Difficult Vascular Access and Ultrasound-guided Peripheral Intravenous Access

Carey Rivinius, MSN, FNP-C
Introduction
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
  - Sickle cell disease
  - Kidney failure
  - Organ transplant
  - Chronic illness such as cancer
  - Patients who have had repeated venipuncture
  - IV drug users
  - Conditions requiring repeated venipuncture
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; Weiner 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, intravenous, 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 (Blavas & Lyon, 2006; Chinnock, Thornton, & Hendey, 2007; Costantino, Panik, Satz, & Fojtik, 2005; Miles, Salcedo, & Spear, 2013; Naidu, Burke, Cowan, Tutuo, Maclean, & Tremen, 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 (Kuening, Detboer, Holleran, Shultz, & Steimann, 2009). Gregg, Murithi, Sidley, Stein, and Scala, (2010) identifies 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 (Apostolle, Catineau, Garrigue, Monmartreau, Houssaye, Vecci, et al., 2007).

| Description of Decision Options / Interventions and the Level of Recommendation: |
|---------------------------------------------------------------|----------------|
| **Vascular**                                                                 | **Level** |
| 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 vasocostriction associated with EMLA Cream™ | C          |
| The practice of using forced air warmers without a blanket know as “hosing” is not recommended | NR         |
| **Intravenous** (IV)                                         | **Level** |
| 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 intravenous 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**                                        | **Level** |
| 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          |
| **Subcutaneous**                                             | **Level** |
| Subcutaneous rehydration therapy is an alternative to peripheral IV insertion for the mildly to moderately dehydrated pediatric and elderly patients | B          |
| **All**                                                      | **Level** |
| 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/CPGs/Documents/DifficultIVAccessCPG.pdf](http://www.ena.org/practice-research/research/CPGs/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:
- Level A (High) Based on consistent and good quality of evidence; has relevance and applicability to emergency nursing practice.
- Level B (Moderate) There are some minor inconsistencies in quality evidence; has relevance and applicability to emergency nursing practice.
- Level C (Weak) There is limited or low-quality patient-oriented evidence; has relevance and applicability to emergency nursing practice.
- 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 titanate
- 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

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

Probe indicator

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

Short Axis and Long Axis

https://pbs.twimg.com/media/B_f8Tz_VEAE93MB.png

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

https://pbs.twimg.com/media/B_f8Tz_VEAE93MB.png

Pros:
- See entire needle
- Steady in plane
- Less anatomy

Cons:
- Adjust left-right
- Seeing up
- Both hands move
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

Long IV catheter

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

Gel Practice Models

Phantom model
- Can be purchased
- Blue gel model

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


(Emme, 2012)
Practice model images

Short axis view, target sign in the center

Image by Carey Rivinius
Practice model images

Long axis view, angiocath is visible

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

Prepare site
Maintain asepsis

Supplies

US machine in view
Patient arm extended

Photos by Carey Rivinius
Transducer preparation

Ultrasound gel and clear transparent cover over probe

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

30 to 45 degree 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

Difficult Vascular Access affects patient care, clinician challenges

USGPIV access brings evidence into practice

USGPIV can be implemented in rural hospital setting

USGPIV can be used in adults and children

Nurses can perform USGPIV

Improve patient care, empowers clinicians
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?

Carey Rivinius, MSN, FNP-C
Jacobson Memorial Hospital
601 E. St North
Elgin, ND 58533
701-584-3338
Email: carey.rivinius@frontier.edu
References


Calderdale & Huddersfield Medical Simulation Team (Producer). (2015, February 15). *Ultrasound guided peripheral venous access* [Video podcast]. Retrieved from https://www.youtube.com/watch?v=NgOF8f7408A


References


