Session 2: Ultrasonography for Primary Care Clinicians

Learning Objectives

1. Assess the main components and functions of a portable ultrasound unit.
2. Identify three clinical applications of portable ultrasound in the primary care setting.
Session 2

Ultrasonography for Primary Care Clinicians

Faculty

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Dr. Victor Rao is the director of ultrasound education at the University of South Carolina (USC) School of Medicine. Dr Rao’s main interests include general, vascular, and point-of-care ultrasound. A radiologist by training, he has also worked as a primary care health provider in rural mission hospitals and has had vast clinical experience in everything from surgery, obstetrics and gynecology to general medicine and dermatology.

Dr Rao is passionate about ultrasound education and currently trains medical students, nurse practitioners, emergency medical technicians, and physicians of varying specialties, as well as primary care physicians, in diagnostic point-of-care ultrasound. His clinical research has involved the use of high-intensity focused ultrasound (HIFU) to treat benign prostatic hyperplasia, prostate cancer, and renal cell carcinoma.

The author of several publications and posters, Dr Rao developed and wrote the online ultrasound learning modules for the Society of Ultrasound in Medical Education. In addition, he provides point-of-care ultrasound training to physicians in Tanzania and, in the United States, to medical residents and faculty through the Family Medicine Residency Program at McLeod Regional Medical Center in Florence, South Carolina.

Faculty Financial Disclosure Statement
The presenting faculty reports the following:
Dr Rao has no financial relationships to disclose.
Faculty Disclosures

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Learning Objectives

- Assess the main components and functions of a portable ultrasound unit
- Identify 3 clinical applications of portable ultrasound in the primary care setting

Pre-test Question 1

Choose the answer that best describes the relationship of transducer frequency, depth of penetration of ultrasound waves, and image resolution.

1. Higher frequency = greater depth and greater resolution
2. Higher frequency = less depth and greater resolution
3. Higher frequency = greater depth and less resolution
4. Higher frequency = less depth and less resolution

Pre-test Question 2

The ultrasound compression test is used to detect:

1. Deep venous thrombosis
2. Left ventricular hypertrophy of the heart
3. Gallstones
4. Aortic aneurysm

Why Ultrasound in Primary Care?

- A safe diagnostic imaging modality
- Ultrasonography as a clinical tool has direct applicability in many clinical scenarios to improve the quality and safety of patient care
- Offers the primary care physician autonomy of practice, especially in regions where sub-specialty care is not available
**Why Now?**

There has been a revolution in ultrasound and digital technology in recent years that has resulted in ultrasound machines that are:

- Smaller
- Cheaper
- Smarter

**Modes of Ultrasound**

- **A-mode**: Amplitude
- **B-mode**: Brightness
- **M-mode**: Motion

**Echogenicity**

- **Echogenicity**: the amplitude / brightness of the image
- **Hyperechoic**: more echogenic than surrounding tissue
- **Hypoechoic**: less echogenic than surrounding tissue
- **Isoechoic**: same echogenicity as surrounding tissue
- **Anechoic**: absence of echoes

**Frequency: resolution and depth**

- Higher Frequency = Greater Resolution
- Lower Frequency = Greater Depth

**What happens to the wave once it leaves the Transducer?**

- Absorption
- Refraction
- Scatter
- Reflection

**Sonogram of the abdomen**
**Doppler**

- Color Doppler: gives direction and quality of flow
- Power Doppler: non-direction flow information but more sensitive to small changes in flow, as with inflammation, and absence of flow, as in testicular torsion

**Power Doppler**

Normal right elbow and lateral epicondylitis of the left elbow (tennis elbow)

- Right
- Left

**The Focused Ultrasound Exam**

- The healthcare provider has a specific clinical question: is there a gallstone, does this patient have an aortic aneurysm, is there heart failure
- Numerous studies have shown that non-traditional users of ultrasound can be taught to perform these examinations with very good results
- Ultrasound can be a valuable point-of-care diagnostic tool to complement the physical exam (it does not replace a good H&P)

**Comparison of Hand-Carried Ultrasound to Bedside Cardiovascular Physical Examination**

- Two first-year medical students
- 4 hrs of lecture and 14 hrs of hands-on experience
- Students outperformed 5 board-certified cardiologists in identifying cardiac pathology in 61 cardiac patients
- Students identified 75% (180/239) of the pathologies and cardiologists identified 49% (160/239) \( p < 0.001 \)

