Handheld Echo: Kona, 2016

Anthony DeMaria
Miniaturization of Echo
Echocardiography on a Laptop

- Highly Portable – 5.3Kg, 1 hr battery
- Performance level of Competitive Leadership systems
- Full Cardiovascular scanning
- Full Connectivity: Lan, Wireless, Bluetooth, DVD
- Raw Data Architecture

Echo Without Boundaries

- Bedside Echo
- OR, ICU, other Monitoring
- Hospital CV Diagnostic Portable Services
Miniaturization of Echo

Learning from 4D echo: in-probe beamformer

Small … smart … high tech
HAND-HELD ECHOCARDIOGRAPHY

• **Emergency imaging**  
  — eg cardiopulmonary arrest

• **Limited exams** (screening, focused)  
  — eg pre-athletic participation

• **Extended physical examination**  
  — the “ultrasonic stethoscope”

• **A harbinger of ultimate miniaturization**
HANDHELD ECHO:
CARDIAC EMERGENCIES

- Pericardial effusion/tamponade
- Profound LV dysfunction
- Mechanical lesions
  - cardiac rupture
  - papillary muscle rupture
HCU in Critically Ill Patients

• Vignon et al; Crit Care, 2003
• 103 pts *on ventilators*
• HCU equivalent to TTE for imaging
  – 83% vs 87% *clinical questions answered*
• HCU lacked spectral Doppler
• HCU comparable to TTE for critically ill patients
Bedside ultrasound examination of the acutely ill medical patient.

“Poorly responsive. BP=80/40, HR=143. No urine output.”

7 sites

Septic? Cardiogenic? Hypovolemic?
Specific Examinations:

Seven Sites

...Simple
...Supported by literature
...Suitable for the inpatient

1. internal jugular
2. pneumothorax
3. pleural effusion
4. cardiac parasternal
5. cardiac subcostal
6. bladder
7. deep leg veins
Specific Examinations:

“Lung comets” indicate pulmonary edema with >90% accuracy.

Lichtenstein D. *Am J Respir Crit Care Med* 1997;156:1640. n=282 consec. ICU pts. 3.0-3.5 MHz. 93% sens, 93% spec for alveolar-interstitial syndrome by CXR (pulm edema, ARDS, pna, interstitial lung dz).
Is Handheld Echocardiography Superior to the *Physical Exam* In Critical Care?

(Yes)
## Missed Findings: POC Echo vs Physical

### Table 1. Frequency of Missed Overall and Major Cardiovascular Findings by PE and POC Echocardiography

<table>
<thead>
<tr>
<th></th>
<th>MD 1</th>
<th>MD 2</th>
<th>MD 3</th>
<th>MD 4</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td>60%</td>
<td>56%</td>
<td>65%</td>
<td>57%</td>
<td>59%</td>
</tr>
<tr>
<td>Echo</td>
<td>31%*</td>
<td>26%*</td>
<td>23%*</td>
<td>37%*</td>
<td>29%*</td>
</tr>
<tr>
<td><strong>Major</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td>39%</td>
<td>31%</td>
<td>58%</td>
<td>46%</td>
<td>43%</td>
</tr>
<tr>
<td>Echo</td>
<td>23%</td>
<td>13%</td>
<td>23%*</td>
<td>29%</td>
<td>21%*</td>
</tr>
</tbody>
</table>

*p < 0.05 vs. PE.

Echo = echocardiography; PE = physical exam; POC = point-of-care.

Spencer, Lang et.al; JACC, 2001
## Comparative Cardiac Findings by PE and POC Echo

<table>
<thead>
<tr>
<th>Finding</th>
<th>Examination</th>
<th>Echocardiography</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Missed</td>
<td>Correct</td>
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<tr>
<td>Aortic stenosis</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Aortic regurgitation</td>
<td>1</td>
<td>7</td>
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<tr>
<td>Mitral stenosis</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Mitral regurgitation</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Pulmonic valve disease</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Tricuspid regurgitation</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>LV systolic dysfunction</td>
<td><strong>14</strong></td>
<td><strong>7</strong></td>
</tr>
<tr>
<td>RV systolic dysfunction</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Hypertrophic cardiomyopathy</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Mitral valve prolapse</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Ventricular septal defect</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

Spencer et al; JACC: 15, 2001
Is Handheld Echo Equivalent to *Standard Echocardiography*?

