ACES

Ultrasound in Undifferentiated Hypotension

Why ultrasound in Shock?

- Initial clinical diagnosis of shock etiology correct in only 50% patients
  - Jones, A. CCM 2004;32(8):1703
- Often mixed aetiology
- Help in initial simplistic therapeutics
- Rapidly identify threats to life e.g. AAA /PE

Shock Ultrasound
The Holy Grail of Ultrasound

Jim Connolly ED Newcastle

Randomised Controlled Trial of Immediate versus delayed Goal directed Ultrasound to Identify the aetiology of Non traumatic Hypotension in ED patients
Jones A Vivek S Acad Emerg 2004 Med 11(5) 445-6

Carolinias Medical Centre
All adults with SBP < 100 or Shock Index >1
Non trauma - 184 included

Scan at either 0 minutes or plus 15 to 30 mins ( Cardiac and Torso views)
Questions asked

- What is the LV Function?
  Hyperdynamic / Normal / moderate impaired / severely impaired

- RV size
- Is there a pericardial effusion?
- Is there free abdominal fluid?
- Presence of AAA
- IVC collapsibility

What will we cover?

- Shock – definition
- Scan sequence
- What are we looking forward
- Start simple and build up

Shock

exists when there is a mismatch between oxygen delivery and demand in the tissues
Aetiology

- Cardiogenic
  - Pump failure
- Distributive
  - Leaky pipe
  - Hypovolaemic
  - Inflated pipe
- Obstructive
  - Blocked pipe
  - Cytotoxic
  - Good pipe
- Mixed

Does ACES scan help define?

- Hypovolaemia
  - Small chambers / IVC with normal / hyperdynamic LV
- Myocardial
  - Poor LV fill, dilated chambers. Wall motion abnormal
  - Dilated IVC
- Obstructive
  - PE - RV>LV; RV hypokineses; IVC dil.; DVT
  - Tamponade
- Distributive
  - Sepsis - hyperdynamic LV, variable IVC

ACES: Abdominal and Cardiac Evaluation with Sonography in Shock

- Filling/Hypovolaemia
- Cardiac Tamponade
- PE
- Sepsis
- AAA
- Blood

Aetiology

- Transthoracic Echo to identify or exclude cardiac cause of shock
  - Mayo Disney et al Chest

- 100 consecutive shocked ITU patients

WHAT IS CAUSE IN YOUR PRACTICE?
63% HAD CARDIAC CAUSE

- Severe LV Dysfunction 33%
- Tamponade 17%
- Post infarct mechanical problem 14%
- R Vent dysfunction 14%

Most common Therapeutic Change

- If dynamic Ventricles fluid load
- If impaired Ventricles inotropes

Surgical intervention
Pericardial drainage

Probe selection

- FAST / IVC / AAA
  - Curvilinear 2.5 - 5.0 MHz
  - Large field of view
- ECHO
  - Phased array 2.5 - 5.0 MHz
  - Small footprint
- Pleura / veins
  - Linear 7.5 - 12 MHz

Hypovolaemic?

Examine the abdomen

- IVC
- Free fluid
- AAA
**Obstructive and Cardiogenic**

Move on to FAST subcostal view and assess

- global function
- pericardial effusion
- right ventricle size

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**IVC size**

- A guide to intravascular volume
- Measure 2 - 4 cm distal to hepatic vein
- Absolute
  - Mean 15 - 18 mm
  - > 23mm = plethora
    - Increased RV pressure PE, CCF, CPD
  - < 12mm = hypovolaemia
- Relative
  - Changes with quiet respiration
  - Sniff test
  - Ventilated vs. non ventilated
**Collapse and Right Atrial Pressure**

<table>
<thead>
<tr>
<th>Expiratory Diameter</th>
<th>% Collapse</th>
<th>RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 cm</td>
<td>100 %</td>
<td>&lt; 5 mm Hg</td>
</tr>
<tr>
<td>&lt; 2 cm</td>
<td>&gt; 50%</td>
<td>5 – 10 mmHg</td>
</tr>
<tr>
<td>&gt; 2 cm</td>
<td>25 – 50%</td>
<td>10 – 15 mmHg</td>
</tr>
<tr>
<td>&gt; 2 cm</td>
<td>&lt; 25%</td>
<td>15 – 20 mmHg</td>
</tr>
</tbody>
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**Focused ECHO**

- Pericardium
  - Effusion, tamponade
- LV
  - Hyperdynamic, normal, depressed, severely depressed
  - Size - dilated, normal, contracted
  - Wall motion
- RV
  - Pressure - volume overload

**Cardiac Views**
Windows for Focused Study

- Subcostal
  - Well known via FAST
- Apical
  - LV - RV
- PLAx
  - LV
- (PSAx)

Which views are most easily obtained?