**Apical Four Chamber View**

- Courtesy R. Hoppmann, MD
Teaching Medical Students US to Measure Liver Size: Comparison with Experienced Clinicians Using Physical Examination Alone

- Ten second-year medical students used bedside ultrasound to measure liver size in six GI patients
- Four Board Certified Internists estimated liver size in the same six patients using physical examination alone
- Students’ measurements were significantly more accurate (p<0.001) than the physicians’ for every patient
- Students overestimated liver size by 1.8 cm and physicians underestimated liver size by 6.7 cm

Case 1: 45-year-old male with leg pain

Presents on Friday afternoon with some pain and slight swelling of the left leg of two days’ duration. He has just completed a cross-country flight from visiting his parents in California.

- Cause of leg swelling?

Case 2

A 55-year-old male with a history of chronic poorly controlled HTN that you are seeing for the first time.

- Has he developed end organ heart damage?
Case 2: Parasternal Long Axis View

NORMAL  Concentric LVH

Case 3

A 42-year-old female patient complains of right upper quadrant abdominal pain, nausea, and vomiting. She reports a 6-month history of intermittent abdominal pain after eating.

What could she have?

Case 3: Ultrasound of Liver and Gallbladder

Case 4

A 32-year-old obese female complains of knee pain and swelling. Knee examination is a challenge.

Does she have an effusion?

Case 4: Knee

Case 5

Your 67-year-old neighbor is found unconscious and his blood pressure is very low. He is a smoker and has a long history of high blood pressure. He is rushed to the hospital but cannot be resuscitated.

Cause of death?

Could his death have been prevented?
Case 5: Abdominal Aortic Aneurysm

Areas in which hand-carried ultrasound has significant clinical application

- Heart Disease
- Lung Disease
- Stroke
- Breast Cancer
- Other Cancers
- Venous thrombosis
- Aneurysms
- Ectopic Pregnancy
- Pregnancy and bleeding

- Eye Disease
- Trauma
- Thyroid Disease
- Internal bleeding
- Fractures
- Gallstones / Cholecystitis
- Kidney disease / stones
- Rotator cuff disease
- Carpal tunnel syndrome

Ultrasound Guided/Assisted Procedures

- Ultrasound can be used for real-time guidance (dynamic) or to “mark the spot” (static)
- Procedures:
  - Central and peripheral venous access
  - Thoracentesis, paracentesis
  - Joint aspiration/Injection
  - Virtually any procedure where visualization enhances success of procedure, increases patient safety, is not terribly time consuming

Phantom Models to Practice Guided Procedures

Ultrasound guided needle placement

Longitudinal View
Ultrasound Protocols

- Protocols exist for a quick point-of-care ultrasound assessment of more complicated patients
- An example would be the RUSH protocol for the patient with severe hypotension or shock
- RUSH = Rapid Ultrasound in Shock
- Rapid assessment of the “pump,” the “tank,” and the “pipes”

RUSH

- The Pump (Heart)
  - Global heart function and contractility
  - Pericardial effusion – tamponade
  - Right ventricular strain from a pulmonary embolus
- The Tank (intravascular volume/venous return)
  - Blood loss – pleural fluid, peritoneal fluid
  - Tension pneumothorax
- The Pipes (thrombosis, dissection)
  - Deep venous thrombosis
  - Aortic aneurysm / dissection

Pericardial Effusion
Training in Point-of-Care Ultrasound for Primary Care Physicians

- CME lectures and hands-on workshops
- Ultrasound texts, e-texts, and journal articles
- Ultrasound DVDs on scanning protocols
- Web-based learning modules
- Teaching centers and industry in-service training
- Image review portals for ongoing training
- Begin with ultrasound basics and develop skill with one application such as US guided injections

Post-test Question 1

Choose the answer that best describes the relationship of transducer frequency, depth of penetration of ultrasound waves, and image resolution.

1. Higher frequency = greater depth and greater resolution
2. Higher frequency = less depth and greater resolution
3. Higher frequency = greater depth and less resolution
4. Higher frequency = less depth and less resolution
### Post-test Question 2

The ultrasound compression test is used to detect:

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### Questions

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