Resuscitation Views...
& Advanced Cardiac
Resuscitation Views... & Advanced Cardiac
OBJECTIVES

• Indications for Echo in...
  • Cardiac Arrest
  • Critical Illness

• Technique

• Pathology
FoCUS

- FoCUS: Focused Cardiac Ultrasound
  - Goal-directed
  - Problem oriented
  - Limited in scope
  - Simplified
  - Time sensitive and repeatable
  - Performed at the point of care

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ACLS / ALS…
ELS (Echo in Life Support)

- CARDIAC ARREST
  - Shockable vs. Non-shockable
  - True Cardiac Arrest vs. Severe Hypotension
  - Predictor of survival?
  - Reversible causes
Most Significant Developments in Resuscitation From 2005 to 2010

Although resuscitation practices are usually studied as single interventions, they are actually performed as a large sequence of actions, each with its own timing and quality of performance. It may be difficult or impossible to assess the contribution of any one action (energy level for defibrillation, airway maneuver, drug) on the most important outcomes, such as neurologically intact survival to discharge. In fact, it is likely that it is the combination of actions, each performed correctly, in time and in order, that results in optimal survival and function. A few studies give insight into this necessary shift from studying changes in individual actions (point improvements) to studying the effects of changing the entire sequence of actions (flow improvement).

The compression-ventilation ratio was one of the most controversial topics of the 2005 International Consensus Conference. The experts began the 2005 conference acknowledging that rates of survival from cardiac arrest to hospital discharge were low, averaging 6% internationally, and that survival rates had not increased substantially in recent years. That observation led to the 2005 change to a universal algorithm.
Most Significant Developments in Resuscitation From 2005 to 2010

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Potential reversible causes:

- Hypoxia
- Hypovolaemia
- Hypo/hyperkalaemia & metabolic disorders
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis (coronary or pulmonary)
Potential reversible causes:
- Hypoxia
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- Thrombosis (coronary or pulmonary)
How is it done?

Basic ELS (Arrest)

Focused ELS (Peri-Arrest)

ACES/RUSH/SHoC (Shock)
FEER: Focused Echo Evaluation in Resuscitation Management

CAUSE: Cardiac Arrest UltraSound Exam
PROBE SELECTION

- Cardiac probe
  - Small footprint for scan between ribs
- Consider curvilinear ("abdominal") probe
APPROACH

+ WHAT DO I NEED TO SEE?

+ “Eye-ball” assessment vs “accurate” measurement

  - FLUID? (PERICARDIAL EFFUSION?)
  
  - FORM (SIZE & SHAPE)
  
  - FUNCTION
    
    - WALL THICKENING
    
    - CHAMBER CONTRACTING
    
    - VALVE MOVEMENTS
  
  - FLOW

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ELS - VIEWS

• Cardiac
  • Subxiphoid/Subcostal
  • Parasternal long axis
  • Parasternal short axis
  • Apical 4C

• Inferior Vena Cava
ELS - VIEWS

- Cardiac
  - Subxiphoid/Subcostal
  - Parasternal long axis
  - Parasternal short axis
  - Apical 4C

- Inferior Vena Cava
Sub-costal view

- Either probe (cardiac/abdominal)
- Excellent for supine patients
  - Away from airway & neck/chest procedures
- Good ‘all around’ imaging window for identification of:
  - Circumferential PCE
  - Overall wall motion
  - IVC
- Easy to obtain
  - Liver is the acoustic window
Subcostal Echo

- Liver
- RV
- LV
Parasternal long axis
Parasternal long axis
Parasternal long axis
Parasternal long axis
Parasternal long axis
Parasternal short Axis
Parasternal Short axis
Parasternal Short axis
Apical four chamber
Echo views
Echo views
ASSESSMENT FOR PATHOLOGY

• FLUID?
  • PERICARDIAL EFFUSION?

• FORM
  • SIZE & SHAPE

• FUNCTION
  • WALL THICKENING
  • CHAMBER CONTRACTING

• FLOW
  • VALVE MOVEMENTS

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Sonography in Cardiac Arrest

Predictor of outcome?

