LEVELS OF COMPETENCE

Level 3
specialist echo examinations, echo for invasive procedures, and majority of post in echo and echo research

Level 2
accept referrals from Level I, perform comprehensive TTE & TEE, diagnose all cardiovascular abnormalities, optimise onward referral, teaching and research

Level 1
acquire all standard views (TTE, TEE), recognise abnormal vs normal, diagnose common abnormalities, recognise when referral indicated, understand echo vs other techniques

Emergency Echo (FEEL, FATE)
acquire standard TTE views in ALS compliant manner, recognise major causes of arrest/shock, recognise when referral for second opinion indicated

Price et al. Cardiovascular Ultrasound 2008
3D echo – Beyond the scope of this course
Stress echo – Beyond the scope of this course
Strain echo – Beyond the scope of this course
LEVELS OF COMPETENCE

Level 1
- acquire all standard views (TTE, TEE), recognise abnormal vs normal, diagnose common abnormalities, recognise when referral indicated, understand echo vs other techniques

Level 2
- accept referrals from Level 1, perform comprehensive TTE & TEE, diagnose all cardiovascular abnormalities, optimise onward referral, teaching and research

Level 3
- specialist echo examinations, echo for invasive procedures, and majority of post in echo and echo research

Appropriate level of competence for most physicians

Price et al. Cardiovascular Ultrasound 2008
PATIENT SELECTION

Transthoracic Echocardiography Is Not Cost-Effective in Critically Ill Surgical Patients

Cook, Charles H. MD, FACS; Praba, Anant C. MD; Beery, Paul R. MD; Martin, Larry C. MD, FACS

PATIENT SELECTION

Transthoracic Echocardiography Is Not Cost-Effective in Critically Ill Surgical Patients

Cook, Charles H. MD, FACS; Praba, Anant C. MD; Beery, Paul R. MD; Martin, Larry C. MD, FACS


Difficult image acquisition in:
PATIENT SELECTION

Transthoracic Echocardiography Is Not Cost-Effective in Critically Ill Surgical Patients

Cook, Charles H. MD, FACS; Praba, Anant C. MD; Beery, Paul R. MD; Martin, Larry C. MD, FACS


Difficult image acquisition in:

Chest Tubes
Transthoracic Echocardiography Is Not Cost-Effective in Critically Ill Surgical Patients

Cook, Charles H. MD, FACS; Praba, Anant C. MD; Beery, Paul R. MD; Martin, Larry C. MD, FACS


Difficult image acquisition in:

PEEP > 15
PATIENT SELECTION

Transthoracic Echocardiography Is Not Cost-Effective in Critically Ill Surgical Patients

Cook, Charles H. MD, FACS; Praba, Anant C. MD; Beery, Paul R. MD; Martin, Larry C. MD, FACS


Difficult image acquisition in:

> 10% Weight Gain
Other patients that may be difficult to image:
Other patients that may be difficult to image:
PATIENT SELECTION

Other patients that may be difficult to image:

Surgical Dressings

COPD Barrel Chest
PATIENT SELECTION

Other patients that may be difficult to image:

General Obesity

Surgical Dressings

COPD Barrel Chest
Transthoracic Echocardiography Is Not Cost-Effective in Critically Ill Surgical Patients

Transthoracic Echocardiography Is Not Cost Effective in Critically Ill Surgical Patients

Transthoracic Echocardiography Is Not Cost-Effective in Critically Ill Surgical Patients

Transthoracic Echocardiography is not cost-effective in critically ill surgical patients, but is still worth attempting.


