Cardiogenic Shock: Complications of Acute MI

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No disclosures
MOC credits for attending Echo Hawaii

• Make sure you enter your ABIM number in your account with ASE
• RUC surveys for the AMA Specialty Society/ Relative Value Update Committee are used to set work RVUs. *This information is critical to ensuring appropriate valuation of echocardiography services!*

• Surveys are sent out from the American Medical Association to randomly selected US based physicians and generally take about 15-20 minutes to complete online.

• These surveys are the basis for Medicare and Commercial code valuation. Your input will help identify the time, intensity required and physician work to perform certain services for patients.

• Previous surveys have helped to establish the new interventional TEE code, (CPT® code 93355), update the existing TEE codes (93312-93318)

• **Surveys for TTE codes will be sent out in late February**

• For more information please go to: [http://asecho.org/what-is-the-ruc-and-ruc-survey/](http://asecho.org/what-is-the-ruc-and-ruc-survey/) or contact Irene Butler at ibutler@asecho.org.

• **Your participation does make a difference!**
Complications of MI: role of TTE & TEE

- **Ongoing chest pain**
  - ischemia
  - pericarditis
  - pulmonary embolism
  - pseudoaneurysm, subacute free wall rupture

- **Shock, hemodynamic compromise w/ or w/o new murmur**
  - mitral regurgitation
  - ventricular septal rupture
  - Primary LV failure
  - RV MI

- **Stroke**
  - LV thrombus

- **VT**
  - aneurysms
Cardiogenic shock

*dual role for echo*

- **Early**
  - differential diagnosis
    - confirm or establish the etiology of the hypotension
  - more rapid triage to appropriate therapy
    - Including mechanical circulatory support
  - assessing prognosis (LVEF, MR, RV function)

- **Later**
  - response to treatment
  - prognosis
Cardiogenic Shock (CS) after MI: etiologies and outcome from a large registry

- 1190 CS pts eligible but not randomized to SHOCK Trial (mechanical complications excluded)

- etiologies:
  - LV failure 78.5%
  - severe MR 6.9%
  - ventricular septal rupture 3.9%
  - isolated RV shock 2.8%
  - tamponade 1.4%
  - other (severe valve ds, hemorrhage, sepsis) 6.7%

- ventricular septal rupture - highest mortality (87.3%)

Hochman et al JACC 2000;36:1063-70
Cardiogenic shock: *Same clinical status, different echoes, different etiologies*

53 yo M hypotension within 12 hours of admission for MI

81 yo M with 3 vessel CAD including left main ds admitted with wheezing, hypotension and pulmonary edema
M.R. - 64 yo F with shock 15 days after first anterior MI

Hx of HTN, elevated chol; 2 weeks prior to transfer to MGH she presented to suburban hospital with evolving MI (saw PCP for GI upset, SOB).

No prior hx of angina

R/I for large anterior MI, recurrent CHF treated medically. Echo there - dilated LV, EF < 20%, moderate MR

on morning of d/c (day 15), in shower experienced chest pain and lightheadedness.
M.R. - 64 yo F with shock 15 days after first anterior MI

Progressive hypotension evolving to shock requiring intubation, levophed, dobutamine, dopamine

Med-flight to MGH

exam on TF - soft flow murmur, elevated neck veins

To cath lab for IABP and cor angio

echo in cath lab
M.R. - 64 yo F with shock 15 days after first anterior MI
M.R. - 64 yo F with shock 15 days after first anterior MI – ventricular septal rupture

Treatment

IABP

urgent surgery

saphenous vein graft to RCA (80% mid RCA, clean circ, proximal LAD recanalized)

LV opened through infarct, 1-1.5 defect in mid to apical septum, re-endothelialization with bovine pericardium patch, infarct trimmed, primary closure of VSD
Myocardial Perforation
septal, free wall, papillary muscle