Real-time Assessment and Evaluation with Sonography - Outcomes Network (REASON) study
The absence of VWM on ultrasound had a negative predictive value of 97% for death. One patient had absent VWM but had thrombolysis.

Overall, seven further interventions were undertaken as a result of ultrasound prompting further (85%) and apical window (50%).

Table 1: Technical aspects of echo in life support

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<th>View</th>
<th>Number (n)% of total</th>
<th>Adequate view (n)</th>
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<th>Number within single 10 s window</th>
<th>Success rate (adequate view and within 10 s)</th>
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<tr>
<td>Subxiphoid</td>
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<td>17</td>
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<tr>
<td>Apical</td>
<td>4 (8%)</td>
<td>3</td>
<td>75%</td>
<td>2</td>
<td>50%</td>
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<tr>
<td>Combined</td>
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Background

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Blyth et al. AEM 2012
US activity is associated with ROSC in PEA, but not in asystole.
US is not a reliable independent test to predict cardiac arrest outcome in ED patients, overall, or even in PEA

LR+ve 1.64 - 2.85; LR-ve 0.42 - 0.49
Assessment of Left Ventricular Function
Echo views
Echo views
Emergency Assessment of LV Function

- **FORM**
  - SIZE & SHAPE

- **FUNCTION**
  - WALL THICKENING
  - CHAMBER CONTRACTING

- VALVE MOVEMENTS
Assessment of Left Ventricular Function

Why:

- One of the most valuable uses of focused echo in emergency medicine

- LV systolic dysfunction is a major prognostic factor in both acute & chronic presentations of cardiac disease:
  - IHD
  - cardiomyopathies
  - valvular heart disease
Assessment of Left Ventricular Function

When

- Clinically suspected heart failure
- Unexplained hypotension
- PEA cardiac arrest
- Cardiomegaly on physical examination or CXR
- (Acute coronary syndromes)
LV Dimensions

- Assess LV geometry (*both shape & size*)
  - A ‘big heart is a bad heart’
- LV internal dimensions measured in end-systole (LVESD) & end-diastole (LVEDD)
- Made at the level of the MV tips in the PSLA
- Measured using 2-D or M-mode
Parasternal long axis
LV Dimensions

Left Atrium: 19-39 mm
LVID_d: 36-56 mm
LVID_s: 25-41 mm
IVS_d: 6-11 mm
Posterior Wall: 6-11 mm
Map 3
170dB/C 3
Persist Low
2D Opt:HPen
Fr Rate:High

D - end systole
E - early opening
F - mid-diastolic closure
A - atrial systole
C - closure of MV

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M-Mode
LV Dimensions

LV Shape

- Normal shape is symmetrical with 2 relatively equal short axes & with the long axis running from the base (mitral annulus) to apex

- ‘Bullet-Shaped’
Parasternal Long-Axis

- Anterior Septum
- Posterior Wall
Parasternal Long-Axis

- Anterior Septum
- Posterior Wall
Parasternal Short-Axis

- Septum
- Anterior Septum
- Anterior Wall
- Lateral Wall
- Posterior Wall
- Inferior Wall
Parasternal Short-Axis

- Septum
- Anterior Septum
- Anterior Wall
- Lateral Wall
- Posterior Wall
- Inferior Wall
Parasternal Short-Axis
Parasternal Short-Axis
Apical 4-Chamber

- Septum
- Lateral Wall
Apical 4-Chamber

- Septum
- Lateral Wall
Apical 4-Chamber
Apical 4-Chamber
Qualitative Evaluation of LV Systolic Function

- Each region of the LV is observed and degree of endocardial *wall motion* and *wall thickening* is observed
- From these observations an assessment can be made of global and regional LV function
- Function can be classified as:  
  - Normal
  - Mildly Impaired
  - Moderately Impaired
  - Severely Impaired
Qualitative Evaluation of LV Systolic Function

Wall (Systolic) Thickening

- During systole the normal myocardial wall thickens from its normal 9 - 11 mm to 14 - 16 mm (35-40% increase in wall thickness)

