Practical Aspects of Ultrasound Education

Alfred Abuhamad, MD.
Eastern Virginia Medical School
Ultrasound Education

- Acquiring knowledge (General – Specialized)
- Understanding technical aspect of ultrasound examination
- Adhering to national guidelines for specific studies
- Demonstrating competency of ultrasound operators
- Growth in knowledge and skills over time
Ultrasound Education

• Acquiring knowledge (General – Specialized)
  – Basic physics and knobology
  – Knowledge of ultrasound applications in various fields
  – Image recognition of normal and abnormal anatomy.
## Basic Knowledge

<table>
<thead>
<tr>
<th>TABLE 1.1</th>
<th>Characteristics of sound waves</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Frequency</td>
<td></td>
</tr>
<tr>
<td>- Period</td>
<td></td>
</tr>
<tr>
<td>- Amplitude</td>
<td></td>
</tr>
<tr>
<td>- Power</td>
<td></td>
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<tr>
<td>- Intensity</td>
<td></td>
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<tr>
<td>- Wavelength</td>
<td></td>
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<tr>
<td>- Propagation speed</td>
<td></td>
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</tbody>
</table>
Basic Knowledge

Piezoelectric Crystals

From SUSME.org with permission
Basic Knowledge

Gray Scale Gradation
Basic Knowledge

- **PI (Pulsatility Index)**: $PI = \frac{S - D}{M}$
- **RI (Resistance Index)**: $RI = \frac{S - D}{S}$
- **S/D**: $\frac{S}{D}$

*Diagram showing velocity scale (cm/sec) and time (sec) with peaks labeled S, M, D.*
Basic Knowledge
Ultrasound Education

• Understanding technical aspect of ultrasound examination.
  – How to hold and manipulate transducer
  – How to operate equipment
  – Learning image orientation
  – Technical limitations and artifact
  – Reporting of ultrasound findings
Technical Aspects
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Technical Aspects
Technical Aspects
Ultrasound Education

• Adhering to national guidelines for specific studies
  – AIUM, ACEP, ACR, AUA, ISUOG,…
Practice guidelines of the AIUM are intended to provide the medical ultrasound community with guidelines for the performance and recording of high-quality ultrasound examinations. The guidelines reflect what the AIUM considers the minimum criteria for a complete examination in each area but are not intended to establish a legal standard of care. AIUM-accredited practices are expected to generally follow the guidelines with recognition that deviations from these guidelines will be needed in some cases, depending on patient needs and available equipment. Practices are encouraged to go beyond the guidelines to provide additional service and information as needed.

The AIUM Practice Guidelines are available to download as pdf files.

Enhanced guidelines offer image references and a self-study test worth .5 credit available to AIUM members.

Abdomen or Retroperitoneum *
Abdominal Aorta
Breast * †
Developmental Dysplasia of the Hip
Documentation
Extracranial Cerebrovascular - Enhanced | PDF
Extremity Arteries
FAST
Fetal Echocardiography *
Head and Neck
Musculoskeletal *
Native Renal Artery
Neonatal Spine - Enhanced | PDF
Neurosonography in Neonates and Infants - Enhanced | PDF
Obstetric - Enhanced | PDF *
Pelvic - Enhanced | PDF *
Peripheral Arterial
Peripheral Venous
Postoperative Dialysis Access
Preoperative Dialysis Access
Prostate & Surrounding Structures - Enhanced | PDF
Reproductive Endocrinology and Infertility
Reproductive Medicine
Scrotal - Enhanced | PDF
Sonohysterography - Enhanced | PDF
Thyroid & Parathyroid - Enhanced | PDF *
Transcranial Doppler - Enhanced | PDF
Urology *
Vascular Access
Standards & Guidelines

Material in this section contains:

- Basic and extended biometry calculators for pregnancy dating, fetal growth assessment (centiles and Z-scores) and weight estimation
- ISUOG published Statements and Guidelines.
- Advertisements of research projects and opportunities
- Links to other relevant organisations
Ultrasound Education

• Demonstrating competency of ultrasound operators.
  – System for competency evaluation during training
  – Study annual volume
  – Ongoing competency over time
Ultrasound Education

- Demonstrating competency of ultrasound operators

<table>
<thead>
<tr>
<th>LEVEL II (all of Level I and items below)</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Sign Off Date</th>
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<tbody>
<tr>
<td>OB – 2\textsuperscript{nd} &amp; 3\textsuperscript{rd} Trimester Exam</td>
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<td></td>
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</tr>
<tr>
<td>1 Survey Uterus for anomalies</td>
<td></td>
<td></td>
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<tr>
<td>2 Survey Right &amp; Left Ovaries/Adnexa for anomalies</td>
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<tr>
<td>3 Bi-Parietal Diameter (BPD)</td>
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<tr>
<td>4 Head Circumference (HC)</td>
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<tr>
<td>5 Lateral Ventricles</td>
<td></td>
<td></td>
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<tr>
<td>6 Cerebellum</td>
<td></td>
<td></td>
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<tr>
<td>7 4 Chamber Heart</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8 Abdomen Circumference (AC)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9 Bilateral Kidneys</td>
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</tbody>
</table>
Ultrasound Education

