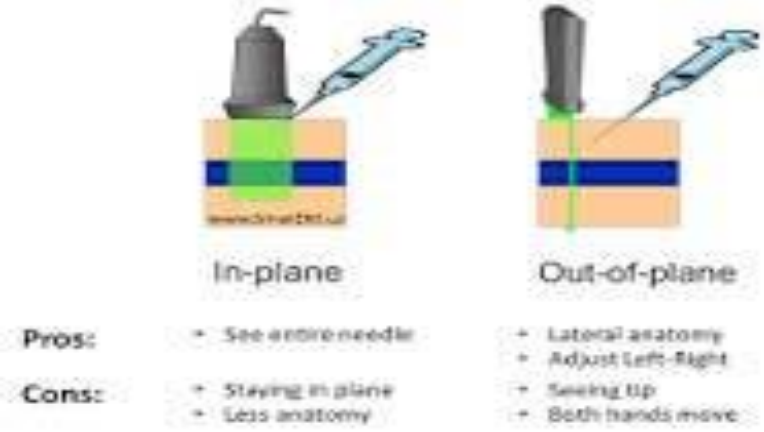
Emme, 2012;Meer, 2015)



https://static-content.springer.com/esm/art%3A10.1186%2F1757-7241-18-39/MediaObjects/13049_2010_180_MOESM8_ESM.jpeg

