HEART FAILURE: IMPACT AND IMPLICATIONS IN ANESTHESIA

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Disclosures

- No financial disclosures
Heart Failure for the Anesthesiologist in 2016

- Epidemiology
- The problem for us
- Special problems for anesthesiologists
  - HTN
  - Obesity
  - Sleep Apnea
  - RV Failure
- New therapies
Heart Failure: Epidemic?
Before surgery
After Surgery
Defining the problem

- ACC/AHA 2014 Guidelines on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Non Cardiac Surgery

- Large Focus on concerns for Perioperative MI

Functional Capacity

- 4 METs (!??! Self reported ????)
  - < 4METs
  - 4-10 METs
  - > 10 METs

- 1 MET = Resting Metabolic rate
  - 3.5 ml O₂/kg/min
Supply and Demand

- VO$_2$ max = anaerobic threshold
- Post-op oxygen consumption = 4-5 ml O$_2$/kg/min

To sustain post-op:

- Patient needs VO$_2$ max of at least 2.5 times resting metabolic rate post-op (5 ml O$_2$/kg/min)
- Minimum VO$_2$ max = 12.5 ml O$_2$/kg/min
- 3.5 METs

What is 4 METs?

- On a Treadmill:
  - 3 minutes at 3.0 mph/2.5% grade
    - (4.82 km/h)

- Very slow effort
Estimated Energy Requirements

- 1 MET
  - Can you...Take care of yourself?
  - Eat, dress, or use the toilet?
  - Walk indoors around the house?
  - Walk a block or 2 on level ground at 2 to 3 mph?
  - Do light work around the house?

- 4 METS
Estimated Energy Requirements

- 4 METS
  - Can you ... Climb a flight of stairs or walk up a hill?
  - Walk on level ground at 4 mph?
  - Run a short distance?
  - Do heavy work around the house?
  - Participate in moderate recreational activities?

- Greater than 10 METS
  - Participate in strenuous sports?
BUT, ARE WE LOOKING AT THE RIGHT THING?
ASA Closed Claims Data

- In the last 35 years

- Decrease in Respiratory complications 50%

- Decrease in Cardiovascular complications < 5%
Readmissions after Surgery

- 13,062,937 patients
- 19.6 % readmitted within 30 days
- #1 Cause of readmission: non ischemic CHF
  - Preop CHF: 37% readmitted post-op

- Cost to system ??!!????
- Cost to patients ??!!????
- Can we identify them pre-op?

**Independent Clinical Markers of Elevated Periop risk**

**Older DATA**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Relative Risk</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known CAD</td>
<td>2.4</td>
<td>1.3-4.2</td>
</tr>
<tr>
<td>Prior CHF</td>
<td>1.9</td>
<td>1.1-3.5</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3.0</td>
<td>1.3-7.1</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>3.0</td>
<td>1.4-6.8</td>
</tr>
</tbody>
</table>

Lee et al. Arch Int Med 1999:159:2185-2192
Newer DATA

Relative risk

Known CAD 1.1

Prior CHF 2.57

“Risk of mortality was 87% higher in CHF group compared to control or CAD group.”

Hammill BG et al. Anesthesiology 2008;108:559-567
Independent Clinical Markers of Elevated Perioperative Risk

Newer DATA

- “Elderly patients with heart failure who undergo major surgical procedures have substantially higher risks of operative mortality and hospital readmission than other patients, including those with coronary disease…”

Hammill BG et al. Anesthesiology 2008;108:559-567
Scope of the Problem in USA

Heart Failure is common

995,000 hospitalizations as primary diagnosis (increased 164% over 15 years)
2.5 million hospitalization as secondary diagnosis

12 to 15 million physician visits

6.5 million hospital days

In-hospital mortality = 5-8%

1-year mortality can be as high as 40-60%

1.2 million NYHA III-IV
Periop Mortality at 30 days

- Mortality and Readmission of Patients with Heart Failure, Atrial Fibrillation or CAD undergoing non cardiac surgery
- 38,047 Patients

