Cath Lab Disasters--
Disclosures

- No relevant conflicts
Cath Lab Disasters

- 46 y.o. presented with respiratory distress and inferior STEMI
- Cath –RCA occlusion– underwent BMS with reperfusion, 100% circ and 90% ramus
- IABP placed via L F
- ECHO
Cath Lab Disasters

- VT/VF arrest
- E-CPR ECMO code activated
- VA ECMO initiated via RFV, RFA
- CTICU
  - Cooling protocol
  - Right leg ischemia— perfusion catheter placed
  - Minimal ejection, clot in LV
  - Anticoagulation— cath lab for impella placement to decompress LV
Cath Lab Emergencies

- Neuro intact/negative head CT
- Improved pulmonary edema/improved organ function
- OR 2 days later—MVR, tricuspid annuloplasty, CABG X 3, open chest, Impella in place, ECMO decannulated
Cath Lab Emergencies

- Day 2, washout, Impella removal, chest closure, IABP placement, femoral artery repair
- Multiple complications
  - Delirium
  - Ileus
  - ARF
- D/C home POD 28, Cr 1.4 normal ambulation
Cath Lab Disasters

- Definition—survival will be significantly impaired without emergency cardiac surgical intervention

- **Pump Failure** (threat of failure)
  - Acute MI/ Unstable coronary ischemic syndrome—no PCI options
    - With or without Cardiogenic shock
  - Mechanical complications of Acute MI
    - Post-Infarct VSD
    - Ruptured Papillary Muscle
Cath Lab Disasters

- **Bleeding** (imminent threat of bleeding)
  - Iatrogenic Perforation/ Structural Disruption
  - Device Embolization
  - Ventricular Wall Rupture
  - Thoracic Aortic Disease—dissection/ aneurysm

```
Surgical candidate
  yes
  ↓
  Arrest/absent circulation
    yes
    ↓
    Aortic dissection
      yes
      ↓
      OR vs. futile
        yes
        ↓
        VA ECMO??
          then OR
          High risk interventions best done in OR
        no
        ↓
        OR repair
    no
    ↓
    OR repair
  no
```
6. Coronary Artery Bypass Graft Surgery: Recommendations

6.1. CABG in Patients With STEMI

**Class I**

Urgent CABG is indicated in patients with STEMI and coronary anatomy not amenable to PCI who have ongoing or recurrent ischemia, cardiogenic shock, severe HF, or other high-risk features.\(^{150-152}\) (Level of Evidence: B)

CABG is recommended in patients with STEMI at time of operative repair of mechanical defects.\(^{153-157}\) (Level of Evidence: B)

**Class IIa**

The use of mechanical circulatory support is reasonable in patients with STEMI who are hemodynamically unstable and require urgent CABG. (Level of Evidence: C)

**Class IIb**

Emergency CABG within 6 hours of symptom onset may be considered in patients with STEMI who do not have cardiogenic shock and are not candidates for PCI or fibrinolytic therapy. (Level of Evidence: C)
9.1. Cardiogenic Shock

9.1.1. Treatment of Cardiogenic Shock: Recommendations

*Class I*

Emergency revascularization with either PCI or CABG is recommended in suitable patients with cardiogenic shock due to pump failure after STEMI irrespective of the time delay from MI onset.\(^212,379,452\) (Level of Evidence: B)

In the absence of contraindications, fibrinolytic therapy should be administered to patients with STEMI and cardiogenic shock who are unsuitable candidates for either PCI or CABG.\(^81,453,454\) (Level of Evidence: B)

*Class IIa*

The use of intra-aortic balloon pump (IABP) counterpulsation can be useful for patients with cardiogenic shock after STEMI who do not quickly stabilize with pharmacological therapy.\(^455–459\) (Level of Evidence: B)

*Class IIb*

Alternative LV assist devices for circulatory support may be considered in patients with refractory cardiogenic shock. (Level of Evidence: C)
One-Year Survival Following Early Revascularization for Cardiogenic Shock
Judith S. Hochman, MD; Lynn A. Sleeper, ScD; Harvey D. White, DSc; Vladimir Dzavik, MD; S. Chiu Wong, MD; Venu Menon, MD; John G. Webb, MD; Richard Steingart, MD; Michael H. Picard, MD; Mark A. Menegus, MD; Jean Boland, MD; Timothy Sanborn, MD; Christopher E. Buller, MD; Sharada Modur, MS; Robert Forman, MD; Patrice Desvigne-Nickens, MD; Alice K. Jacobs, MD; James N. Slater, MD; Thierry H. LeJemtel, MD; for the SHOCK Investigators

Cath lab Emergencies

- Outcomes with surgery for pump failure indications
  - Profound shock—40-60% mortality
  - Post infarct VSD—23-53% mortality
    - Lower mortality in patients who could tolerate delayed intervention
  - Ruptured papillary muscle—20-40% mortality
  - No significant changes in outcomes over the last 3 decades