(Not quite)
Is There a Role for a Limited (Focused) Echo?
Requirements for a Focused Exam

• A focused exam can be defined
• The exam retains diagnostic accuracy
• The exam will not miss important findings
• The exam saves significant time/money
Time Required for Complete Examination

Kimura et al; JASE: 16, 2003
Time Reduction by Echo Referral

- Likelihood of referral disease, $R$
- $(L_s/L_{std}) \leq 0.15$

1. PE $\geq 65$
2. SOE $\geq 65$
3. ICU
4. SOE $< 65$
5. PE $< 65$
6. MVP
7. LVH
8. HCM
FOCUSED ECHO: THE MVP EXAMPLE

- MVP frequently suspected
- MVP usually not present
- Accurately diagnosed in PLA view
- Pt population young, ambulatory and with few incidental findings
- Echo limited to PLA saves time/cost
Handheld Echo Will Complement/Replace the Stethoscope for Physical Exam

- The PE is indirect, imprecise, limited
- Accuracy of performing PE is limited
- Handheld is comparable to standard echo
- Handheld is superior to PE (for all organs)
- Trainees can master basic handheld skills
- Handheld units will be smaller/cheaper

- A handheld exam will supplant the PE as the primary cost-effective cardiac screen
Accuracy of Current PE

- **St Clair**  AnnIntMed 1992  63 res  50-60% error
  MR, AR, MS
- **Mangione**  JAMA 1997  453 res  80% error
- **Roldan**  AJC 1996  15 card  20% error
- **Jost**  AmJMed 2000  20 card  21% error
- **March**  MayoProc 2005  17 card  66% error
  All MDs had 76% error
- **Criley**  ArchIntMed 2006  860 MDs  42% error
  Cards fellows best at 30% error
  No difference for intern to faculty
ULTRASOUND PHYSICAL: 
ASSUMPTIONS

• A hand-held echograph is available
  – Gray scale and color flow minimum

• Non-sonographers can master echo exam

• Non-echocardiographraphers can master diagnosis

• The exam is *Screening* and is not a replacement for full echo
“ULTRASOUND STETHESCOPE”: LVEF EXAMPLE

- Physical exam limited in assessing EF
- Echo gives good visual EF estimate
- Echo exam of LV may be easier to master than physical exam
- Echo can provide directional changes
- Echo improves LV assessment by medical residents (Kimura et al)
Improvement after Ultrasound Use

Number of patients

Decreasing Error

Increasing Error

Total Net Error

-6  -5  -4  -3  -2  -1  0  1
Conclusion:

• These findings suggest that a briefly-trained physician can perform a simplified bedside ultrasound exam using a hand-held device to improve detection of LV systolic dysfunction.
Carotid Artery (I-M) Screening
Detection of Abdominal Aortic Aneurysm
Cardiovascular Limited Ultrasound Examination (CLUE)

- 196 pts in Medicine Clinic (40% new)
- Risk stratified by NCEP guidelines

- *HCU of carotid, heart, abd aorta*

- 36% had undetected abnormalities
- 20% had change in management
Clinical recommendations made in patients (n=196) as a result of CLUE:

- Change LDL goal to <100mg/dl  31
- Order echocardiogram  7
- Order carotid ultrasound  3
- Order abdominal ultrasound  1
- TOTAL:  42

Kimura et al, AJC, 2007
So why isn’t everyone using Handheld Echo?

1. Reimbursement issues (there is none)

2. Devices still not ideal
   - too expensive
   - too bulky

3. Physician training, unfamiliarity

4. Lack of published data on USE model
Stethoscopes are *being* reinvented!
Variable Echo Reimbursement??

<table>
<thead>
<tr>
<th>Exam</th>
<th>Operator</th>
<th>Instrument</th>
</tr>
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<tbody>
<tr>
<td>Limited</td>
<td>Novice</td>
<td>Stripped</td>
</tr>
<tr>
<td>Focused</td>
<td>Experience</td>
<td>Basic</td>
</tr>
<tr>
<td>Complete</td>
<td>Expert</td>
<td>Full feature</td>
</tr>
</tbody>
</table>