Mortality at 30 days

# Unadjusted 30-Day Perioperative Mortality in Minor Procedures


<table>
<thead>
<tr>
<th>Minor Procedure Category</th>
<th>Non ischemic HF N(%)</th>
<th>Ischemic HF N(%)</th>
<th>CAD N(%)</th>
<th>AF N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL</td>
<td>511 (8.5)</td>
<td>782 (8.1)</td>
<td>266 (2.3)</td>
<td>177 (5.7)</td>
</tr>
<tr>
<td>In-patient</td>
<td>367 (14.7)</td>
<td>429 (13.2)</td>
<td>191 (8.5)</td>
<td>131 (13.4)</td>
</tr>
<tr>
<td>Out-patient</td>
<td>144 (4.1)</td>
<td>278 (4.8)</td>
<td>75 (0.8)</td>
<td>46 (2.2)</td>
</tr>
</tbody>
</table>
Scope of the Problem

- **Population involved**
  - 5 million Americans
  - 15 million Europeans

- **New Heart failure in USA**
  - 670,000 new patients each year in people over 45
  - Lifetime risk of heart failure: 20%
  - Most common diagnosis for hospital admissions in USA

- **Cost in USA**: $34 billion dollars per year
  - No disease is more expensive

Gheorghiade et al. JACC 2009; 53: 557-573
Classifications of Heart Failure

- Heart failure stages A-B-C-D
  - Different than functional classes
- Acute vs Chronic
- Low LVEF vs Normal LVEF
- Right failure VS Left failure
Heart Failure Progression

Goodlin JACC 2009; 54: 386-396
Therapeutic Options

**Stage A**
High risk with no symptoms

**Stage B**
Structural heart disease, no symptoms

**Stage C**
Structural disease, previous or current symptoms

**Stage D**
Refractory symptoms requiring special intervention

- Hospice
- VAD, transplantation
- Inotropes
- Aldosterone antagonist, nesiritide
- Consider multidisciplinary team
- Revascularization, mitral-valve surgery
- Cardiac resynchronization if bundle-branch block present
- Dietary sodium restriction, diuretics, and digoxin
- ACE inhibitors and beta-blockers in all patients
- ACE inhibitors or ARBs in all patients; beta-blockers in selected patients
- Treat hypertension, diabetes, dyslipidemia; ACE inhibitors or ARBs in some patients
- Risk-factor reduction, patient and family education
Heart Transplant – Worldwide Experience

NOTE: This figure includes only the heart transplants that are reported to the ISHLT Transplant Registry. As such, the presented data may not mirror the changes in the number of heart transplants performed worldwide.
Bridge to Transplantation

Heart Transplantation
Survival long term

Risk Factors for Heart Failure

- Major clinical risk factors
  - Age, male sex
  - Hypertension, LVH
  - Myocardial infarction
  - Diabetes mellitus
  - Valvular heart disease
  - Obesity

Horwich et al. JACC 2010; 55: 283-293
Prevalence of Disease in the Baby Boomers

- Obesity 77%
- Hypertension 55%
- Hypercholesterolemia 27%
- Smokers 16%
- Valvular heart Disease 10%
- Diabetes 10%
- Coronary heart disease 7%

Jessup et al. JACC 2009; 53: 1343-1382
Risk Factors for Heart Failure

- **Minor Clinical risk factors**
  - Smoking
  - Dyslipidemia
  - **Sleep-disordered breathing**
  - Chronic kidney disease
  - Albuminuria
  - Homocysteine
  - Immune activation, IGF-1, TNF-alpha, IL-6, CRP
  - Natriuretic peptides
  - Anemia
  - Dietary risk factors
  - **Increased HR**
  - Sedentary lifestyle
  - Low socioeconomic status
  - Psychological stress

- **Toxic risk precipitants**
  - Chemotherapy (anthracyclines, cyclophosphamide, 5-FU, trastuzumab)
  - Cocaine, NSAIDs
  - Thiazolidinediones
  - Doxazosin
  - Alcohol

- **Genetic risk predictors**
  - SNP (e.g., alpha-2CDel322-325, beta-1Arg389)

- **Morphological risk predictors**
  - Increased LVID, mass
  - Asymptomatic LV dysfunction
  - LV diastolic dysfunction

Horwich et al. JACC 2010; 55: 283-293
Heart failure symptoms

Goodlin JACC 2009; 54: 386-396
Heart Failure: Acute Episode

- Patient Characteristics:
  - 20%: Failure for the first time (no previous history)
  - 53% female
  - Most common symptom: Dyspnea on exertion
    - 2nd: Peripheral edema
  - Associated disease:
    - 70%: HTN
    - 30%: atrial fibrillation
    - 30%: Chronic renal failure
    - 60%: CAD
  - 55%: Preserved LVEF