PATIENT SELECTION

Can be Challenging in Certain
CLINICAL CASE 1

71 year old man POD # 7 from meningioma resection. Hypotensive. BP 70/30
PRE-EXISTING DISEASE

CLINICAL CASE 1
CLINICAL CASE 1

Initial Diagnosis: Cardiogenic Shock

Intervention: Epinephrine started, Fluids minimized

Result: Worsening clinical condition
CLINICAL CASE 1

Chart Review: Baseline LVEF 10-15%

Findings: MRSA growing from blood culture

Intervention: Treated with routine sepsis management with significant improvement
PITFALL # 1

PRE-EXISTING CARDIAC DISEASE MAY CAUSE INTERPRETATION CHALLENGES
EFFUSIONS/TAMPONADE

CLINICAL CASE 2

34 y.o. male one month after aortic valve replacement

Main complaints:
• shortness of breath
• chest pain

Vital signs: stable

Tuesday, March 19, 13
• This was a 34 y.o. male with aortic insufficiency & aortic stenosis complicated by recurrent endocarditis s/p multiple repeat aortic valve replacements, most recently a month prior to this admission.
• The night before this admission he was abruptly awakened from sleep with acute dyspnea and increase in his chest pain to 7/10,
• He was transferred to the ICU for further management and a TTE was done
• On first look in this parasternal short axis view the heart does not seem to be the cause of shortness of breath
The apical 4-chamber view, though, is concerning. The right atrium is not well seen. There is a sense that there is something compressing on it. The yellow arrow points out to this area.

The subcostal view confirms the suspicion of a clot compressing on the heart. In this window, we see the left and right ventricles, but both chambers are small and there appears to be something compressing on the right ventricle. The white arrow shows the area suspicious for a clot.
The apical 4-chamber view, though, is concerning. The right atrium is not well seen. There is a sense that there is something compressing on it. The yellow arrow points out to this area.

The subcostal view confirms the suspicion of a clot compressing on the heart. In this window, we see the left and right ventricles, but both chambers are small and there appears to be something compressing on the right ventricle. The white arrow shows the area suspicious for a clot.
• The apical 4-chamber view, though, is concerning. The right atrium is not well seen. There is a sense that there is something compressing on it. The yellow arrow point out to this area.
• The subcostal view confirms the suspicious of a external clot compressing on the heart. In this window we see the left and right ventricles, but both chambers are small and there appears to be something compressing on the right ventricle. The white arrow shows the area suspicious for a clot.
The apical 4-chamber view, though, is concerning. The right atrium is not well seen. There is a sense that there is something compressing on it. The yellow arrow points out to this area.

The subcostal view confirms the suspicion of an external clot compressing on the heart. In this window we see the left and right ventricles, but both chambers are small and there appears to be something compressing on the right ventricle. The white arrow shows the area suspicious for a clot.
Next, this is a demonstration of an IVC plethora with very large IVC without respiratory variation at all, indicating very high right-sided pressure.
Lastly, Doppler interrogation of mitral valve inflow, which will be learned tomorrow, demonstrates more than 25% variation in flow during inspiration and expiration.

This indicates tamponade physiology.
CLINICAL CASE 2

49 y.o. male admitted to the hospital due to worsening dyspnea

PMHx:
- HTN
- h/o pericarditis
- HCV
- s/p renal transplant on immunosuppression
- Cryoglobulinemia

VS: Within normal limits
BUT IS THIS TAMPONADE???

- This parasternal short axis view demonstrates circumferential pericardial effusion
- The parasternal long axis view again confirm the circumferential pericardial effusion without chamber collapse
BUT IS THIS TAMPONADE???

- This parasternal short axis view demonstrates circumferential pericardial effusion
- The parasternal long axis view again confirm the circumferential pericardial effusion without chamber collapse
This apical 4–ch view demonstrates circumferential pericardial effusion but...
- No RA systolic collapse
- No RV diastolic collapse
- Finally, mitral valve inflow shows variation in inflow less than 25%
- Putting it all together -- pericardial effusion without echocardiographic evidence of tamponade
EFFUSIONS/TAMPONADE

