Echo for the Assessment of Acute Chest Pain

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- Chest pain is very common problem presenting to ER
- Broad differential
  - Includes life threatening conditions
- Echo can be used to rapidly and accurately arrive at a diagnosis
  - Point of care approach
  - Should be mastered by all trainees
  - Modern core of triage
• Chest pain ≠ coronary artery disease
  – Numerous other causes
  – Triage
  – Particularly the sick patient

Challenges include:
• Myocardial infarction
• Pulmonary embolism
• Aortic dissection
• Pericardial causes
• Mediastinal causes
• Musculoskeletal
• Biliary colic and oesophagitis
where, what & whom?

- Point of care devices are everywhere
- Embrace ultrasound as the modern stethoscope
- ER physicians “invading” the space
  - Justifiable need
  - Practicing clinical cardiologists need same/superior skill set
  - All trainees
  - All emergency cath patients ideally

The American Society of Echocardiography - published this statement in 2010

“...The use of ultrasound has developed over the last 50 years into an indispensable first-line test for the cardiac evaluation of symptomatic patients. The technologic miniaturization and improvement in transducer technology, as well as the implementation of educational curriculum changes in residency training programs and specialty practice, have facilitated the integration of focused cardiac ultrasound into practice by specialties such as emergency medicine. In the emergency department, focused cardiac ultrasound has become a fundamental tool to expedite the diagnostic evaluation of the patient at the bedside and to initiate emergent treatment and triage decisions by the emergency physician.”
Systematic Approaches

- ER rapid scan algorithms
  - Point of care focused
  - Rapid, Logic tree concept
  - Caution with limited approach
    - Missing/misinterpretation
    - Limitation of training
- Traditional full ECHO scan
  - Often difficult to complete
  - Time pressure
  - Potentially more expert
Figure 1: Undifferentiated chest pain sonographic algorithm.
Abbreviations: DVT, deep vein thrombosis; LV, left ventricle; RV, right ventricle; IVC, inferior vena cava.
Studies Chestpain evaluation in ER

- Sobczyk, Nycz and Zmudka in 2015
- excluded patients with acute STEMI, patients under 18, and patients whose body habitus was incompatible
- series of approximately 1100 patients
- Non-STEMI, over 70% had wall motion abnormalities
- thought not to have an ACS at all, echo abnormalities were found in 55%
  - Aortic dissection
  - Changes suggesting PE
  - Pleural and pericardial effusion
  - Cardiac tumours
  - etc
Studies Chestpain evaluation in ER

- F.J. Mancuso, 2014 Archive of Brazilian Cardiology
- Point of care echocardiography was performed in a series of 100 patients
- 28 patients, the focused echocardiography confirmed initial diagnosis
- In 17 patients, the echocardiography changed the diagnosis:
  - ten with suspicious of heart failure,
  - two with pulmonary embolism suspicious,
  - two with hypotension without cause,
  - one suspicious of ACS,
  - one of cardiac tamponade and one of aortic dissection

Studies Chestpain evaluation in ER

- Ahn JH, Jeon J, Toh H-C et al
- PLOS One Journal  March 2017
- SEARCH 8Es – a novel point of care ultrasound protocol for patients with chestpain, dyspnea or symptomatic hypotension in the emergency department
- Single centre: 12 months, 308 patients (184 male, 124 women) mean age 67.7 yrs
- Narrowed initial diagnosis 2.5 ± 1.5 vs 1.4 ± 0.7 p<0.001
- Overall:
  - sensitivity 90.9%,
  - specificity 99.0%,
  - positive predictive value 89.7%,
  - negative predictive value 99.0%
Choice of imaging modality

- Sensitivity and specificity of the test for problem suspected
- Risk of transportation to remote point of hospital (CT, MRI)
- Echocardiography
  - Device to patient
  - Point of care triage
  - No ionizing radiation
  - Indicated in the majority of serious cardiac emergencies

<table>
<thead>
<tr>
<th>Condition</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma and COPD</td>
<td>89.0</td>
<td>97.0</td>
</tr>
<tr>
<td>Infectious endocarditis (children)</td>
<td>86.0</td>
<td></td>
</tr>
<tr>
<td>Infectious endocarditis (adults)</td>
<td>34.2</td>
<td>99.0</td>
</tr>
<tr>
<td>Pericardial effusion</td>
<td>95.0</td>
<td>91.0</td>
</tr>
<tr>
<td>Pericardial tamponade</td>
<td>85.0</td>
<td>92.0</td>
</tr>
<tr>
<td>Pericardial (constrictive)</td>
<td>87.0</td>
<td>91.0</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>89.0</td>
<td>94.0</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>81.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Pulmonary embolus (direct visual)</td>
<td>50.0</td>
<td></td>
</tr>
<tr>
<td>Pulmonary embolus (indirect signs)</td>
<td>93.0</td>
<td>81.0</td>
</tr>
<tr>
<td>Pulmonary embolus: DVT + Neg lung scan</td>
<td>81.0</td>
<td>99.0</td>
</tr>
<tr>
<td>Pulmonary oedema</td>
<td>97.0</td>
<td>95.0</td>
</tr>
<tr>
<td>Thoracic aortic aneurysm</td>
<td>78.0</td>
<td></td>
</tr>
<tr>
<td>Wall motion abnormality (CAD)</td>
<td>90-95</td>
<td>80.0</td>
</tr>
</tbody>
</table>