Gheorghiade et al. JACC 2009; 53: 557-573
Heart Failure: Acute Episode

- Precipitant Factors:
  - Fluid overload
    - Not low cardiac output
  - Recent surgery/intervention
  - Uncontrolled HTN
  - Ischemia (acute coronary syndrome)
  - New onset atrial fibrillation

Gheorghiade et al. JACC 2009; 53: 557-573
Heart Failure: Acute Episode

- Pathophysiology
  - Congestion
    - High LVEDP
    - Pulmonary + Systemic congestion
    - With or Without Low CO
    - May have acute increase in Afterload
      - Worse diastolic dysfunction
  - Myocardial Injury
    - Supply and Demand mismatch
  - Renal impairment
    - Cardio-renal syndrome
  - Untoward Drug effects

Gheorghiade et al. JACC 2009; 53: 557-573
Heart Failure: Acute Syndrome

- Therapy:
  - LV dysfunction
  - Congestion
  - Ischemia/CAD
  - Atrial Fibrillation
  - Hypertension

Gheorghiade et al. JACC 2009; 53: 557-573
Heart Failure: Chronic

- LV progressively Dilates and/or Hypertrophies
- Spherical remodeling

- Increased Wall Tension
- Worsening Mitral Regurgitation

- Further
  - Dilation and Contractile Dysfunction

- Further
  - Remodeling
Heart Failure: Chronic
Mechanical Dyssynchrony in Heart Failure

- CRT: Cardiac Resynchronization Therapy
- Internal Cardiac Defibrillator (ICD)

Nagueh JACC 2008; 51: 18-22
Anemia and Heart Failure

- **Definition of anemia:**
  - Hb < 12 g/dl in women
  - Hb < 13 g/dl in men

- **Prevalence: 7-50%**
  - Anemia associated with an increased risk of mortality in both systolic HF and diastolic HF

Hessel F et al. JACC 2008; 52: 818-827
Systolic Heart Failure

- Anesthetic Challenges
  - ICD impact
  - Electrolyte and anticoagulation issues
  - Fluid management
  - Intracardiac pressure management
  - Preload
  - Afterload
  - Contractility
  - Heart rate and rhythm
  - RVAD and/or LVAD in place?
Heart Failure

Conclusions: Diastolic dysfunction as rigorously defined by comprehensive Doppler techniques is common, often not accompanied by recognized CHF, and associated with marked increases in all-cause mortality

Redfield et al. JAMA 2003; 289:194-202
“55 to 70 % of CHF patients have Normal LVEF (Systolic Function)”

Aurigemma, GP. NEJM 2006; 355:308-310
<table>
<thead>
<tr>
<th></th>
<th>HF with impaired LVEF</th>
<th>HFNEF</th>
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<tbody>
<tr>
<td>LV morphology</td>
<td>[Image]</td>
<td></td>
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<tr>
<td>Pressure-volume loop</td>
<td>[Image]</td>
<td>[Image]</td>
</tr>
<tr>
<td>LV pressure</td>
<td>[Image]</td>
<td>[Image]</td>
</tr>
<tr>
<td>LV volume</td>
<td>[Image]</td>
<td>[Image]</td>
</tr>
<tr>
<td>LVEDV</td>
<td>↑</td>
<td>normal</td>
</tr>
<tr>
<td>LV mass</td>
<td>eccentric LV hypertrophy</td>
<td>concentric LV hypertrophy or concentric LV remodeling</td>
</tr>
<tr>
<td>Left atrium</td>
<td>dilated</td>
<td>dilated</td>
</tr>
<tr>
<td>LVEF</td>
<td>↓</td>
<td>normal</td>
</tr>
<tr>
<td>dp/dt</td>
<td>↓</td>
<td>normal</td>
</tr>
<tr>
<td>LVEDP</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>β</td>
<td>normal</td>
<td>↑</td>
</tr>
<tr>
<td>E/E'</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>BNP/NT-proBNP</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>
Heart Failure with Normal LVEF

Symptoms/signs of HF

LVEF > 50% and LVEDVI < 97 ml/m²

Evidence of abnormal LV relaxation, filling, diastolic distensibility, and diastolic stiffness

Invasive measurements
• mPCWP > 12 mmHg
• LVEDP > 16 mmHg
• τ > 48 ms
• b > 0.27

Echo TDI
• E/E’ > 15
• 8 < E/E’ < 15

Natriuretic peptides
• NT-proBNP > 220 pg/ml
• BNP > 200 pg/ml

Natriuretic peptides
• E/A ↓, DCT ↑
• abnormal pulmonary venous flow
• left atrial dilation
• LVH
• atrial fibrillation

