Disclosures

None
Overview

Incidence/ Prevalence of Heart Failure (HF)

Arrhythmia in HF
- Pathophysiology
- HF, sleep-disordered breathing & arrhythmia

Treatment strategies in HF
- When to treat
- Medical treatment
- Electrophysiology Therapy
  - Ablation
  - CRT
- Cardiac Transplantation/Mechanical Circulatory Support
- Palliative care
Incidence of Heart Failure Deaths: United States
Arrhythmia in Heart Failure

HF
- Characterized by disordered contractility
- Abnormal intracellular calcium homeostasis

Up-regulation of the sodium-calcium exchanger

In the setting of downregulation of the inward rectifier and maintained β-adrenergic responsiveness

Intracellular calcium overload

- Reduction in a range of potassium currents, including $I_{TO}$, $I_{K1}$, and the delayed rectifier components
- Attributed to decreased ion channel gene transcription, contributes to action potential prolongation and disordered QT regulation
- Torsades de pointes–like mechanism might be linked to the problem of serious arrhythmias in heart failure
Mortality in Heart Failure

Patients with heart failure die for two main reasons

I. Advanced circulatory insufficiency
II. Sudden death
Arrhythmia in Heart Failure

Malignant or potentially lethal arrhythmias
- Sustained ventricular tachycardia (VT) and VF

Nonsustained or hemodynamically tolerated arrhythmias
- VPBs, nonsustained ventricular tachycardia (NSVT), and accelerated idioventricular rhythm (AIVR)
- Ventricular Premature beats
  - In non-ischemic cardiomyopathy- Limited data, but do not appear to be associated with a worse prognosis
Heart Failure, Sleep-disordered breathing & Arrhythmia

- Intermittent hypoxemia and hypercapnea
- Enhanced inflammatory and oxidative stress
- Autonomic nervous system dysregulation
- Neurohumoral activation, β-receptor downregulation
- Increased sympathetic drive, parasympathetic withdrawal
- Intrathoracic pressure changes and rostral fluid shifts
- Increased myocardial strain and decreased contractility
- Myocardial ischemia, platelet dysfunction, increased wall stress
- Myocardial fibrosis due to myocyte necrosis and apoptosis

Arrhythmia risk

abnormal automaticity

reentry mechanisms

triggered activity
Relationship between sleep-disordered breathing (SDB) and ventricular arrhythmias

Study of 283 HF patients with ICD
170 with no or mild SDB
113 with untreated SDB

Measured
Time periods to first monitored ventricular arrhythmias (VT or VF)
and to first appropriate defibrillator therapy

Results
Significantly shorter time to arrhythmia in patients with SDB
SDB was an independent risk factor for ventricular arrhythmias
and appropriate defibrillator therapies

? Therapy for SDB can reduce ventricular arrhythmias
CRT, HF and Ventricular Arrhythmias

Reverse remodeling response
Reduction in risk of ventricular arrhythmias

MADIT-CRT
Comparing high responders to CRT-D therapy (≥25 percent reductions in LV end-systolic volume at one year) to low and intermediate responders

Cumulative probability of a first ventricular arrhythmias (VT, VF)
- Highest for low responders (28 percent)

- Multivariate analysis -55% reduction in the risk of ventricular arrhythmias in high responders compared to ICD-only patients
- No significant difference between low responders and ICD-only patients
- Non-significant trend toward higher risk of ventricular tachycardia among low responders compared to ICD-only patients (p = 0.074)
Advanced Heart Failure Patient

- Cardiac Transplant
- LVAD
- Palliative Care
- Medical Therapy/CRT
Spectrum of Heart Failure

**ACC/AHA**
- **Stage A**: High risk, no symptoms
- **Stage B**: Structural disease, no symptoms
- **Stage C**: Symptomatic
- **Stage D**: Refractory symptoms, very advanced HF

**NYHA**
- **Class I**: No symptoms
- **Class II**: Limited with activity
- **Class III**: Limited with less than ordinary activity
- **Class IV**: Severely limited, any activity worsens symptoms

**INTERMACS**
- **1**: Crash and burn
- **2**: Sliding on inotropes
- **3**: Inotrope dependent
- **4**: Frequent hospitalizations
- **5**: Housebound
- **6**: Walking wounded

