Point-of-Care Ultrasound

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History of Ultrasound

Early use of ultrasound focused on therapy

Treatment of gastric ulcers (left) and arthritis (right) in the 1940s.
History of Ultrasound

- Karl Dussik, 1946
  - University of Vienna in Austria
  - Cerebral ventricles
History of Ultrasound

• Diagnostic ultrasound
  – George Ludwig, 1940s
  – Classified experiments with the Navy
  – Gall stones
A-mode

- A-mode ultrasound
- $A = \text{amplitude}$
History of Ultrasound

- Howry’s somascope
- 2-D images called “somagrams”
B-mode

- B-mode ultrasound
- B = brightness
- Intensity of echoes in grey scale
M-mode

- Early echocardiogram
  - 1953 Edler & Hertz
- M = Motion
D-mode

- D = Doppler
- Satomura, 1956
  - freq returning echoes ≈ velocity of flow
- Moving RBCs create a Doppler shift
History of Ultrasound

• 1960s – Commercial machines available
• 1970s – Grey scale becomes common
• 1980s – Use in trauma in Europe & Japan
• 1990s – Introduced into EM curriculum
Emergency Medicine
Mateer J et al. 1994

• Goal-oriented
• Core applications
  – Trauma (FAST)
  – Renal
  – Cardiac
  – Biliary (RUQ)
  – Aorta
  – Early pregnancy
Additional applications

- **Diagnostic**
  - DVT
  - Soft tissue (abscess)
  - Ocular
  - Testicular
  - Long bone fractures
  - Lung (thoracic)
  - Joint effusions
  - Bladder volume
  - IVC diameter

- **Procedural**
  - Vascular access
  - Thoracentesis
  - Paracentesis
  - Arthrocentesis
  - Nerve blockade
  - Foreign body removal
  - Lumbar puncture
Probe Orientation
FAST

- Right flank
FAST

• Left flank
FAST

- Cardiac
FAST

- Bladder
FAST

Hemopericardium

Free fluid
Extended FAST
(with pleural view)
Cardiac

- Ejection fraction
  - Normal or poor?
Cardiac

- **Effusion**
  - present or absent

- **Ejection fraction**
  - Normal or poor
Renal

- Ureterolithiasis
  - Flank pain, N/V
  - Hematuria

- Options
  - KUB, CT, U/S, IVP
  - No imaging?

- Ultrasound
  - Hydronephrosis
  - Sensitive for large stones
Renal

- Hydronephrosis
Renal

- Moderate hydro
Biliary Ultrasound

- Stones?
- Wall thickening? (>3mm)
- Fluid around wall?
- CBD dilated?
Biliary

- Transverse view
• Longitudinal view
Biliary

- Thickened wall
- Pericholecystic fluid

- Portal vein and dilated CBD
Early Pregnancy

• Ectopic pregnancy
  – 2% incidence
  – Abdominal pain
  – Bleeding

• Goal
  – Identify IUP
Early IUP (6 wks)

- Yolk sac
- Fetal pole
- Gestational Sac
Ultrasound Findings
Variations in hCG occur

- **Gestational sac**
  - 4-5 weeks TVS: 1000 mIU/mL

- **Fetal pole**
  - 6 weeks TVS: 2000 mIU/mL

- **Cardiac activity**
  - 7 weeks TVS: 10,000 mIU/mL
Early Pregnancy

- Gestational sac
- Yolk sac
- Fetal pole
Aorta

- AAA
  - 2-4% of population >50
  - 10,000 deaths/yr
  - Rupture: 80% mortality
Aorta

- Normal transverse
- Normal longitudinal

IVC
Vertebral body
Aorta
Aorta

- AAA transverse
- AAA longitudinal
Aorta

- AAA
Aorta

- AAA

- True lumen

- Mural thrombus
Rule out DVT

- Two-site compression
  - $\approx$ formal ultrasound
  - Misses calf DVTs
  - Follow up in 5-7 days

Femoral

Popliteal
Normal study
DVT
DVT
Ocular

- Retinal detachment
Ocular

- Vitreous hemorrhage
Ocular

- Nerve sheath diameter
Ocular

- Nerve sheath diameter
Procedural Ultrasound

• Standard of care for IJ vein catheterization
Procedural Ultrasound

- Standard of care for IJ vein catheterization
### Table 1. Selected Applications of Point-of-Care Ultrasonography, According to Medical Specialty.