HFNEF

TDI
• E/E’ > 8
Diastolic Dysfunction

Graph showing the relationship between diastolic pressure (mmHg) and LV diastolic volume (mL). Points A, B, C, and D represent different stages of diastolic dysfunction, with A being normal, B showing an increase in EDV (DHF), C indicating HFNEF (DHF) with normal EDV, and D showing HFNEF with increased EDV.
Detection subclinical LV systolic and diastolic dysfunction

- Early detection associated with better outcome
- Avoiding/delaying 1st episode Acute heart failure syndrome: lower mortality

2009 Focused update: ACCF/AHA Guidelines for Diagnosis and Management of Heart Failure in Adults
Jessup et al. JACC 2009; 53: 1343-1382
Echo vs heart cath

Kirkpatrick et al. JACC 2007; 50: 381-396
B-Type Natriuretic Peptide and Left Ventricular Diastolic Function

Troughton et al. JACC imaging 2009; 2: 216-225
Integrating BNP and Echo

Acute dyspnea presenting to the emergency room

If BNP / NT-proBNP Level

~40%

- BNP < 100 pg/ml
- NT-proBNP < 300 pg/ml

- Restrictive transmitral filling pattern or Doppler evidence of elevated filling pressures
  - Not Heart Failure (<5% likely)
  - ~15%

~30%

- 100 > BNP < 500 pg/ml
- 300 > NT-proBNP > 1800 pg/ml*

- ~15%

~30%

- BNP > 500 pg/ml
- NT-proBNP > 1800 pg/ml*

- ~15%

Heart Failure almost certain (>90% likely)

Troughton et al. JACC imaging 2009; 2: 216-225
Dyspnea differential diagnosis

**Shortness of breath and LVEF >50%**

- **Cardiac causes**
  - HFNEF
  - Other Cardiac Entities
    - Coronary artery disease
    - Valvular heart disease
    - HOCM
    - Restrictive CMP
    - Constrictive pericarditis
    - Intracardiac shunt

- **Non-cardiac causes**
  - Lung disease
  - Obesity
  - Deconditioning
  - Anemia
  - Hyperventilation
  - Thyrotoxicosis
  - PAHT
  - Extracardiac shunt
Causes of Diastolic Heart Failure

- Hypertensive Heart Disease
- Cardiomyopathies
  - Hypertrophic, Dilated, Restrictive
- Valvular Heart Disease
- Pericardial Disease
- Coronary Artery Disease
Prevalence of Diastolic Dysfunction

<table>
<thead>
<tr>
<th>% of patients affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
</tr>
<tr>
<td>45-54</td>
</tr>
<tr>
<td>55-64</td>
</tr>
<tr>
<td>65-74</td>
</tr>
<tr>
<td>Mild</td>
</tr>
<tr>
<td>5 %</td>
</tr>
<tr>
<td>13 %</td>
</tr>
<tr>
<td>34 %</td>
</tr>
<tr>
<td>Moderate</td>
</tr>
<tr>
<td>1.5 %</td>
</tr>
<tr>
<td>6 %</td>
</tr>
<tr>
<td>10 %</td>
</tr>
<tr>
<td>Severe</td>
</tr>
<tr>
<td>1 %</td>
</tr>
<tr>
<td>2 %</td>
</tr>
<tr>
<td>3 %</td>
</tr>
</tbody>
</table>

Increased Mortality Rate in ALL Groups

Redfield et al. JAMA 2003; 289:194-202
Diastolic Dysfunction for the periop physician:

- Flash pulmonary edema
- Extreme sensitivity to increase in EDV (fluid overload)
  - Delayed pulmonary edema with fluid shifts
- Extreme sensitivity to decrease diastolic time (tachycardia)

- Identification of these patients is essential to us PRIOR to the periop period.
Recent periop data
Diastolic dysfunction and periop risk

- Diastolic dysfunction associated with worse outcomes after vascular surgery
  - More post-op CHF
  - Increased length of stay
- Asymptomatic LV dysfunction (systolic and diastolic) is associated with worse outcome after open vascular surgery

Flu et al. Anesthesiology 2010;112:1316-1324
Recent data
Diastolic dysfunction and periop risk

- Diastolic dysfunction is associated with increased incidence of post-op cardiac events (CHF) and death at 30 days.