**Disease Trajectory**
## Hemodynamically Unstable Patient

<table>
<thead>
<tr>
<th>Device</th>
<th>Size, Location</th>
<th>Flow (L/min)</th>
<th>Insertion technique</th>
<th>Insertion time (min)</th>
<th>LV unload</th>
<th>RV support</th>
<th>Bed rest</th>
<th>Bleeding risk</th>
<th>Limb ischemia risk</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>IABP</td>
<td>7–9Fr in descending aorta</td>
<td>0.5</td>
<td>Easy</td>
<td>10</td>
<td>Maybe</td>
<td>No</td>
<td>Yes</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>TandemHeart pVAD</td>
<td>Inflow: 21Fr in LA; Outflow: 15–17Fr in FA</td>
<td>3–4</td>
<td>Difficult</td>
<td>30–60</td>
<td>Maybe</td>
<td>Yes</td>
<td>Yes</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Impella pVAD</td>
<td>12–21Fr pump across AV, 11Fr catheter in FA or AxA</td>
<td>2.5–5</td>
<td>Less difficult</td>
<td>15–30</td>
<td>Yes</td>
<td>Near future</td>
<td>Maybe</td>
<td>Relatively low</td>
<td>Relatively low</td>
<td>Hemolysis</td>
</tr>
<tr>
<td>Reitan pVAD</td>
<td>14Fr sheath in FA</td>
<td>5</td>
<td>Less difficult</td>
<td>NA</td>
<td>Maybe</td>
<td>No</td>
<td>Yes</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>CentriMag surgical VAD</td>
<td>Any surgical cannula in any cardiac chamber</td>
<td>10</td>
<td>Surgery</td>
<td>120</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Very high</td>
<td>No</td>
<td>Surgical risks</td>
</tr>
<tr>
<td>VA-ECMO</td>
<td>Inflow: 19–25Fr in RA; outflow: 13–23Fr in FA</td>
<td>3–6</td>
<td>Easy</td>
<td>15–30</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>High</td>
<td>High</td>
<td>LV distension</td>
</tr>
</tbody>
</table>
Spectrum of Heart Failure

ACC/AHA

Stage A
High risk, no symptoms

Stage B
Structural disease, no symptoms

Stage C
Symptomatic

Stage D
Refractory symptoms, very advanced HF

NYHA

Class I
No symptoms

Class II
Limited with activity

Class III
Limited with less than ordinary activity

Class IV
Severely limited, any activity worsens symptoms

INTERMACS

Walking wounded

6

5

4

3

2

1

Frequent hospitalizations

Inotrope dependent

Sliding on inotropes

Crash and burn

Disease Trajectory
Early Evaluation is Critical

As advanced heart failure patients pass through Class III into Class IV, survival rate decreases and hospitalization increase.

<table>
<thead>
<tr>
<th>NYHA Class</th>
<th>Survival Rate</th>
<th>Hospitalizations per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deceased</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Survival difference between moderate risk and high risk patients at 1 year: 34%

Survival difference between moderate risk and high risk patients at 2 years: 20%

## Transplant: Indications and Contraindications

### Acceptable Indications
- Refractory cardiogenic shock
- Intravenous inotropic support required to maintain adequate end-organ perfusion and inability to wean off inotropes
- Maximal VO₂ less than 10 mL/kg/minute with achievement of anaerobic metabolism
- Severe symptomatic coronary artery disease not amenable to coronary artery bypass surgery or percutaneous coronary intervention
- Recurrent ventricular arrhythmias

### Probable Indications
- Maximal VO₂ less than 14 mL/kg/minute and major limitation of the patient’s activities
- Recurrent unstable ischemia not amenable to percutaneous or surgical interventions
- Volatility of fluid balance and renal function despite compliance with diet and medications

### Inadequate Indications
- Low left ventricular ejection fraction < 20%
- Maximal VO₂ greater than 15 mL/kg/minute (and greater than 55% predicted) and absence of other indications
- History of NYHA class III or IV heart failure
- Prior history of ventricular arrhythmias

### Absolute Contraindications
- Systemic non-cardiac illness with a life expectancy less than 2 years
- Known current malignancy or recent malignancy within 5 years with a high-risk of recurrence
- Untreated systemic infection rendering immunosuppression unsafe
- AIDS with opportunistic infections
- Significant pulmonary disease despite optimal medical therapy and not expected to improve with cardiac transplantation
- Fixed pulmonary hypertension evidenced by pulmonary vascular resistance greater than 5 Wood Units or mean transpulmonary gradient greater than or equal to 16 mm Hg

