Focused Cardiac Ultrasound in the Critically Ill Patients

Ahmed Labib FRCA
A Prof Clinical Anaesthesiology - WQM
Disclosure

• No COI related to this presentation
Objectives

- Define focused ECHO in critically ill patients
- Demonstrate advantages and use of ECHO in ICU
- Discuss intensivist-led vs cardiologist-led ECHO
- Describe clinical application of focused ECHO
What is focused ECHO?

- FICE, FEEL, RACE......
- Binary questions!
- Identify relevant left and right ventricular abnormality/presence of pericardial or pleural fluid
- In the acute situation a basic study reveals immediate results allowing initiation of therapy
- A follow-up advanced study for refining the diagnosis and tailored hemodynamic assessment
- No other bedside tool can offer a similar diagnostic capability, allowing for exact targeting of the underlying cardiac and hemodynamic problems whether it be the right or left heart, intravascular volume, pericardial, or a cardiac response to vasoplegia as in septic shock
<table>
<thead>
<tr>
<th>Modality</th>
<th>Focused study</th>
<th>Advanced study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2D, M-mode</td>
<td>• 2D, M-mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Color Doppler (CFM)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Special Doppler (PW&amp;CW)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• TDI</td>
</tr>
<tr>
<td>Assessments</td>
<td>• LV shape/contraction</td>
<td>• LV systolic function</td>
</tr>
<tr>
<td></td>
<td>• RV shape/contraction</td>
<td>• Diastolic function</td>
</tr>
<tr>
<td></td>
<td>• Intravascular fluid status</td>
<td>• RV systolic function</td>
</tr>
<tr>
<td></td>
<td>• Pericardial tamponade</td>
<td>• Intravascular fluid status</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Valve structure/function</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Pericardial tamponade</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hemodynamics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• PAP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Left atrial pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cardiac output</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ventricular outflow obstruction</td>
</tr>
</tbody>
</table>
Why we need focused ECHO?
Why should all intensivist do this?

• Achieving full accreditation (BSE or ASE, ESE) is a lengthy process; 2 years of training, a comprehensive logbook and examinations

• Impractical to train a large proportion of intensivists to this standard

• Many life-threatening causes of shock can be diagnosed and quantified by a focused study with a significantly less training burden

• FICE accreditation
  • Attend an approved course
  • Complete an e-learning module
  • A minimum of 50 focused scans under supervision
  • Finally, assessment of scanning and interpretation ability
Limitations

• Operator, machinery
  • Reliability of diagnostic information obtained by non-experts from a focused scan
Critically ill patient challenges

• Many
  • Technically difficult to obtain high-quality images
  • Rapidly changing physiology
  • Effects of positive-pressure ventilation
  • Inotropic and mechanical cardiovascular support
  • Tachy-arrhythmias
  • Patient positioning.

• Possibility of missed echocardiographic pathology or misinterpretation leading to deleterious changes in clinical management
Dangerous in the wrong hands
Misinterpretation

• False negative/positive/discrepant

• Contributing factors:
  • Administrative/data-entry related
  • Procedural
  • Communication/information
  • Cognitive
  • Technical
  • Disease-related: rare and complex
What can focused ECHO offer?

• First line to assess shocked patients
• Assess fluid requirement and tolerance
• Diagnosis of ARDS
• Individualized management of critically ill patients
• Monitoring tool (previously known as diagnostic)
Diagnosis and management of Shock

• Unique real-time functional and morphological information
• ESICM consensus
Hypovolemic shock

- Almost all forms of acute circulatory failure
- Kissing LV end systolic wall
- LVEAD
- Inter-atrial septum bowing throughout cardiac cycle
- IVC dispensability index > 18% (90% S&S)
  - Spontaneous breathing
  - MV
  - Caveats
  - < 10 & >20 mm
Fluid challenges and heart-lung interaction

• MV 8-10 ml/kg
• RV output followed by LV output 2-3 beats
• Protective lung ventilation
• Arrhythmias
• A change in VTI of >10 % after the first 100 ml predicted fluid responsiveness with a S&S of 95 % and 78 %, respectively.
Passive leg raising (PLR)

• Applicable in both spontaneously breathing and ventilated patients
• CO/SV by PW Doppler
• An increase in CO or SV of >12 % during PLR was highly predictive of fluid responsiveness with an AUC of 0.89 for the cardiac index and 0.9 for the SV. Sensitivity and specificity were 63 and 89 % for CO, and 69 and 89 % for SV, respectively
• Abdominal hypertension
• Positioning
Cardiogenic shock

• Most literature is CAD-related
• Mixed/undifferentiated shock commonest in ICU/sepsis
• Overall cardiac performance
  • CPI
  • MAPSE
• LV systolic function
  • EF eyeballing, M-mode, Simpson disc
  • Fractional area change (FAC > 25%)
  • PW LVOT VTI >20 cm
  • TDI basal segments S’ > 5.4 = EF >50%
• Valve pathology acute/pre-existing (AMR)
LV diastolic dysfunction (filling pressures)

• Common problem 50% PEFHF

• E/A ratio >2 & E wave deceleration time <120 ms predict a LAP >20 mmHg

• Using TDI, the mitral annulus e’ with a lateral e’ <10 and medial <7 cm/s highly suggestive of diastolic dysfunction and elevated LAP

• Beware the E/e’ ratio affected by loading condition but can be used to predict LAP.

• E/e’ <8 indicates normal LAP and >15 gave an LAP >13 mmHg
ECHO in obstructive shock

• Acute PE
• Cardiac tamponade
• Dynamic LVOT obstruction
Acute PE

• Dilated right heart chambers, changes in right ventricular contraction, elevated PAP, decreased CO, and intra-cavity emboli.
• Dilated RC in A4C view with a right ventricle/left ventricle area ratio >0.6; gross dilatation is seen with a ratio >1.0
• M-mode TAPSE > 16 mm
• RV S’ velocity <110 cm/s predicts RV dysfunction (RVEF <45 %) with a sensitivity of 90 % and specificity of 85 %
• McConnell sign
• Bernoulli equation $4V^2$
• PA acceleration time 70-90
Cardiac tamponade

• Life saving (ACLS)
• Intra-pericardial pressure > right filling pressure
• Right atrial wall systolic collapse for longer than one-third of the cardiac cycle, right ventricular wall diastolic collapse, and a dilated IVC
• Emergency drainage
Dynamic LVOT obstruction

- LV hypertrophy cardiomyopathy
- Critical illness inotropes, tachycardia, hypovolaemia
- Lateral and septum approximation
- Systolic anterior motion of AML
- Colour Doppler: turbulent flow through the LVOT
- CW Doppler picking up high velocities indicating obstructive
- PW Doppler identify exactly where that obstruction occurs
Anything can happen in septic shock

- Normal study......Takutsubo’s
- LV dilatation
- LV contraction impairment
  - Global
  - Segmental
- LV diastolic dysfunction
- RV systolic/diastolic dysfunction
- Ventricular outflow obstruction
- Valve lesions
  - Functional
  - Endocarditis
ECHO in septic shock

• Almost always reversible within days except CAD/myocarditis
• Vasoplegia hyperdynamic, well-filled LV
• Valvular lesions infective endocarditis/abscess
• Speckle tracking, global longitudinal strain
Conclusion

• ECHO is the most valuable diagnostic tool in the ICU
• ECHO help diagnose and manage all types of shock
• Training and basic level accreditation should be a must
• Limitations should be recognised
• Befriend your cardiology colleagues