Adapted from Colony, et al. American J of Emergency Medicine 2017
Challenges for Echo in the acute setting

- Patient habitus
  - Upright or prone patient
- Patient access and windows
  - Unable to position
  - Ventilated
  - Dressings and lines
  - Rapidity
  - Pneumothoracic, pneumomediastinum
  - Trauma – head, neck, thorax
- Interpretation of images in acute setting
  - Abnormal loading conditions
  - Ventilated – positive pressure

Recommendations for echocardiography in patients with acute chest pain

**Recommended:**
- Evaluation of acute chest pain in patients with suspected myocardial ischaemia, non-diagnostic ECG and cardiac necrosis biomarkers, and when resting echocardiogram can be performed during the pain;
- Evaluation of acute chest pain in patients with underlying cardiac disease (valvular, pericardial or primary myocardial disease);
- Evaluation of patients with chest pain and haemodynamic instability unresponsive to simple therapeutic measures;
- Evaluation of chest pain in patients with suspected acute aortic syndromes, myocarditis, pericarditis or pulmonary embolism.

**Not recommended:**
- Evaluation of chest pain in patients for which a non-cardiac aetiology is apparent;
- Evaluation of ongoing chest pain in patients with a confirmed diagnosis of myocardial ischaemia/infarction.

Acute coronary syndromes

ECG in chest pain

• Remains key initial step
  – Highly specific for STEMI (definition)
    • ECHO still highly recommended in STEMI cases
  – Highly fallible
  – Normal vs non-specific vs Bundle branch block
  – Pre-existing changes no comparator
Echo in ACS – Acute indications

- Triad Chest pain, ECG changes and hsTrop
- Acutely “inconclusive” – common
- Echo valuable bedside triage
- Limitations:
  - Wall motion abnormalities in ischaemia reversible and non-specific
  - If present ischaemia vs necrosis, old vs new, other
  - High sensitivity, low specificity

- Diagnosis
- Location and extent
- Overall LV/RV function
- Complications
- Rule out CAD
  - Stress
  - Contrast
Post VF x2, Extensive Anterior ECG changes. Heli retrieval, systolic 90
Very proximal LAD
No collaterals
Mid LAD Collaterals present

Involvement of the septum, apex, and anteroseptal regions of the left ventricle are typical LAD occlusion
Lateral wall may become akinetic in circumflex artery occlusion, also frequently involved as a component of multisegmental territory.
RCA variable but most are found at the base of the inferior or diaphragmatic wall; the apex is often spared.
Apical 2CH, Apical LAX, SAX
• Uncertain territory prior to STEMI PCI
  – Ideally every STEMI case should have imaging during setup in lab
  – Huge advantage
    • Territory
    • LV function
    • Valvular disease
    • RV infarction/function
    • Complications of MI
Tako-tsubo cardiomyopathy – overview

- Sato and Dote 1991
- 1-2% ACS presentations
- Post-menopausal women
- Frequently misdiagnosed
- Mimics MI
- Characteristic wall abnormalities
- Resemble Japanese octopus trap

- Apical ballooning syndrome, broken heart syndrome, scared to death, ampulla syndrome, acute stress cardiomyopathy, apical cardiomyopathy
Tako-tsubo cardiomyopathy – clinical features

- Preceding stressful event
  - physical 17-22%
  - emotional 33-45%

- Chest pain or SOB in most patients
  - 50-60% CP at rest

- ST-T abnormalities on ECG +/- QT prolongation

- Elevation of cardiac enzymes

- Absence of CA narrowing on angiography
  - Case series 2009 (Gaibazzi) - bystander lesions >50% included

- Balloon-like LV wall motion abnormality at apex
  - most cases abnormality extends beyond perfusion territory of single CA
  - Case series 2007 (Kurowski) - midventricular abnormality 40%

- Good prognosis
  - complete recovery in vast majority within 4-8 weeks
  - in-hospital mortality 1%

Aortic dissection

- Life threatening emergency
- Chest pain and syncope
- Cornerstone is visualization of flap
  - Tamponade
  - Ao Valve incompetence
  - Wall motion ab’s

- Type A (ascending) vs Type B (descending)
- TTE vs TEE
- Pitfall – reverberation artifact
- Triage to alternative imaging – CT contrast
Next on cath list after urgent transfer as Non-STEMI – 64 yrs. Post CABG 7 years, ongoing pain, no ECG changes, looked sick
**Pulmonary embolism cases**

**Recommendations for echocardiography in patients with suspected/confirmed pulmonary embolism**

**Recommended:**
- Suspected high risk of pulmonary embolism where shock or hypotension are present and CT is not immediately available
- For distinguishing cardiac vs. non-cardiac aetiology of dyspnoea in patients in whom all clinical and laboratory clues are ambiguous;
- For guiding the therapeutic option in patients with pulmonary embolism at intermediate risk.