Short Axis and Long Axis

https://i.ytimg.com/vi/lviC5wU-14U/hqdefault.jpg



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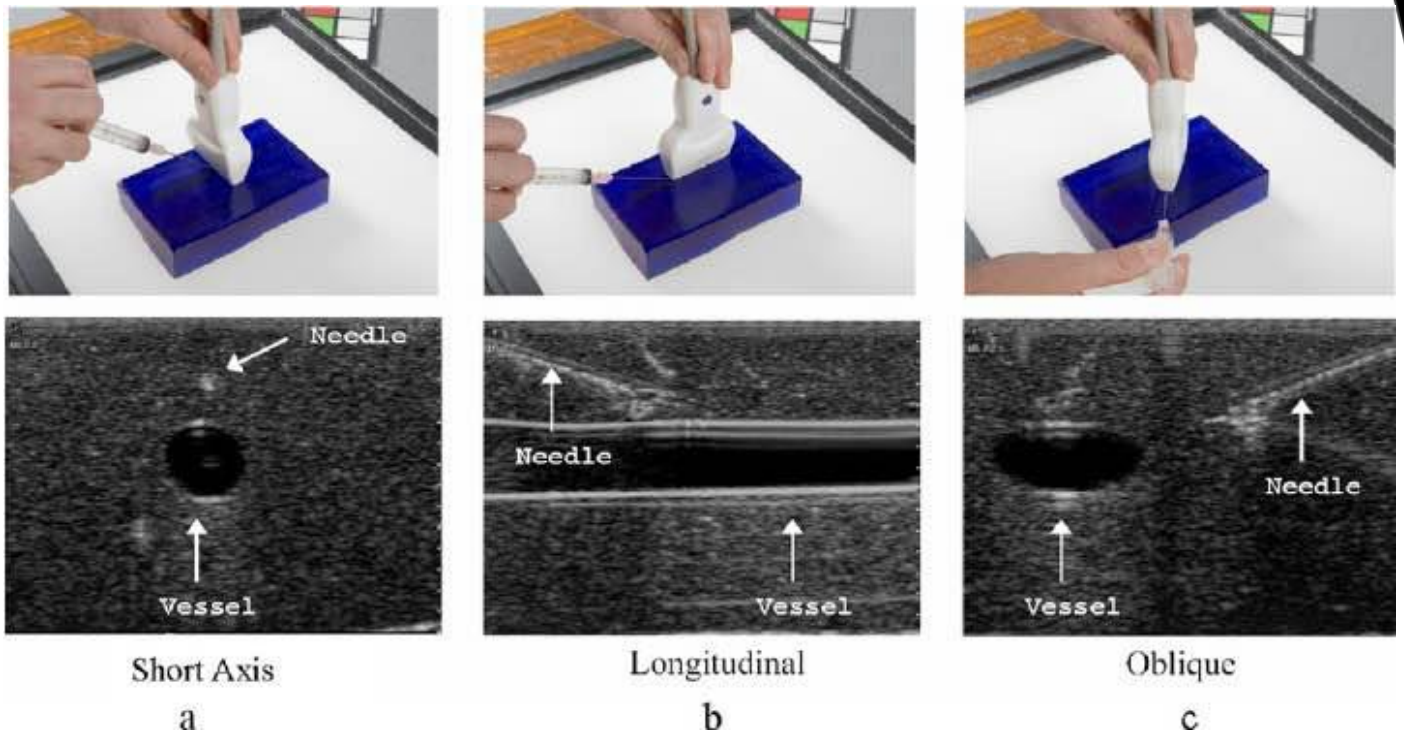
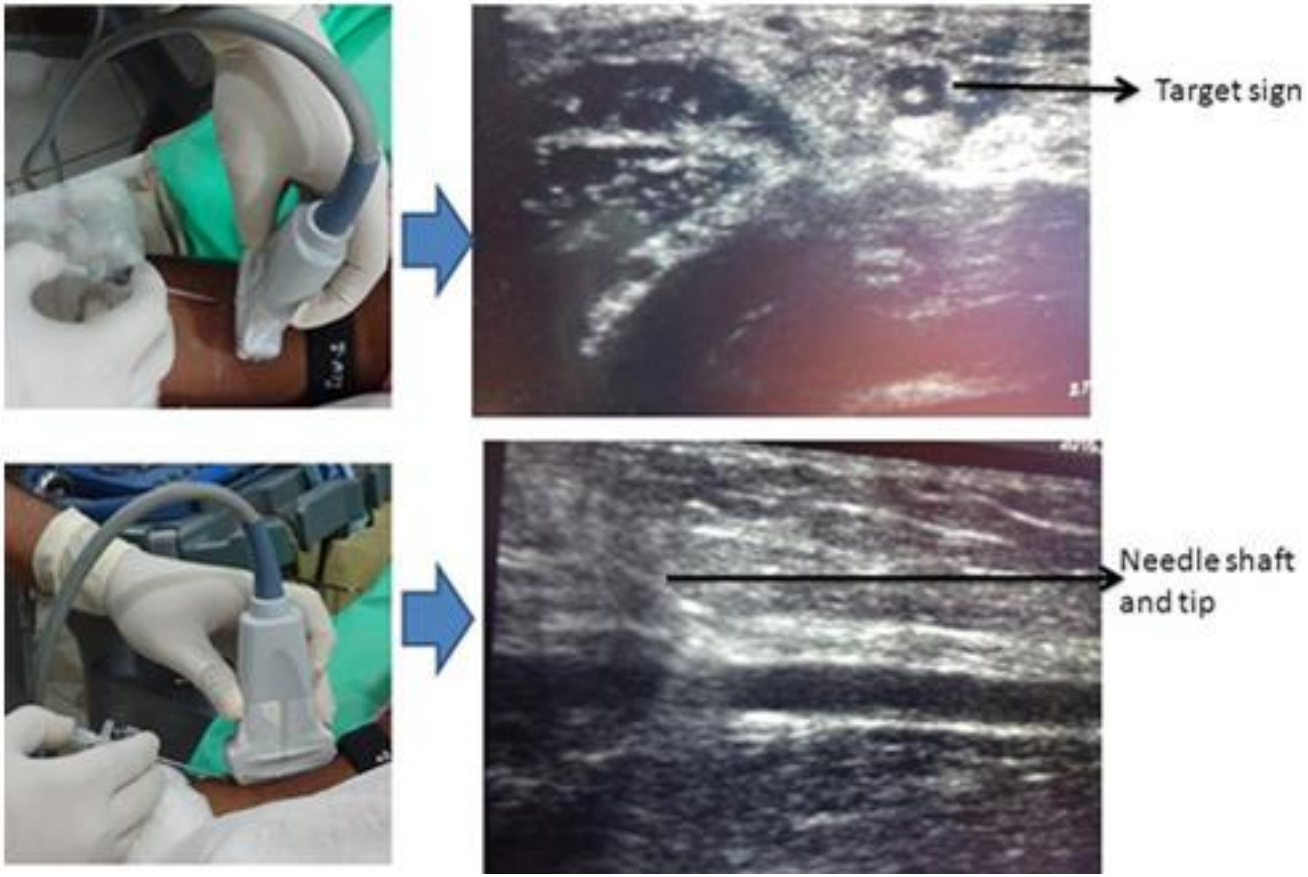
Short Axis and Long Axis