• Growth in knowledge and skills over time
  – Requirement for ongoing CME
  – Research
  – Reading
  – MOC
What is done at Residency Level?
<table>
<thead>
<tr>
<th>Obstetrics</th>
<th><strong>IV.A.5.a).(2).(a).(viii)</strong></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>The full range of commonly employed obstetrical diagnostic procedures, including ultrasonography and other relevant imaging techniques;</td>
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</table>

<table>
<thead>
<tr>
<th>Gynecology</th>
<th><strong>IV.A.5.a).(2).(b).(ix)</strong></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>The full range of commonly employed gynecologic diagnostic procedures, including ultrasonography and other relevant imaging techniques;</td>
</tr>
<tr>
<td>Category</td>
<td>Minimum</td>
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<tr>
<td>--------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Spontaneous vaginal delivery</td>
<td>200</td>
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<tr>
<td>Cesarean delivery</td>
<td>145</td>
</tr>
<tr>
<td>Operative vaginal delivery</td>
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</tr>
<tr>
<td>Obstetric ultrasound i</td>
<td>50</td>
</tr>
<tr>
<td>Abdominal hysterectomy</td>
<td>35</td>
</tr>
<tr>
<td>Vaginal hysterectomy</td>
<td>15</td>
</tr>
<tr>
<td>Laparoscopic hysterectomy</td>
<td>20</td>
</tr>
<tr>
<td>Incontinence and pelvic floor procedures (excluding cystoscopy)</td>
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<tr>
<td>Cystoscopy</td>
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<tr>
<td>Hysteroscopy</td>
<td>40</td>
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<tr>
<td>Abortions</td>
<td>20</td>
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<tr>
<td>Transvaginal ultrasound</td>
<td>50</td>
</tr>
<tr>
<td>Surgery for invasive cancer</td>
<td>25</td>
</tr>
</tbody>
</table>

Obstetric ultrasounds include fetal biometry performed at over 14 weeks’ gestation.

July 2012 – Ob/Gyn RRC
The new minimums will reflect the lowest acceptable clinical volume of procedures performed per resident for program accreditation. A program will be considered in compliance if each resident in the program achieves the minimum number of procedures for each listed procedure or category.
### ACGME Program Requirements for Graduate Medical Education in Obstetrics and Gynecology (2012)

<table>
<thead>
<tr>
<th>Gynecology</th>
<th>Number of Programs in the Nation: 242</th>
<th>Number of Residents in the Nation: 1,221</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Surgeon</strong></td>
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<tr>
<td>RRC Procedure</td>
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<td>38.5</td>
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<td>114.9</td>
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<td>98.3</td>
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<td>79.6</td>
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<tr>
<td>Abortion</td>
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<td>46.0</td>
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<td>Transvaginal ultrasound</td>
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<td>119.9</td>
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<tr>
<td>- Total Hysterectomy Procedures</td>
<td><strong>112</strong></td>
<td>116.1</td>
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<td>- Total Laparoscopy Procedures</td>
<td><strong>129</strong></td>
<td>136.8</td>
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<tr>
<td>Total Invasive Cancer</td>
<td>58</td>
<td>65.9</td>
</tr>
<tr>
<td>Total Robotic Procedures</td>
<td>10</td>
<td>19.0</td>
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ACGME Program Requirements for Graduate Medical Education in Obstetrics and Gynecology (2012)

<table>
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<th>Procedure</th>
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<tbody>
<tr>
<td></td>
<td>Surgeon</td>
<td>Surgeon &amp; Teaching Assistant</td>
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<tr>
<td>Percentiles</td>
<td>10</td>
<td>15</td>
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<tr>
<td>Abdominal hysterectomy</td>
<td>36</td>
<td>40</td>
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<tr>
<td>Vaginal hysterectomy</td>
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<td>11</td>
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<tr>
<td>Laparoscopic hysterectomy</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Incontinence and pelvic floor</td>
<td>57</td>
<td>65</td>
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<tr>
<td>Laparoscopy</td>
<td>60</td>
<td>65</td>
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<tr>
<td>Operative Hysteroscopy</td>
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<td>47</td>
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<tr>
<td>Abortion</td>
<td>18</td>
<td>21</td>
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<tr>
<td>Transvaginal ultrasound</td>
<td>52</td>
<td>60</td>
</tr>
<tr>
<td>Total Hysterectomy Procedures</td>
<td>82</td>
<td>86</td>
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<tr>
<td>Total Laparoscopy Procedures</td>
<td>86</td>
<td>94</td>
</tr>
<tr>
<td>Total Invasive Cancer</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Total Robotic Procedures</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
The ACGME mandates procedural competency for all EM residents in emergency ultrasound as it is considered a “skill integral to the practice of Emergency Medicine” as defined by the 2007 Model of Clinical Practice of Emergency Medicine.59
Figure 2. Pathways for emergency ultrasound training, credentialing, and incorporation of new applications.