**Reasonable:**
- Search for pulmonary emboli and suspected clots in the right atrium or ventricle or main pulmonary artery branches;
- For risk-stratification in non-high risk pulmonary embolism.

**Not recommended:**
- For elective diagnostic strategy in haemodynamically stable, normotensive patients with suspected pulmonary embolism.
Female 25 years, 7 days post knee injury
Chest pain to ER, hypotensive.

Good LV function
Dilated RV
Severe RV impairment
Female 25 years, 7 days post knee injury
Chest pain to ER, hypotensive.

RV dilation
Flattened IVS
Systole & diastole
Pressure Volume overload

Female 25 years, 7 days post knee injury
Chest pain to ER, hypotensive.

RV apex
Dilated non-contractile
McConnells sign?
Female 25 years, 7 days post knee injury
Chest pain to ER, hypotensive.

Subcostal
RV markedly
Dilated and dysfunction

Moderate pulmonary hypertension
Think pulmonary/systemic ratio
Think severe RV impairment
Low systemic BP
35 year old, presents ER with chest pain. Bruised leg 4 weeks ago
Apparently well

McConnell’s sign

McConnell M et al. Regional RV dysfunction detected by echo in acute PE. Am J Cardiol 1996;78, 469-473
Thrombus at bifurcation: Saddle PE directly visualized
Causes of Pericarditis

- Idiopathic
- Renal failure
- Viral infections
- Neoplastic
- Bacterial, tuberculous,
- Hypothyroidism
- Rheumatoid
- Systemic lupus
- Scleroderma, sarcoidosis
- Rheumatic fever
- Myocardial infarction/Dressler’s syndrome
- Aortic dissection/Takotsubo
- Drugs/Irradiation/interventions
- Sjögren syndrome
- Mixed connective-tissue disease
- Reiter syndrome
- Ankylosing spondylitis
- Inflammatory bowel disease
- Wegener granulomatosis
- Vasculitis (e.g., giant cell arteritis, polyarteritis)
- Polymyositis
- Behçet syndrome
- Whipple disease
- Familial Mediterranean fever
- Serum sickness
Pointers in clinical story

• Pleuro-pericardial features
  – Hurts to breath – splinting on inspiration
  – ↑ comfort leaning forward, shallow inspiration
  – Positional
• Unremitting, background discomfort
• Prolonged intense episodes:
  – too long for angina
  – Crippled by pain: “exquisite pain”

• Pericardial effusion – borderline tamponade
• Pericardial Tamponade
Chest pain and dyspnoea in ER
Female 60 years. 15 years post mastectomy

Freq.: 1.7 MHz/3.3 MHz
FPS: 48.0
Chestpain and dyspnoea in ER
Female 60 years. 15 years post mastectomy

- Pericardial Aspiration
Draining a pericardial effusion

- Locate an area where you are close to the fluid from the surface
- Have ECG and BP monitoring on
- Angle to find a direction where you can hit fluid but not heart
- Mark this point on chest wall
- Instill lignocaine and advance needle between intercostal space
- Advance small distance aspirate, repeat
- Once in effusion draw off and inspect, remember how deep
  - Clear, bloody, purulent
- If you hit heart, lots of ectopics
- Take larger bore needle and advance, aspirate
  - In tamponade a small volume will make a big difference
- Can place guide wire and aspiration pigtail catheter

Surface Anatomy:
Sites for pericardial aspiration
Agitated saline contrast
Confirming correct percutaneous drainage placement
- Small pericardial effusion with large left pleural effusion
- Chest pain 3 weeks post DDD pacemaker
- Diagnosis
- Guidance of Pericardial drainage
- Guidance after new lead placed
- Guidance after perforated lead removed with surgical back up available
Extracardiac
The use of echocardiography in acute cardiovascular care: Recommendations of the European Association of Cardiovascular Imaging and the Acute Cardiovascular Care Association

- Echocardiography is one of the most powerful diagnostic and monitoring tools available to the modern emergency/critical care practitioner
  - provision of echocardiography is fundamental to the management of patients with acute cardiovascular disease.
  - Echo can provide important information throughout the whole patient pathway, having been shown to change therapy in 60–80% of patients in the pre-hospital setting.
  - improve diagnostic accuracy and efficiency in the emergency room,
  - reveal the aetiology of unexplained hypotension in 48% of medical intensive care patients
  - Echocardiography is now included in the universal definition of acute myocardial infarction (AMI), and in international guidelines regarding the management of cardiac arrest.

Pulmonary Oedema & Pneumothorax

- Pulmonary Oedema
  - Accuracy approaches 100%
  - Characteristic lung rockets
  - Caused by intraalveolar oedema

- Pneumothorax
  - Absence pleural sliding
  - Barcode sign, absent waves on beach (m-mode)