Focused Cardiac Ultrasound in the Critically Ill Patients

Ahmed Labib FRCA

A Prof Clinical Anaesthesiology - WQM

Disclosure

- No COI related to this presentation

Objectives

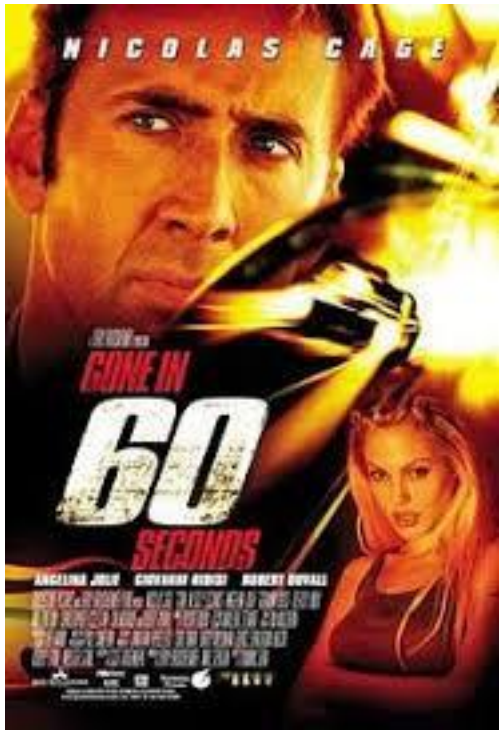
- Define focused ECHO in critically ill patients
- Demonstrate advantages and use of ECHO in ICU
- Discuss intensivist-led vs cardiologist-led ECHO
- Describe clinical application of focused ECHO

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

	Focused study	Advanced study
Modality	2D, M-mode	• 2D, M-mode • Color Doppler (CFM) • Special Doppler (PW&CW) • TDI
Assessments	• LV shape/contraction • RV shape/contraction • Intravascular fluid status • Pericardial tamponade	• LV systolic function • Diastolic function • RV systolic function • Intravascular fluid status • Valve structure/function • Pericardial tamponade • Hemodynamics • PAP • Left atrial pressure • Cardiac output • Ventricular outflow obstruction

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
- Cecconi et al. Consensus on circulatory shock and hemodyn monitoring. Task force of the European society of Intensive Medicine. Intensive Care Med. 2014;40:1795–815

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 mange all types of shock
- Training and basic level accreditation should be a must
- Limitations should be recognised
- Befriend your cardiology colleagues