Wall Motion

- Normal
- Hypokinetic (reduced movement)
- Akinetic (absent movement)
- Dyskinetic (movement in the wrong direction, ie outward movement of the LV free wall during LV systole)
Qualitative Evaluation of LV Systolic Function

Normal

Severe Dysfunction
Qualitative Evaluation of LV Systolic Function

Normal

Severe Dysfunction

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Regional Wall Motion Abnormality

**LAD:**
- Anterior Wall
- Anterior Septum
- Mid & Apical Septum
- Inferior & Lateral Apical Wall

**RCA:**
- Inferior Wall
- Basal Septum

**Cx:**
- Lateral Wall
- Posterior Wall
Regional Wall Motion Abnormality

Anterior Wall Dyskinesis
Regional Wall Motion Abnormality

Anterior Wall Dyskinesis
Regional Wall Motion Abnormality

Inferior Dyskinesis
Regional Wall Motion Abnormality

Inferior Dyskinesis
Regional Wall Motion Abnormality

Apical Dyskinesis
Regional Wall Motion Abnormality

Apical Dyskinesis
Angina Pectoris:

- Echo is more sensitive for ischaemia than ECG
- Ischaemia involving more than 20% of the wall thickness will result in akinesia or dyskinesia of the whole wall
Regional Wall Motion Abnormality

Acute Myocardial Infarction

• 80-95% of patients with documented myocardial infarction will have detectable wall motion abnormalities

• Extent of wall motion abnormality is directly related to the volume of myocardium in jeopardy

• Prognosis also determined by the area of ventricle involved—in this regard anterior ischaemia/infarction carries a worse prognosis than inferior

• Echocardiography provides information on functional recovery following reperfusion therapy
Regional Wall Motion Abnormality

Prior to Reperfusion

Following Reperfusion
Regional Wall Motion Abnormality

Prior to Reperfusion

Following Reperfusion
Regional Wall Motion Abnormality

Prior to Reperfusion

Following Reperfusion
Regional Wall Motion Abnormality

Prior to Reperfusion

Following Reperfusion
Mitral Valve motion

- The separation between the maximum anterior motion of the anterior mitral leaflet and maximum posterior motion of the ventricular septum is referred to as the: *E-Point Septal Separation*

- With normal systolic function
  - little (0-5 mm) E-point septal separation

- With systolic dysfunction,
  - distance is increased (>6mm)
  - LV dilatation and reduced motion of the MV
Mitral Valve Motion
Mitral Valve Motion
Mitral Valve Motion

E-Point Septal Separation
Aortic Valve Motion

Normal

LV Dysfunction
Aortic Valve Motion

Normal

LV Dysfunction
Mitral Valve annular motion

- On 2-D echo the annulus moves towards the apex in systole, with the magnitude of this motion being proportional to the extent of shortening of the LV - this is a useful measure of overall LV systolic function

- Normal = motion of the MV annulus towards the apex of $\geq 8$ mm, with a mean value of $12 \pm 2$ mm in both the 4- & 2- chamber views

- The sensitivity of MV annulus motion $< 8$ mm is 98% sensitive, with a specificity of 82%, for identification of an $\text{EF} < 50\%$
MAPSE
(mitral annular plane systolic excursion - 1 cm)
MAPSE

(mitral annular plane systolic excursion - 1 cm)
MAPSE

(mitral annular plane systolic excursion - 1 cm)
No measurement of stroke volume?

• **Global assessment**
Qualitative Evaluation of LV Systolic Function

Normal

Severe Dysfunction
Qualitative Evaluation of LV Systolic Function

Normal

Severe Dysfunction
Summary

• Evaluation of LV systolic function is one of the most valuable uses of focused echo in EM

• LV systolic dysfunction is a major prognostic factor in acute cardiac disease

• Semi-quantitative assessment of regional and global LV systolic function by an experienced observer provides an accurate assessment of LV systolic function
Summary

• Evaluation of LV systolic function:
  • FORM
  • SIZE
  • SHAPE
  • FUNCTION
  • THICKENING
  • WALL & VALVE MOVEMENTS