Prehospital Point-of-Care-Ultrasound

Children’s Hospital Colorado EMS Conference

January 27th, 2022

Julia Aogaichi Brant, MD
Objectives

1. Review what point of care ultrasound is, how it works, and its uses and limitations.

2. Identify how to detect the presence or absence of lung slide, cardiac activity, and how to distinguish a vein from an artery on ultrasound.
Disclosures

• I have nothing to disclose
• ...except that I love ultrasound
What is POCUS?

• POCUS stands for Point of Care Ultrasound
• “Real time”
• Portable
• Affordable
• Operator provides the read for the image
What can we use it for?

• Can actively alter decision making
  • Is there heart motion present? Yes or No?
  • Is there a pneumothorax? Yes or No?
• Augment the physical exam
Ultrasound basics

• “Ultra-sound” = sound waves transmitted at a frequency higher than human hearing
• The US probe both transmits and receives US waves
• Humans can hear frequencies of 20 to 20,000 Hz
• Diagnostic US have a frequency of 1 to 20 MHz (20,000,000Hz)
More US basics

• The image created depends on the characteristics of both the probe and the tissue through which the US wave is transmitted.

• All probes generate US waves of different frequency, impacting the resolution and depth of the image.

• Different body tissues have different amounts of impedance (resistance to propagation of sound).
As frequency goes up, you will get a clearer picture (increased resolution) but you will not be able to see as deep into body (decreased depth)
Welcome to your crash course in reading US

- Black or hypo-echoic → Fluid
- Gray or iso-echoic → Partial impedance (organs)
- White or hyper-echoic → Bone or Air
What’s wrong with this image?
What’s wrong with this image?
3 kinds of probes
Linear probe

- High frequency
- Limited depth
- Great for skin findings, lungs, ET tube placement, arteries and veins (line placement
Cardiac probe

• Good for deeper structures
• Use for focused assessment with sonography for trauma (FAST) in big kids/adults
• Great for cardiac views
Curvilinear probe

• Lower frequency—better for deeper structures of the abdomen (FAST)

• Not super useful applications in EMS
Or just one
Prehospital POCUS (P-POCUS)

• Relatively new application
• Many studies have shown feasibility of P-POCUS
• Few to no studies on actual use or change in practice
Prehospital Applications

• Out of hospital arrest
• Pulseless Electrical Activity
• Pericardial effusion
• Pneumothorax
• Abdominal aortic aneurysm
Prehospital Procedures

• Difficult IV placement
• Needle decompression for pneumothorax
• Nerve blocks for analgesia
• Endotracheal tube placement confirmation
• Thoracotomies
The role of point of care ultrasound in prehospital critical care: a systematic review

Morten Thingemann Bøtker¹,², Lars Jacobsen³,⁴, Søren Steemann Rudolph⁵,⁶ and Lars Knudsen²
In the news...

Prehospital point-of-care ultrasound: A transformative technology

Colton B Amaral, Daniel C Ralston and Torben K Becker
Pre-hospital assessment with ultrasound in emergencies: implementation in the field

Kevin P. Rooney¹, Sari Lahham², Shadi Lahham², Craig L. Anderson², Bryan Bledsoe³, Bryan Sloane², Linda Joseph², Megan B. Osborn², John C. Fox²

¹ Department of Emergency Medicine, Henry Ford Hospital, Detroit, Michigan 48202, USA
² Emergency Medicine, University of California, Irvine, Orange, California 92868, USA
³ Emergency Medicine, University of Nevada School of Medicine, Las Vegas, Nevada 89102, USA
In the news...

ORIGINAL RESEARCH

Paramedic-performed Prehospital Point-of-care Ultrasound for Patients with Undifferentiated Dyspnea: A Pilot Study

Jacob H. Schoeneck, MD*†
Ryan F. Coughlin, MD*
Cristiana Baloescu, MD*
David C. Cone, MD*
Rachel B. Liu, MD*
Sharmin Kalam, MD*
Amanda K. Medoro, MD*
Ian Medoro, MD*
Daniel Joseph, MD*
Kevin Burns, EMT-P, PA-C*
Jesse I. Bohrer-Clancy, MD*
Christopher L. Moore, MD*

*Yale University School of Medicine, Department of Emergency Medicine, New Haven, Connecticut
†Wake Forest University School of Medicine, Department of Emergency Medicine, Winston-Salem, North Carolina
Case 1

• You arrive to the scene of an MVA
• 16 year old unrestrained driver
  • Alert and oriented
  • Short of breath and complaining of right sided chest pain
Vitals and exam

- Clutching chest, tachypneic on exam
- Awake but anxious
- Remembers entire event, has difficulty speaking
- Heart rate: 140s
- BP 80/54
- RR 30s
- Bilateral breath sounds
Diagnosis?

What do you do next?
Introduction to lung ultrasound!

• Lungs are close to the surface → use the linear probe!