(VO₂: Oxygen consumption per unit time; NYHA: New York Heart Association; AIDS: Acquired immunodeficiency syndrome).
Heart Transplants - Number of Transplants by Year & Location

Number of transplants

- Other
- Europe
- North America

Year:
- 1982
- 1983
- 1984
- 1985
- 1986
- 1987
- 1988
- 1989
- 1990
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
Mechanical Assist Device Options - Long & Short-term

- Thoratec Heartmate II
- Heartware HVAD
- Thoratec Centrimag
- TandemHeart PVAD
- Abiomed Impella
- Maquet Cardiohelp
Improving Outcomes with LVADs


Source: Park SJ, AHA 2010
**Bridge-to-Transplant (BTT)**
- Non-reversible left heart failure
- Candidate for cardiac transplantation

**Destination Therapy (DT)**
- Significant functional limitation
- Optimal medical therapy or unable to tolerate medical therapy
- Not candidate for cardiac transplantation
Survival- Heart Transplant vs. LVAD

Median survival = 11 years
Median survival conditional on surviving


When to Refer?

- More than 1 hospitalization or ED visit within the last year for CHF
- Systolic blood pressure < 100 mm Hg
- Labile renal function (rising BUN/Creatinine)
- Unable to tolerate oral medical therapy (development of CHF decompensation or hypotension)
- Persistent NYHA 3 or 4 symptoms (short of breath while dressing, showering, or walking 1 block)
- “Non-responder” to biventricular pacing
When Should the MCS Discussion Begin?

- **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

- Risk-factor reduction, patient and family education
- ACE inhibitors or ARBs in some patients
- ACE inhibitors or ARBs in all patients; beta-blockers in selected patients
- Dietary sodium restriction, diuretics, and digoxin
- Cardiac resynchronization if bundle-branch block present
- Revascularization, mitral-valve surgery
- Consider multidisciplinary team
- Aldosterone antagonist, nesiritide
- VAD, transplantation
- Hospice
Effects of CRT vs LVAD on Health Status Measures: 6-Minute Walk

Clinical Scenario

Pleasant 78-year-old male

Prior history of CAD, s/p CABG in 2003 with unknown grafts
Chronic kidney disease, stage 3 with a baseline Creatinine of 1.7 to 2.4

Ischemic cardiomyopathy with an EF of 15%-20%

Admitted to outside hospital with shortness of breath, fatigue, and lower extremity edema
1. Coronary artery disease status post coronary artery bypass grafting with unknown grafts, which performed in 2003
2. Chronic kidney disease, stage 3 with a baseline Creatinine of 1.7 to 2.4
3. Hypertension
4. Type 2 diabetes
5. History of ICD placement
6. Ischemic cardiomyopathy with the most recent ejection fraction of 10%
7. Severe symptomatic aortic stenosis with the most recent echo at the referring facility showing the valve area 0.8
8. History of atrial fibrillation
9. Hyperlipidemia
Options

a) Dobutamine Stress echo
b) LHC and RHC
c) Proceed with TVAR - Repeat assessment for Aortic valve not needed
d) Consult CT surgery for surgical AVR
e) Consult EP for CRT
Pre- Dobutamine
On Dobutamine
The Right Time for LVAD Implantation
Key to Survival after Destination Therapy

Worsening of nutritional state, end-organ and RH function

Operative Risk Death

Futile Implants
1-Year Survival 19%

Successful Implants
1-Year Survival 69%

Too Late

I’M SORRY…THERE’S NOTHING MORE WE CAN DO....
Communicating at End of Life

Ask, Tell, Ask

Ask the patient what they understand to be the situation

- Ask what kind of information they want to know
- Don’t assume they want statistics and facts
- Ask them what the goals are if not for a cure

Ask them if they understand what you said
- Preferably let them tell you what they understand
Conclusion

Recognizing that Heart Failure is a progressive illness is critical

Knowledge of advanced therapy options and appropriateness is a key differentiator of the HF cardiologist

Knowing when to choose which option and not waiting too long to “pull the trigger” is paramount
Thank You!