**Residency Training**

- Didactics:
  - Attends residency curriculum covering emergency ultrasound curriculum
  - Attends introductory emergency ultrasound course

- Experiential:
  - Training is residency per Emergency Medicine Residency Ultrasound Guidelines

- Proficiency:
  - Residency Director and/or Ultrasound Coordinator certifies ultrasound training categorized by the ACEP emergency ultrasound proficiency guidelines and ACEP/ABEM “The Model of the Clinical Practice of Emergency Medicine”

- Credentialed:
  - Acquired at local hospital setting within departmental privileges

**Practicing Physician**

- Didactics:
  - Attends introductory emergency ultrasound course or courses that cover core emergency US applications

- Experiential:
  - Performs ultrasounds under supervision over-reads, gold standard confirmatory testing or patient outcome review within departmental ultrasound plan

- Proficiency:
  - Ultrasounds are obtained with documentation and review to meet ACEP emergency ultrasound proficiency guidelines. Ultrasound available for departmental and hospital examination

- Credentialed:
  - Quality review of ultrasound performed continuously. CME attended in accordance with specialty guidelines

- Continuing Medical Proficiency and Education:
  - New applications adopted after CME, research, or other training
Residency Training

• Lack of a comprehensive & uniform curriculum
• Lack of a competency evaluation
• Need for more faculty trainers
• Need for expansion of simulation training
• Larger focus on life-long learning in ultrasound
Global Training
Maternal Mortality

- Estimated at 529,000 per year in the world
- 99% of maternal mortality occur in the developing world

Paula Bronstein
http://blog.gettyimages.com/tag/afghanistan/
Maternal Mortality

- Over 80% could be prevented through timely interventions proven to be effective and affordable

Pregnancy Care in Developing World

- Antenatal care is the most utilized of the maternal services
- Antenatal care should be used as a platform to promote health and ensure safe delivery
- Ultrasound services may play a critical role in this regard

WHO reproductive health indicators database, 2007
ISUOG Outreach

Haiti Program

• ISUOG – education / training
• GE – US equipment (10 machines)
• Partners in Health – local support
ISUOG Outreach

Haiti Program
May 2011 – January 2012

• ISUOG – education / training
• RAVA Foundation
• St Damien Hospital
• Operation Blessing International
• Medecins Sans Frontieres

[Images of people and logos]
ISUOG Outreach

Ghana Program

September 2010 – May 2011 – May 2012

- ISUOG – education / training
- Siemens – US equipment (3 machines)
- Physicians for Peace – international support
- Millennium Cities Initiative – local support
- Metro Health Disctrict – local support
ISUOG Outreach
Somaliland Program
September-2011, May 2012

• ISUOG – education / training
• Sonosite– US equipment (4 machines)
• Medecins Sans Frontieres
• Edna Adan Hospital – local support
ISUOG Outreach
Mongolia Program
September-2012, 2013

- ISUOG – education / training
- Samsung Medison– US equipment (4)
- South Korean Ultrasound Society
- Central Government
Impact:
What have we done so far?

* Our costs are kept low by:

- Contributions of time, skills and travel costs from our volunteers
- Generous donations from our industry partners
- Logistical and organisational assistance from our NGO partners
- Financial donations from ISUOG members
Educational Approach

Course Program

- basic physics of ultrasound
- basic functionality of the machine
- hands-on approach to the core topics such as:
  - fetal presentation
  - placental localization
  - amniotic fluid assessment
  - pregnancy dating, etc.
- Topics on important diagnoses such as ectopic pregnancy, placenta previa, Gyn etc
Basic Approach to Ultrasound Training in Obstetrics
Six Steps

• 1) Fetal presentation/lie
• 2) Fetal viability (heartbeat)
• 3) Number of fetuses
• 4) Placental location
• 5) Amniotic fluid
• 6) Biometric measurements
Step 1

Fetal Presentation/lie

Transverse – above symphysis pubis and angle towards cervix
Step 2

Fetal Heartbeat

Transverse – Slide up towards belly button
Step 3

Number of Fetuses

Transverse – and parasagittal as shown
Step 3

Number of Fetuses

Transverse – and parasagittal as shown
Step 4

Placental Localization

Right parasagittal – midsagittal – left paraasagittal
Step 4

Placental Localization

If close to lower segment – do a transvaginal ultrasound
Step 5

Amniotic Fluid

Four Quadrants – Sagittal probe perpendicular to floor
Step 6

Fetal Biometry – Biparietal Diameter
Step 6

Fetal Biometry – Abdominal Circumference
Step 6

Fetal Biometry – Femur Length
Practical Training

- Include basic knowledge on ultrasound and equipment
- Standardize approach to ultrasound examinations
- Teach and assess hands-on competency
- Develop learning bundles (modules)
- Encourage long term learning