PITFALL # 2

- NOT ALL POST-SURGICAL TAMPONADES HAVE EFFUSIONS

- NOT ALL EFFUSIONS = TAMPONADE
67 year old man POD # 3 from MI and CABG

- Intra Aortic Balloon Pump
- Normotensive

Echo Performed for Routine Post-Op Evaluation
CLINICAL CASE 4

- IABP removed
- Hypotension develops
- Echo repeated
PITFALL # 3

CARDIAC FUNCTION CAN BE OVERESTIMATED WHEN PATIENTS RECEIVE MECHANICAL OR INOTROPIC SUPPORT
With significant hypovolemia, like in the patient from which this clip was recorded, things are fairly obvious. This is a case of a patient in septic shock on multiple pressors. As a side note, while initially the PAC demonstrated “biventricular failure” (CVP was 24 mmHg, PAOP 24 mmHg), the echo clearly demonstrated that the problem was not with systolic failure, but rather severe hypovolemia. The next clip was taken 24 hours later after aggressive fluid therapy where we obviously see that the LV is “full” again.

Morale: with extreme physiology, in this case severe hypovolemia -- it is fairly easy to diagnose.
With significant hypovolemia, like in the patient from which this clip was recorded, things are fairly obvious. This is a case of a patient in septic shock on multiple pressors. As a side note, while initially the PAC demonstrated “biventricular failure” (CVP was 24 mmHg, PAOP 24 mmHg), the echo clearly demonstrated that the problem was not with systolic failure, but rather severe hypovolemia. The next clip was taken 24 hours later after aggressive fluid therapy where we obviously see that the LV is “full” again.

Morale: with extreme physiology, in this case severe hypovolemia -- it is fairly easy to diagnose.
The problem is when we deal with patients who do not have severe hypovolemia. For the majority of our patients, just looking at the LV size, or preload does not allow up to predict fluid “status” or fluid responsiveness.
LV End Diastolic Area
VOLUME “STATUS” ASSESSMENT

LV End Diastolic Area

© WINFOCUS' CRITICAL CARE ECHOCARDIOGRAPHY

Tuesday, March 19, 13
VOLUME “STATUS” ASSESSMENT

LV End Diastolic Area
Predicting Fluid Responsiveness in ICU Patients*  
A Critical Analysis of the Evidence  
Frédéric Michard, MD, PhD; and Jean-Louis Teboul, MD, PhD

Table 4—LVEDA Before Volume Expansion in Responders and Nonresponders*

<table>
<thead>
<tr>
<th>Source</th>
<th>Responders</th>
<th>Nonresponders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tavernier et al⁹</td>
<td>9 ± 3</td>
<td>12 ± 4†</td>
</tr>
<tr>
<td>Tousignant et al¹¹</td>
<td>15 ± 5‡</td>
<td>20 ± 5††</td>
</tr>
<tr>
<td>Feissel et al¹³</td>
<td>10 ± 4</td>
<td>10 ± 2</td>
</tr>
</tbody>
</table>

* Indicates significant difference.
PITFALL # 4

SUBJECTIVE ESTIMATION OF VOLUME STATUS IS ONLY APPROPRIATE AT EXTREME ENDS OF CARDIAC FILLING

LEFT VENTRICULAR END DIASTOLIC AREA IS NOT PREDICTIVE OF FLUID RESPONSIVENESS
PULMONARY EMBOLISM

CLINICAL CASE 5

- 22 year old female
- s/p MVA with Pelvic Fractures
- Hospital Day # 5
- Acute onset of hypoxia
- Concern: Pulmonary embolism
Pulmonary Embolism

Echo Findings of Cor Pulmonale:

- RV dilation
- RV pressure overload
- RV volume overload
- RV dyskinesia (McConnell’s Sign)
- IVC plethora
Pulmonary Embolism