• Ultrasound hates air. Air (including air in the lungs) scatteres the ultrasound beam, making it impossible to “see” structures deep to the air interface

• Then why do we use ultrasound for lungs?
  • We are bad at auscultating lungs
  • Lung auscultation has a low sensitivity in different clinical situations
  • CXR is not much better
  • Ultrasound is a better option with better sensitivity (and it’s portable!)
Probe Position
Basic lung image acquisition

Area of interest is the Pleural Line, where there should be Sliding if there is no pneumothorax.
Normal lung
Abnormal lung
Compare sides...where is the pneumothorax?
Exceptions to the rule

• If you see B line which appears like a **Thick White Flashlight Beam (aka B-lines)**, there is NO pneumothorax

• There are other (much less common) things that cause no lung sliding.
  • Single lung intubation, pulmonary fibrosis, cardiopulmonary arrest, lung adhesions, lung scarring
Take home points for pneumothorax

1. The presence of lung sliding OR B-Lines definitively RULES OUT Pneumothorax AT THAT LUNG SPACE you are scanning

2. The absence of lung sliding is consistent with Pneumothorax-
   • If your clinical suspicion is high and patient it unstable, TREAT with needle decompression
   • If your clinical suspicion is high and patient is stable, put on oxygen and transfer ideally by ground to a center with surgery for chest tub placement
   • If your clinical suspicion is low, treat as you would pre-POCUS
Case 2

- You arrive to a home responding to a call about a 6mo F who has been vomiting for several hours
- She is currently sleeping
- Also has had 3 days of diarrhea with no urine output today
Vitals and exam

- Infant is sleepy and barely arousal
- Has a sunken fontanelle, dry mucus membranes
- HR 180s
- BP 75/palp
- BGL 70
Diagnosis?
What do you do next?
Hypovolemia, dehydration, hypoglycemia... Oh my!

- You try for a line and you fail
- Your partner tries and fails
- You left your IO kit back at the station
Introduction to vascular access!

• You are looking for a vein that is likely small given patient’s dehydration
• Use the linear probe and identify your structures
• Try to make the procedure as sterile as possible
• Center your needle in the center of the screen and watch the tip as you advance it
Identify your structures

- Vessels are black (hypoechoic) because they are full of fluid aka blood
- Usually very round with hyperechoic (bright white) outer circle
How do you distinguish artery from vein?

• Use color flow to identify vasculature
• Veins are easily compressible! Apply gentle pressure until you are able to collapse the vessel completely

• Pitfalls
  • All arteries will collapse with enough pressure
  • The color is not associated with artery or vein
    • Blue is away from the probe, NOT vein
    • Red is toward the probe, NOT artery
Artery vs Vein
Color flow
Which is which?
Two ways to insert needle

In-plane technique

Out of plane technique
Out of plane video
Take home points for vascular access

• If the patient is sick and needs access, POCUS is a great option
• Do not delay access; if you do not feel comfortable with US and you have an IO, just get access
• Look for black round structures surrounded by a white circle
• Veins are collapsible and do not pulsate
• Use color flow but remember, blue vein and red artery
Case 3

• You are called to find an 18yo in cardiac arrest, empty pill bottles beside her
• You cannot get pulses
• She has been down for an unclear amount of time
What do you do? What do you know?

• Start CPR
• Patient down for unclear amount of time
• What are patient survival rates for out of hospital arrests?
• When do you call the code?
(Brief) Introduction to Cardiac Ultrasound

- Use phased array or cardiac probe
- Place on the left side of the chest along the nipple line or just below
- Answers a question: is there cardiac activity?
- Can support termination of resuscitation
Probe position
Normal cardiac function
No cardiac activity
Think about your POCUS Hs&Ts

<table>
<thead>
<tr>
<th>Hs</th>
<th>Ts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolemia</td>
<td>Toxins</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>Tamponade</td>
</tr>
<tr>
<td>Hydrogen Ion (acidosis)</td>
<td>Tension Pneumothorax</td>
</tr>
<tr>
<td>Hypo/Hyperkalemia</td>
<td>Thrombosis</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td>Trauma</td>
</tr>
<tr>
<td>Hypothermia</td>
<td></td>
</tr>
</tbody>
</table>

POCUS: Point-of-Care Ultrasound
Take home points for cardiac POCUS

• Cardiac ultrasound can tell you
  • Is the heart beating?
  • Is there a large effusion? Tamponade? Thrombus?

• But...do NOT delay CPR to obtain an image

CPR saves lives, cardiac ultrasound does NOT
Barriers in P-POCUS

• No consensus for scope of use in EMS
• No consensus for training needed for proficiency
• Need initial education, hands on experience
• Expensive
• Supervision is needed by ultrasound expert
• Need for continued training—Use it or lose it!
Acknowledgements

• The POCUS Atlas
• NYSORA
• Dr. Jonathan Orsborn
• Dr. Maria Mandt
• All first responders—THANK YOU!
Thank you!
References