- “Routine resting echocardiography should be used to assess LV systolic and diastolic function in asymptomatic patients undergoing high-risk non-cardiac surgery.”

Flu et al. Anesthesiology 2010;112:1316-1324
Groban et al. Anesthesiology 2010;112:1303-1306
Clinical Implication

IF YOU DON’T LOOK,
YOU DON’T KNOW !!!
How can we identify the patients at risk?
Focused Transthoracic Echocardiography

Quick Evaluation

Can be performed by Anesthesiologist

Systolic Function
Valvular Function
Diastolic Function
Filling Pressures
Volume Status

Manecke, GR et al. Journal of Cardiovascular and Thoracic Anesthesia. 2009; 447-449
Focused Transthoracic Echocardiography PRE-OP

- Anesthesiologists able to obtain images in 98% of patients
  - Diagnostic Quality images
- Major findings correlated with “formal cardiology-based TTE” in 87% of cases
- Results of Focused TTE changed periop care in 84% of cases

When should we have a preop TTE?

Patient 55 yo and over with:
- HTN
- Diabetes
- Obesity
- Smoker
- Sleep Apnea
- Murmur
- CAD
- Afib
- CHF
- Chest Pain
- SOB
- Palpitation
- Syncope

“EGHEM”

Pre-op TTE for identification of patients at risk of peri-op CHF

Not useful if nothing is done about the result!
Hypertensive Heart disease

- 3 X the risk of Heart Failure
  - lifetime risk: 60%

- Disease that includes:
  - Left Ventricular Hypertrophy
  - Diastolic Dysfunction
  - Systolic Dysfunction
  - Dysrhythmias
  - Symptomatic Heart Failure

Drazner Circulation 2011; 123: 327-334
Obesity
Obesity

- Risk of heart failure increases:
  - 5% for men
  - 7% for women
  - FOR EVERY POINT INCREASE IN BMI

Horwich et al. JACC 2010; 55: 283-293
Obesity and Heart Failure

Horwich et al. JACC 2010; 55: 283-293
Obesity Cardiomyopathy

- Diabetic Cardiomyopathy
- Insulin-resistant Cardiomyopathy
- “Obesity Paradox”
  - Better survival after onset of heart failure
    - Earlier detection?
    - Protective effect from lipoprotein-mediated down regulation of cytokines?
    - Greater metabolic reserve to surmount catabolic and inflammatory stresses of cardiac cachexia?

Horwich et al. JACC 2010; 55: 283-293
Obesity and Heart Failure

Excessive Adipose Accumulation

- Sleep Apnea/Obesity Hypoventilation Syndrome
  - Hypoxia/Acidosis
    - Pulmonary Arterial Hypertension
    - Pulmonary Venous Hypertension
- ↑Systemic Vascular Resistance
  - No Change in Heart Rate
    - RV Hypertrophy and Enlargement
      - RV Failure
    - ECCentric LV Hypertrophy
      - LV Diastolic and Systolic Dysfunction
      - LV Diastolic Dysfunction
- ↑Circulating Blood Volume
  - ↑LV Stroke Volume
    - ↑Cardiac Output
      - LV Enlargement
        - ↑LV Wall Stress
          - LV Failure

Lavie et al. JACC 2009; 53: 1925-1932
Obesity and Heart Failure

- Most at risk in men:
  - Obese men, physically inactive
  - Obese men, active
  - Overweight men, inactive
  - Overweight men, active

- Better
  - Lean men, active

Horwich et al. JACC 2010; 55: 283-293
Obstructive Sleep Apnea and Heart Failure
Obstructive Sleep Apnea and Heart Failure

Kasai et al. JACC 2011; 57: 119-127
Kasai et al. JACC 2011; 57: 119-127
Heart Failure Mortality and Sleep Apnea

Kasai et al. JACC 2011; 57: 119-127
Incidence of sleep apnea in heart failure population

Kasai et al. JACC 2011; 57: 119-127
Effect of CPAP therapy

- Stops nocturnal BP and HR swings
- Reduces LV afterload
- Increases LVEF (average 10%) within 3 months
- Decreased sympathetic vasoconstrictor activity
- Increased parasympathetic modulation of HR

Kasai et al. JACC 2011; 57: 119-127
Right Ventricular Failure

- Dilatation (stretching)
- Hypertrophy (overgrowth of cells)
Right Ventricular Failure

- Causes:
  - Left ventricular dysfunction
  - RV ischemia
  - RV afterload increase
  - RV preload decrease
  - Intrinsic myocardial disease
  - Congenital and Valvular heart disease
  - Pericardial disease
  - Dysrhythmias