- FATE protocol
  - 227 ICU pts, Denmark
- 97% overall, 80% apical, 69% parasternal, 58% subcostal
- Information decisive 37.3%,
  - Eur J Anaesth 2004

Cardiac - LV function

- Subcostal - apical - PSLA
- LV
  - Hyperdynamic
  - Normal
  - Depressed LV
  - Severely depressed LV
Evidence for agreement of global function using HEE versus standard echo

<table>
<thead>
<tr>
<th>Study</th>
<th>EF</th>
<th>Agreement</th>
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<tbody>
<tr>
<td>Lemola et al Echocardiology 2003</td>
<td>Normal abnormal</td>
<td>100%</td>
</tr>
<tr>
<td>Kimura et al Am J Cardiol 2002</td>
<td>Normal Abnormal</td>
<td>100%</td>
</tr>
<tr>
<td>Bruce et al</td>
<td>&lt;40 40-54 55-70  &gt;70 %</td>
<td>90%</td>
</tr>
<tr>
<td>Vourvuri et al Am J Cardiol</td>
<td>&lt;35 35-55 &gt;55%</td>
<td>93%</td>
</tr>
</tbody>
</table>

Global Dysfuncitio

Sepsis

SHOCK scan aims to identify:

- Hyperdynamic left ventricular function
- Hyperdynamic heart has sensitivity of 33% and a specificity of 94% for sepsis

   Jones A et al Shock 2005 Dec;24(6) :S13-7

Pericardial Effusion & Tamponade

Aim:

- Identify pericardial effusion
- Collapse RA/RV during diastole = tamponade
Abnormal Pericardial View

Cardiac - RV
- Pressure - (volume) overload
- LV:RV 1:0.6
- If RV> or equal to LV = strain
- If free wall < 5mm = acute
- Apical best view

Tamponade

PE
- SHOCK scan aims to identify:-
  - RV dilatation
    - RV hypokinesis
    - Paradoxical septal motion
  - IVC distension
  - Leg veins for DVT
PE - in context!!

Transverse-femoral venous thrombus cf Dan

Increased complexity

Wall motion abnormality

Valve disease

Measurements?

High frequency probe
Any evidence of PTHx
look at veins
JVP/CVP

Segmental wall dysfunction
Valves - qualitative

M Mode ejection fraction

MAPSE TAPSE FRACTIONAL SHORTENING
AORTA

?AAA ? Leak

- Emergency ultrasound
  - sensitivity of 96.3% (95% confidence interval (CI) 81.0% to 99.9%)
  - a specificity of 100% (95% CI 91.8% to 100%)
  - a negative predictive value of 98.6% (95% CI 88.0% to 99.9%)
  - positive predictive value of 100% (95% CI 86.8% to 100%)
  - for the detection of AAA

AAA

Normal 2.5cm
Aneurysm > 50% increase

- Longitudinal
  - Transverse - measure outer to outer, as CT

Transverse

- Probe marker to the right of the patient = liver to left of screen
- Start just below xiphoid & trace to bifurcation
- Pressure to displace bowel
- Identify liver, aorta, IVC and spinal column
- Aorta / IVC = anechoic
- Spine = hypoechic
Abdominal & Pleural Free Fluid

- FAST scan

F.A.S.T. – Normal Appearances

Hepatorenal Window

- Liver
- Diaphragm
- Right kidney

- Normal right and left perirenal fat
- Splenorenal angle
- Subphrenic
- Pelvis

Splenorenal Window

- Transducer positioned in left posterior axillary line between 10th and 11th ribs with beam in coronal plane.
- Demonstrates spleen, kidney and diaphragm
- May be marred by acoustic shadows from ribs
- May be improved by imaging patient whilst in full inspiration.
**Pleural Effusion**

- Extension FAST
- Can identify pleural fluid - haemothorax
- Sensitivity >96%, specificity 99-100%

**Pleural effusion - pitfalls**

**Questions**