https://www.researchgate.net/profile/Michael_Phelan2/publication/23293871/figure/fig6/AS:277353948303364@1443137742814/Figure-6-Photographs-of-ultrasound-probe-position-with-needle-placement-over-a.png

Short Axis and Long Axis, Target Sign



http://www.apicareonline.com/wordpress/wp-content/uploads/2015/12/Scanning-views-of-peripheral-vein.jpg

Long IV catheter

- Standard length 1.16 inch
- Important to use longer IV catheter
- 1.88 inch or longer (Meer, 2015)

http://emedicine.medscape.com/article/1433943-overview?imageOrder=9

Gel Practice Models

Phantom model

- Can be purchased
- Blue gel model

http://www.bluephantom.com/product/Branched-4-Vessel-Ultrasound-Training-Block-Model.aspx?cid=525

- Homemade models
- Instructions available online
- Unflavored gelatin and metamucil, Penrose drains

(Emme, 2012)

Photo by Carey Rivinius

Practice model images

Image by Carey Rivinius

Practice model images

Image by Carey Rivinius

USGPIV Technique

- Follow facility protocol for use
- Prepare, gather supplies
- Position patient and yourself
- Ultrasound machine in direct view
- Scan arm with linear transducer
- Imaging depth 2 to 2.5 cm
- Choose larger superficial vessels far from arteries, most distal site
- Non-dominant hand to hold the probe
- Dominant hand to hold the IV catheter
- Hold the probe with hand in a C-shape
- Patient arm extended

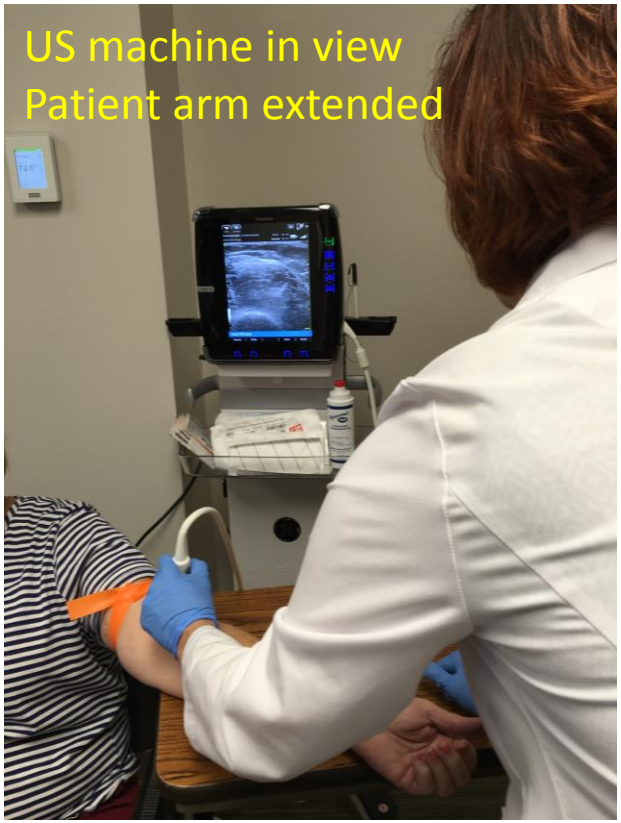
(Emme, 2012;Silverberg, 2015)