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Ultrasound Applications</th>
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<tbody>
<tr>
<td>Anesthesia</td>
<td>Guidance for vascular access, regional anesthesia, intraoperative monitoring of fluid status and cardiac function</td>
</tr>
<tr>
<td>Cardiology</td>
<td>Echocardiography, intracardiac assessment</td>
</tr>
<tr>
<td>Critical care medicine</td>
<td>Procedural guidance, pulmonary assessment, focused echocardiography</td>
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<tr>
<td>Dermatology</td>
<td>Assessment of skin lesions and tumors</td>
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<tr>
<td>Emergency medicine</td>
<td>FAST, focused emergency assessment, procedural guidance</td>
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<tr>
<td>Endocrinology and endocrine surgery</td>
<td>Assessment of thyroid and parathyroid, procedural guidance</td>
</tr>
<tr>
<td>General surgery</td>
<td>Ultrasonography of the breast, procedural guidance, intraoperative assessment</td>
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<tr>
<td>Gynecology</td>
<td>Assessment of cervix, uterus, and adnexa; procedural guidance</td>
</tr>
<tr>
<td>Obstetrics and maternal–fetal medicine</td>
<td>Assessment of pregnancy, detection of fetal abnormalities, procedural guidance</td>
</tr>
<tr>
<td>Neonatology</td>
<td>Cranial and pulmonary assessments</td>
</tr>
<tr>
<td>Nephrology</td>
<td>Vascular access for dialysis</td>
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<tr>
<td>Neurology</td>
<td>Transcranial Doppler, peripheral-nerve evaluation</td>
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<tr>
<td>Ophthalmology</td>
<td>Corneal and retinal assessment</td>
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<tr>
<td>Orthopedic surgery</td>
<td>Musculoskeletal applications</td>
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<tr>
<td>Otolaryngology</td>
<td>Assessment of thyroid, parathyroid, and neck masses; procedural guidance</td>
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<tr>
<td>Pediatrics</td>
<td>Assessment of bladder, procedural guidance</td>
</tr>
<tr>
<td>Pulmonary medicine</td>
<td>Transthoracic pulmonary assessment, endobronchial assessment, procedural guidance</td>
</tr>
<tr>
<td>Radiology and interventional radiology</td>
<td>Ultrasoundography taken to the patient with interpretation at the bedside, procedural guidance</td>
</tr>
<tr>
<td>Rheumatology</td>
<td>Monitoring of synovitis, procedural guidance</td>
</tr>
<tr>
<td>Trauma surgery</td>
<td>FAST, procedural guidance</td>
</tr>
<tr>
<td>Urology</td>
<td>Renal, bladder, and prostate assessment; procedural guidance</td>
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<tr>
<td>Vascular surgery</td>
<td>Carotid, arterial, and venous assessment; procedural assessment</td>
</tr>
</tbody>
</table>
Future Directions

• Hand-held ultrasound

• Vscan (GE)
  – $7000-$8000
  – One probe
Future Directions

• MobiUS (Mobisante)
  – Connects to cell phone
  – $7000-$8000

• Hand-held ultrasound
Conclusion

• Probe indicator → head or right
• Free fluid is hypoechoic
• Standard of care for IJ lines
• Numerous applications
  – EM: FAST, Cardiac, Renal, Biliary, Aorta, IUP, DVT, Ocular
• Hand-held devices coming soon…
References