• Typically occurs Day 2 – 8 post-MI
• Risk factors
  – 1° - Q waves, first MI
  – 2° - women > male, elderly, hypertensives
  – 3° - delayed recognition, continued physical activity
• 90 % fatal
• Pathophysiology
  – total or near-total occlusion of coronary artery with inadequate collateral circulation
rupture of the ventricular septum

• 0.5 - 2% of MIs; 1 - 5% of MI deaths
• exam -
  – new holosystolic murmur. +/- thrill, biventricular CHF, ↓CO, cardiogenic shock (exam may mimic pap mus rupture)
• anterior MI (60%) - apical septum
• inferior MI - basal septum (worse prognosis)
• pathophysiology
  – L to R shunt, RV volume overload, ↑PA flow, ↓systemic flow and CO, ↓BP
• RV function - important determinant of survival
Ventricular septal rupture - role of TEE

**pre-op planning**

- Location
  - antero-apex
    - involvement of free wall?
  - infero-basal
    - involvement of subvalvular apparatus (MV + TV)
- complex (multiple) vs. simple
- RV size and function
- severity of MR
57 yo M with fatigue

- chest pain and dyspnea while digging grave for pet
- Improved with massage
- Persistent fatigue
- Trouble sleeping
- thought symptoms due to stress at work
- 3 days later sees PCP
  - Inferior STE and Q waves
- Sent to community hospital ER
  - Murmur in ED, BP 110/60
  - Cardiol consult - Echo: high velocity flow in RV, ? VSR
- TF to MGH
Image similar to initial ER image
TTE by fellow on call
64 mm Hg gradient between ventricles
• Percutaneous device closure vs. surgical repair?
TEE to better define landmarks
Transesophageal Echocardiogram

- Overall normal LV systolic function with inferior WMA
- Large VSD from base of inferior septum (near insertion of AV valves) to inferior edge of posteromedial papillary muscle (LV orifice 24x16 mm by 3D imaging)
- Trace-mild MR, mild TR
- RV diffusely hypokinetic
- No PFO
- No pericardial effusion
VSR Morphology

• **Simple:**
  – Direct, “through-and-through”
  – Anteroapical septum

• **Complex:**
  – Hemorrhage with irregular, serpiginous tracts
  – Basal inferoposterior septum
  – May have concomitant ventricular free wall or papillary muscle tears

• Good surgical repair (defect and free wall) including CABG
• Long recovery due to slow recovery of RV function
Echo in Cardiogenic Shock: *Is TTE sufficient?*

- TEE when TTE does not reveal the answer
  - inadequate TTE
  - unexplained hemodynamic instability
    - small MI but cardiogenic shock
    - inadequate response to treatment
  - high index of suspicion of mechanical complication
76 yo F pulmonary edema and shock 48 hours after RCA stent for acute MI
PAPILLARY-MUSCLE RUPTURE

RUPTURE OF ENTIRE TRUNK

DEATH

RUPTURE OF ONE HEAD

SEVERE HEART FAILURE → SURVIVAL
Day 4 s/p IMI – collapses during cardiac rehab
Papillary muscle rupture: *flail mitral leaflet*

- 1% of MIs; 5% of MI deaths
- total rupture - rare (shock, fatal)
  partial rupture - more common

chest pain, hypotension, shock, initial period of stabilization followed by rapid unpredictable deterioration, pulmonary edema (asymmetric)

Exam - new, loud holosystolic murmur at apex (murmur decreases as BP falls); severe CHF
Papillary muscle rupture: *flail mitral leaflet*

- Important to distinguish etiology of MR as this will not improve with relief of ischemia
- Inferior MI > anterior MI
  - posteromedial PM > anterolateral PM
    (PDA)                  (LAD/Diag + Circ)
- Echo
  - small inferior WMA, whipping motion of tip of MV leaflet, complete transection rare - rupture of tip more common
  - imaging - sweep through entire valve
  - MR may be underestimated! - eccentric nature of jet, large regurgitant orifice
67 yo M with acute MI – hypotension at presentation; primary PTCA of culprit circ lesion. Return to cath lab 12 hours later for re-look due to persistant hypotension – circ open. TTE in CCU
Subacute rupture