USGPIV Technique

- Cleanse arm according to protocol
- Cover transducer with probe cover
- Use sterile ultrasound gel on probe and cover
- IV catheter should be at least 1.88 inches
- Short axis approach generally used, can also incorporate long axis
- Probe ridge on left of patient
- Find vein
- Center arrow of transducer over vein
- Follow tip of IV catheter with probe-keep probe 0.5 to 1 cm ahead of IV insertion site
- Insert IV at 30 to 45 degree angle
- Target sign
- Advance IV catheter

(Meer, 2015; Moore,C., 2013)

Supplies and Position Patient



Photos by Carey Rivinius

Transducer preparation

Photo by Carey Rivinius

Line it Up!

Yellow notch over center of vessel on US screen correlates with line on transducer over patient arm

Photos by Carey Rivinius

IV Catheter angle

Photo by Carey Rivinius

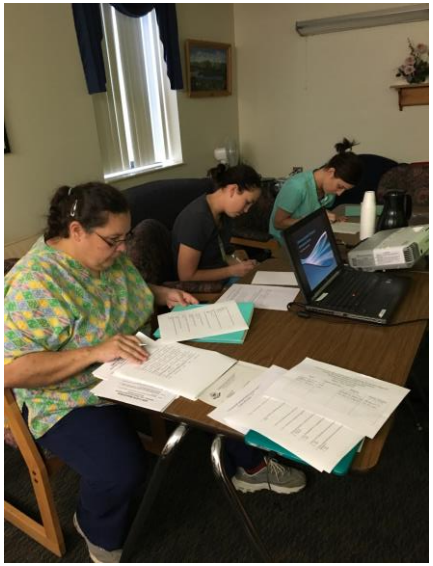
Tips for Success

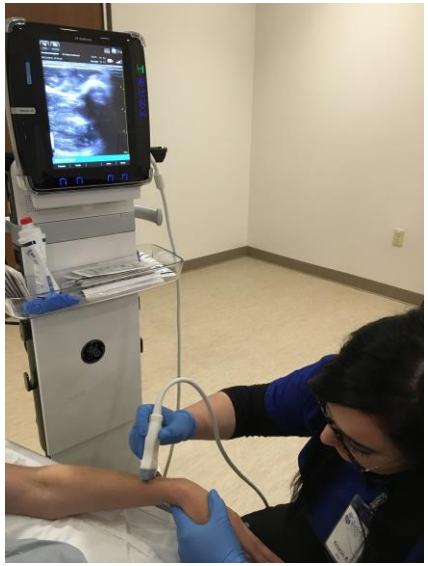
- Superficial vessels, best at 1 cm depth or less, larger diameter better
- Start distally on arm, scan for ideal vessel
- Use light pressure with probe
- Position US machine and patient properly
- Use US gel
- C-clamp probe with non-dominant hand
- 1.88 inch IV catheter or longer
- 45 degree angle IV catheter
- Short axis view generally easier but long axis can be helpful too
- Keep US probe ahead of IV catheter (0.5 to 1 cm)
- Probe marker on pt's arm over center of vein, correlates with arrow on US machine; keep it lined up!
- Watch for target sign in vessel
- May need 2 people at first until comfortable

(Emme, 2012)