Lahm et al. JACC 2010; 56: 1435-1446
Right Ventricular Failure

- Diagnosis
  - Echocardiography and perhaps PAC
    - TTE and TEE
    - Most reliable for diagnosis and for evaluation of treatment response

Lahm et al. JACC 2010; 56: 1435-1446
RV Failure in cardiac surgery

RV Failure: Anesthetic implication

- Suspect RV issues in high risk groups
- Look
RV Failure: Anesthetic implication

- Potential hemodynamic collapse at induction
  - Poor tolerance of RV preload sudden decrease
  - Poor tolerance of RV afterload sudden increase
New therapies

- Ventricular assist devices
- Stem cell therapies for the heart
Ventricular Assist Devices

- University of Utah Tradition
- Utah Artificial Heart Institute
Left Ventricular Assist Devices

- Acute or Chronic Support
- Bridge to recovery
- Bridge to Transplantation
- Destination Therapy
Left ventricular assist devices –
Smaller and faster

2 pounds
7-12 Hours
Destination Therapy

- Pumps available
  - Heartmate XVE, Heartmate-II, Heartware (FDA approved)
  - Trials: Debakey, Duraheart, Jarvik 2000, Levacor

- Reasons for Transplant Ineligibility
  - Age
  - Diabetes
  - Renal failure/insufficiency
  - Obesity
  - Pulmonary hypertension
  - COPD
  - Smoking
  - History of malignancy
  - Peripheral vascular disease
Destination Therapy – Rematch Trial

<table>
<thead>
<tr>
<th></th>
<th>LVAD</th>
<th>Medical</th>
</tr>
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<tbody>
<tr>
<td>1 yr</td>
<td>52%</td>
<td>28%</td>
</tr>
<tr>
<td>2 yr</td>
<td>28%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Heartmate II DT Trial - Outcomes

- **Endpoint:**
  - Primary composite: Survival free from disabling stroke and reoperation to replace LVAD at 2 years (HMII vs HMI)
    - 46% vs 11%*
  - First event:
    - Stroke 11% vs 12%
    - Reop 10% vs 36%*
    - Death 33% vs 41%

*\(p<0.001\)
Destination Therapy – Rematch vs HMII Trial

LVAD and Non-Cardiac Surgery

- 24% underwent non-cardiac surgery
  - Most common: Abdominal
- 30 day mortality: 12%
- Most common complication:
  - Bleeding: 10%

Stehlik et al. AM J Cardiol 2009; 103: 709-712
LVAD potential

- Reversal of end-stage heart failure secondary to non ischemic cardiomyopathy
  - 83% survival at 3 years

- Continuous LVAD Survival All Etiologies
  - > 85% at 1 year

Birks et al. Circulation 2011; 123: 381-390
Stewart et al. Circulation 2012;125:1304-1315
Triggers for LVAD

- Inability to wean inotropes or frequent inotrope use
- Peak VO₂ < 14-16 ml/kg/min or < 50% predicted
- Two or more HF admissions in 12 months
- Worsening right heart failure and secondary pulmonary HTN
- Diuretic refractoriness associated with worsening renal function
- Circulatory-renal limitation to ACE inhibition
- Hypotension limiting betablocker therapy
- NYHA class 4 symptoms at rest on most days
- Seattle HF model score with anticipated mortality > 15% at 1 year
- Six-minute walk distance < 300 m
- Persistent hyponatremia < 134 mEq/L
- Recurrent refractory ventricular tachyarrhythmias
- Cardiac cachexia

Stewart et al. Circulation 2012;125:1304-1315
LVAD: Anesthetic implications

- Anticoagulation
- ICD
- No pulsatile flow!
  - No pulse oximetry
  - No NIBP
  - Potential challenge for arterial access
- LVAD are preload dependent
  - Intravascular volume
  - RV function
- LVAD are afterload sensitive
Stem Cell Therapy

1. Stem cells are filtered from bone marrow removed from a patient's hip.

2. The cells are injected into the heart's damaged area.

3. The cells embed themselves and produce proteins that signal the growth of new blood vessels and heart muscle.
Conclusion

- Stop the focus on perioperative MI only!
- Thinking of CAD is not enough
- Knowing the LVEF is only the start!

- Periop CHF and afib are the problem

- Start evaluating your patients NOW
Conclusion: Epidemic Heart Failure