- Mortality Etiology
  - MOSF
  - Neurologic
  - Sequela of persistent hypoperfusion—low cardiac output +/- impact of inotrophic/vasoconstrictor agents
Cath Lab Disasters—shift the focus from getting to the OR quickly to establishing adequate perfusion

- Focus on hemodynamic status
  - CPR/arrest
  - Shock
  - **Stable/ mild hypoperfusion**

- Candidacy Assessment-- Would they have been a candidate for intervention in an elective situation??
  - Life expectancy
  - Baseline function

- Organ Function
  - Neurologic
  - Cardiac (ventricular function)
  - Pulmonary
  - Renal
  - Hepatic
Use of ECMO to reduce Mortality

Schematic presentation of the enrollment status of the patients. ECMO, extracorporeal membrane oxygenator. * vs. †, p = .347;

Early extracorporeal membrane oxygenator-assisted primary percutaneous coronary intervention improved 30-day clinical outcomes in patients with ST-segment elevation myocardial infarction complicated with profound cardiogenic shock

Jiunn-Jye Sheu, MD; Tzu-Hsien Tsai, MD; Fan-Yen Lee, MD; Hsiu-Yu Fang, MD; Cheuk-Kwan Sun, MD, PhD; Steve Leu, PhD; Cheng-Hsu Yang, MD; Shyh-Ming Chen, MD; Chi-Ling Hang, MD; Yuan-Kai Hsieh, MD; Chien-Jen Chen, MD; Chiung-Jen Wu, MD; Hon-Kan Yip, MD
eCPR Patient Selection - Exit Strategy

- Bridge to Recovery
- Bridge to Transplant
- Bridge to VAD

Exclusion Criterion
- Permanent end organ dysfunction
- Advanced age
- Aortic insufficiency
- Out of hospital arrest
Veno-Arterial ECLS

- Cannulation
  - Fem-Fem
  - Ax-Fem
  - Central
  - RIJ-Fem
  - RIJ-Ax
  - Carotid-IJ (Peds only)
Indications for VA ECLS

- Cardiopulmonary Failure
  - Acute myocardial infarction (VA)
    - 6% MI patients have cardiogenic shock
    - 60% mortality
  - Myocarditis (VA)
  - Chronic cardiomyopathies (VA)
  - Post cardiotomy shock (VA)
    - 80% mortality

- High risk PCI or EP ablation
VA ECLS - Advantages

- Bedside/ICU/Cath lab deployment
- Inexpensive (relative to VAD/Impella)
- Minimally invasive (peripheral cannulation)
- Biventricular support
- Pulmonary Support
VA-ECLS - Disadvantages

- Labor intensive
  - Close PTT monitoring
  - Continuous bedside equipment monitoring
- Patient potentially immobilized
- LV distension
  - Limits LV recovery
  - Pulmonary Edema/Injury
- Higher risk of stroke
- Limb ischemia with Fem-Fem cannulation
  - 5 Fr cannula in SFA
Cannulation strategy

- Traditionally femoral arterial access
  - 10-16% complication rate (primarily limb ischemia)\(^1\)

- Subclavian arterial cannulation as alternative
  - Offers mobility, root and brain perfusion
  - Also has 15% complication rate\(^2\)
    - Bleeding, hematoma, arm hyperperfusion, Venous hypertension and arm swelling

Cardiac/Cerebral Hypoxia

- Fem-Fem VA ECLS
- LV Ejection in the setting of pulmonary failure
- Hypoxic blood perfusion of Coronary vessels and carotids

- Monitor Right Arm sPO2 and ABG to best approximate coronary blood flow oxygenation
- Improve RV drainage (with larger/more venous cannula)
- LV Venting
Mini-thoracotomy Cannulation

- To date, 8 patients
  - 4 deaths
    - All emergent cannulation, no neuro recovery
  - 4 alive
    - All 4 ambulated on ECLS
    - 3 bridge to durable LVAD (1 subsequently transplanted)
    - 1 bridge to recovery
Fig. 3. Fluoroscopy of the Cribriform closure device being positioned across the defect.
Case Report

- 57 yo male with HTN, CRI presents with 3 days of worsening chest pain
- Admitted from ED with positive enzymes and pulmonary edema
- Cath reveals RCA occlusion and posterior VSD, LVEF 35%.
- Intubated and IABP for shock
Case Report

- Underwent attempt surgical repair
- Recurrent edema and shock with TEE of repair breakdown
- Reoperation with second attempted repair
- Recurrent VSD necessitating VA ECMO with central cannulation
VA ECMO Open Chest
Central Cannulation
HVAD sewing rings attached at mitral and tricuspid annuli
Total Artificial Heart
Two HVAD devices
Conclusions

• Cath lab disasters are associated with substantial mortality and morbidity with little changes in modern era with current techniques

• Improvement in ECMO and other heart assist technologies offer an opportunity to substantially change care paradigms and outcomes

• Focus on early re-establishment of perfusion to bridge to decision making and recovery