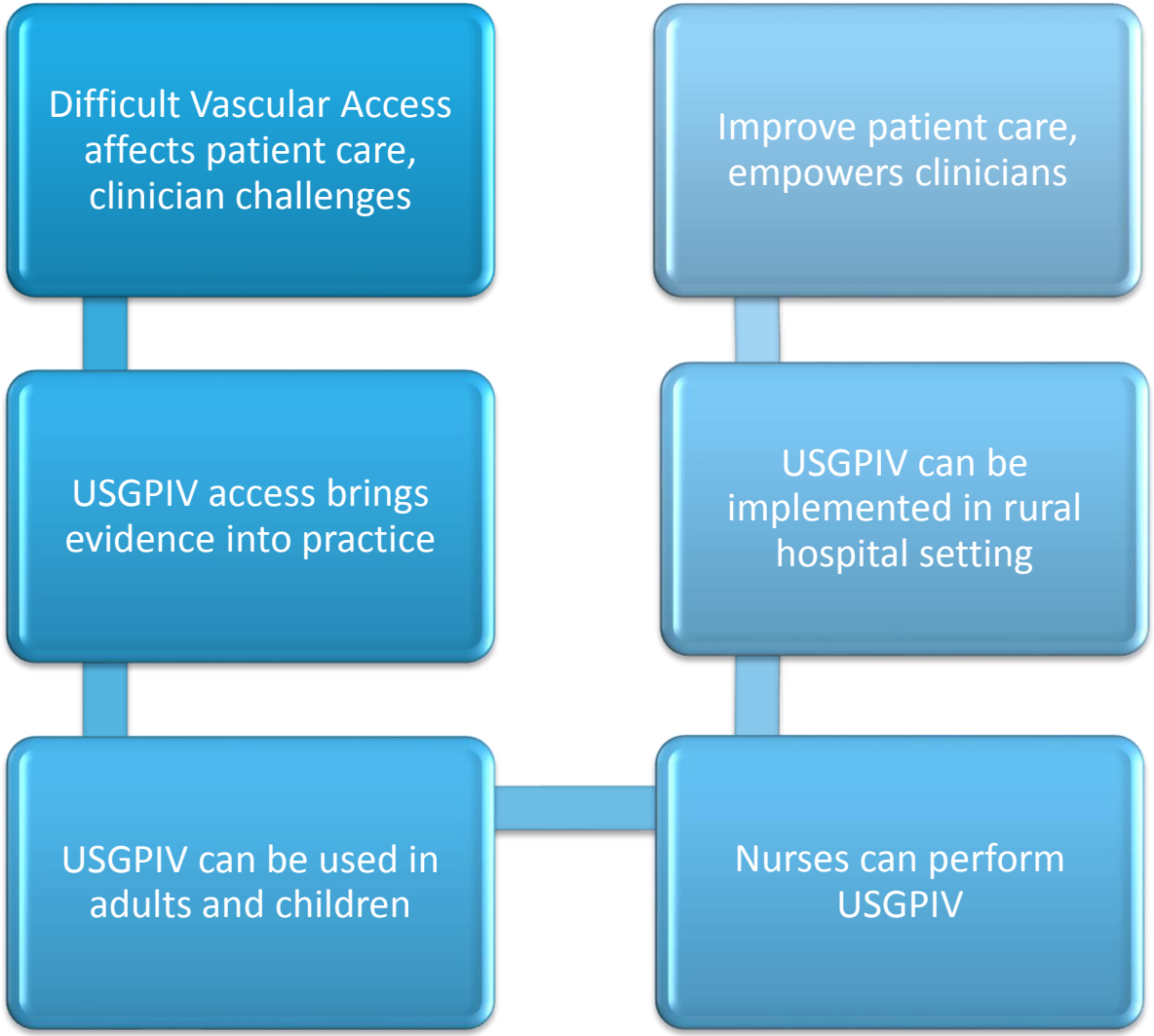
Training

- Includes lecture, vessel visualization, and simulation on gel model
- Live supervised patient starts once trained





Implications for Practice



Podcasts

There are great podcasts available to demonstrate USGPIV:

Ultrasound guided peripheral IV course:
Siegfried Emme, FNP:
https://www.youtube.com/watch?v=d8VFgb9Edfw

(Emme, 2012)

Ultrasound-guided IV video
https://www.youtube.com/watch?v=NgOF8f7408A

(Calderdale & Huddersfield Medical Simulation Team, 2015)

Ultrasound-guided IV video
https://www.youtube.com/watch?v=Xofk-XBKZ6E

(Hsu, 2014)

Ultrasound-guided IV video
http://www.ultrasoundpodcast.com/2013/10/ultrasound-guided-peripheral-iv-podcast-give-nurses-teach-providers-foamed/

(Dawson & Mallin (2013)

Questions?

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