• Same risk factors, presentation different
• moderate pericardial effusion
  – with tamponade - modest progressive hypotension
  – without tamponade
• management
  – surgery vs. medical therapy

• Difficult TTE/TEE diagnosis
  – Role of contrast
TEE in subacute free wall rupture

• Rare, case reports

• TEE findings
  – discontinuity of wall or marked thinning of wall
  – thinned akinetic wall
  – pericardial effusion +/- thrombus in pericardial space
  – low velocity Doppler flow in myocardium

• LV contrast
  – delineate serpiginous channels, opacify pericardial space
Elderly diabetic, hypertensive women with 3 days of chest pain and dyspnea found unresponsive at home revived and then transferred from community hospital for R/O aortic dissection

TEE at MGH ER negative for dissection, however……..
Surgical findings

- Thinned inferior wall
- Pericardial hematoma
- Myocardial hemorrhage
- Multiple complex serpiginous tracts in the inferior wall
RV infarction

• RV involvement in 1/3 of inferior MIs
• Symptoms, signs
  – Systemic hypotension
  – RV failure
    • elevated JVP, clear lungs
• Echo
  – RV enlargement
  – RV free wall - abnormal motion
  – TR, thrombus, RV aneurysm
  – “stretched” PFO (r to l shunt)
RV MI
suggested indications

- Short term support (or stabilization for transfer)
- High risk interventions
  - PCI, perc valve, VT ablation
- Post-cardiotomy
- Cardiogenic shock anticipated to be quickly reversible
  - Revascularized acute MI
- Decompensated heart failure
- Complications of acute MI, Acute valve failure (pre-op)
- Impaired oxygenation

Rihal et al, JACC 2015;65:e7-e26
ASE GUIDELINES & STANDARDS

Echocardiography in the Management of Patients with Left Ventricular Assist Devices: Recommendations from the American Society of Echocardiography

Raymond F. Stainback, MD, FASE, Chair; Jerry D. Estep, MD, FASE, Co-Chair; Deborah A. Agler, RCT, RDCS, FASE; Emma J. Birks, MD, PhD, Merri Bremer, RN, RDCS, EdD, FASE, Judy Hung, MD, FASE, James N. Kirkpatrick, MD, FASE, Joseph G. Rogers, MD, and Nishant R. Shah, MD, MSc, Houston, Texas; Cleveland, Ohio; Louisville, Kentucky; Rochester, Minnesota; Boston, Massachusetts; Philadelphia, Pennsylvania; and Durham, North Carolina

(J Am Soc Echocardiogr 2015;28:853-909.)
## Types of Mechanical Support

<table>
<thead>
<tr>
<th>Device</th>
<th>Remove Blood From</th>
<th>Inject Blood Into</th>
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</thead>
<tbody>
<tr>
<td>IABP</td>
<td>Aorta</td>
<td>aorta</td>
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<tr>
<td>ECMO (VA)</td>
<td>RA</td>
<td>Descending aorta</td>
</tr>
<tr>
<td>Tandem Heart</td>
<td>LA</td>
<td>Descending aorta</td>
</tr>
<tr>
<td>Impella</td>
<td>LVOT</td>
<td>Ascending aorta</td>
</tr>
<tr>
<td>LVAD</td>
<td>LV apex or LA</td>
<td>Ascending Ao Pulm artery</td>
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<tr>
<td>RVAD</td>
<td>RV</td>
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<tr>
<td>BiVAD</td>
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</tr>
<tr>
<td>ECMO (VV)</td>
<td>Venous or RA</td>
<td>Pulm Artery</td>
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Mechanical complications of MI

**conclusions**

- May mimic other problems
- Prompt recognition and intervention can reduce the high mortality
- Key to early diagnosis:
  - High index of suspicion
  - Use of bedside noninvasive imaging
    - TTE, TEE, contrast