Parasternal Long Axis
Pulmonary Embolism

Parasternal Short Axis

Tuesday, March 19, 13
Pulmonary Embolism

Apical 4-Chamber
Pulmonary Embolism

CLINICAL CASE 5

A CT Angio reveals...
PITFALL # 5

ECHOCARDIOGRAPHY IS *NOT SENSITIVE* FOR THE DETECTION OF PULMONARY EMBOLISM
Pulmonary Embolism

RV Pressure Overload
Pulmonary Embolism

RV Pressure Overload

Parasternal Short Axis View
- RV Dilation
- Systole septal flattening

↑↑RV Pressure
Pulmonary Embolism

McConnell’s Sign

RV free wall hypokinesis with apical sparing

Apical 4 Chamber View
Pulmonary Embolism

McConnell’s Sign

RV free wall hypokinesis with apical sparing

Normal RV Apex Motion

Apical 4 Chamber View
McConnell’s Sign
RV free wall hypokinesis with apical sparing

Apical 4 Chamber View

Hypokinetic RV Free Wall

Normal RV Apex Motion
McCONNELL’S SIGN

Regional Right Ventricular Dysfunction Detected by Echocardiography in Acute Pulmonary Embolism

Michael V. McConnell, MD, Scott D. Solomon, MD, Mamdouh E. Rayan, MD, Patricia C. Come, MD, Samuel Z. Goldhaber, MD, and Richard T. Lee, MD

This study analyzed the regional pattern of right ventricular (RV) dysfunction on transthoracic echocardiograms in patients with and without acute pulmonary embolism. Quantitative (centerline) and qualitative (wall motion score) analyses of segmental RV free wall motion were performed on a “training” cohort of 41 patients (group 1), including 14 patients with acute pulmonary embolism, 9 patients with primary pulmonary hypertension, and 18 normal subjects. Patients with acute pulmonary embolism had a distinct regional pattern of RV dysfunction, with akinesia of the mid–free wall (centerline excursion: −0.2 ± 0.8 mm, p = 0.0001 vs normal) but normal motion at the apex (centerline excursion: 5.7 ± 0.8 mm, p=NS vs normal). In contrast, patients with primary pulmonary hypertension had abnormal wall motion in all regions (p <0.03 vs normal). This echocardiographic finding of normal wall motion at the apex and abnormal wall motion in the mid–free wall in acute pulmonary embolism was then tested in a “validation” cohort of 85 patients (group 2), consisting of hospitalized patients with RV dysfunction from any cause, including 13 patients with acute pulmonary embolism. The finding had a 77% sensitivity and a 94% specificity for the diagnosis of acute pulmonary embolism, with a positive predictive value of 71% and a negative predictive value of 96%. Thus, a distinct echocardiographic pattern of regional RV dysfunction, in which the apex is spared, occurs in acute pulmonary embolism. This finding should raise the level of clinical suspicion for the diagnosis of acute pulmonary embolism.

(Am J Cardiol 1996;78:469–473)

77% Sensitivity
94% Specificity
• Although initially the McConnell sign was thought to be specific for PE, other studies could not replicate this specificity
Diagnostic Utility of Echocardiography in Patients With Suspected Pulmonary Embolism

CARLO BOVA, MD, FRANCESCO GRECO, MD, GIANFRANCO MISURACA, MD, OSCAR SERAFINI, MD, FRANCESCO CROCCO, MD, ANTONIO GRECO, MD, AND ALFONSO NOTO, MD


- If we look at the utility of echocardiography in the diagnosis of PE, the findings are not very encouraging....
- In this study enrolling large sample of unselected patients (outpatient as well as inpatient) the sensitivity of echocardiographic signs ranged from 30–50% and the specificity ranged from 87%–98%
- The sensitivity may increase, though, when patient with acute event and high suspicion for PE are being examined with echocardiography.
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The sensitivity may increase, though, when patient with acute event and high suspicion for PE are being examined with echocardiography.
CONCLUSIONS

- Most ICU echocardiography are focused exam
- Not all patients will have adequate images
- Must consider pre-existing disease when interpreting echocardiography
- Tamponade can be a challenge to diagnose, especially in the post-cardiac surgery patient
• Concurrent inotropic and mechanical support must be considered in evaluating cardiac function

• Subjective evaluation of intravascular volume status can be difficult, and must be done with caution

• Echocardiography is not sensitive for the detection of pulmonary embolism
Thank You!