Management of the Patient with Acute Decompensated Heart Failure

Disclosures
I have received funding from:

- NIH/NHLBI: Mentored Patient-Oriented Research Career Development Award, # 1K23HL132048-01
- Susie and Kurt Lochmiller Distinguished Heart Transplant Fund
- University of Colorado Anschutz Medical Campus MicroGrant Program Award

Objectives:
1. Provide an overview of heart failure etiologies, predisposing/risk factors, epidemiology of disease
2. Review types of acute heart failure, ranging from mild dyspnea to overt cardiogenic shock
3. Discuss options for medical management of acute heart failure
4. Discuss options for temporary mechanical circulatory support for patients suffering from cardiogenic shock, including intraaortic balloon pumps, impellas, ECMO and LVADs.
Epidemiology of Heart Failure (HF)

HF is COMMON
- Incidence: 550,000 Americans diagnosed per year
- Prevalence: >6 million Americans have HF

HF is COSTLY
- 2012: $40 billion spent on HF
- Medicare: HF is #1 billing diagnosis; 7% of primary discharge diagnoses

HF is DEADLY
- 5-year survival rate: 50% among all-comers
- End-stage HF: 5-year survival rate 20%

---

Heart Disease and Stroke Statistics 2017; Circulation 2017; 135(10); e146-e603

---

HF Risk Assessment

1. HF is primarily a disease of the aged

HF burden is greatest among elderly populations

Heart Disease and Stroke Statistics 2017; Circulation 2017; 135(10); e146-e603
2. African-Americans are at higher risk of HF than other ethnicities

Risk-Adjusted Association of Race with HF*

Risk of HF among different ethnicities: Chinese < White < Hispanic < African-American

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Risk</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic</td>
<td>1.51</td>
<td>(0.71, 3.23)</td>
</tr>
<tr>
<td>African-American</td>
<td>2.00</td>
<td>(1.11, 3.61)</td>
</tr>
</tbody>
</table>

*Model adjusted for age, sex, HTN, DM, LV hypertrophy, obesity, cholesterol, smoking, and MI

3. More Comorbidities = Greater HF Risk

10 most common comorbidities among Medicare HF beneficiaries

- HTN
- Ischemic HD
- Hyperlipidemia
- Anemia
- Diabetes
- Arthritis
- Chronic kidney disease
- COPD
- Atrial fibrillation
- Dementia

Over 50% of patients with HF have at least 5 comorbidities

Comorbidities that are common among patients with HF: HTN, CAD, hyperlipidemia, diabetes

<table>
<thead>
<tr>
<th>Condition</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTN</td>
<td>84.2</td>
</tr>
<tr>
<td>Ischemic HD</td>
<td>71.9</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>60.0</td>
</tr>
<tr>
<td>Anemia</td>
<td>50.3</td>
</tr>
<tr>
<td>Diabetes</td>
<td>46.3</td>
</tr>
<tr>
<td>Arthritis</td>
<td>43.5</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>42.3</td>
</tr>
<tr>
<td>COPD</td>
<td>30.0</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>28.5</td>
</tr>
<tr>
<td>Dementia</td>
<td>27.6</td>
</tr>
</tbody>
</table>

Common comorbidities drastically increase risk of developing HF

<table>
<thead>
<tr>
<th>Comorbidity</th>
<th>Odds ratio for HF</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD</td>
<td>3.1</td>
</tr>
<tr>
<td>Cigarette Smoking</td>
<td>1.4</td>
</tr>
<tr>
<td>HTN</td>
<td>1.4</td>
</tr>
<tr>
<td>Obesity</td>
<td>2.0</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Heart Disease and Stroke Statistics 2017. Circulation 2017; 135(10); e146-e603
Several Classification Schemes to Describe HF

1. New York Heart Association (NYHA) classification:
   - Class I: symptoms with > normal activity
   - Class II: symptoms with normal activity
   - Class III: symptoms with < normal activity
   - Class IV: symptoms at rest

American Heart Association Stages and Progression of HF

At risk of HF
- Stage A: At high risk but NO HF

Clinical HF
- Stage B: Heart disease but NO HF
- Stage C: HF signs, symptoms
- Stage D: refractory HF

Medical Therapy
- Beta-blockers
- ACE inhibitors
- Aldosterone Antagonists
- Hydralazine, isosorbide

Assessing Candidacy for Temporary/Durable Mechanical Circulatory Support

Stage D: Refractory HF

Level 1: "Crash and Burn"
Level 2: "Sliding Fast" on inotropes
Level 3: "Stable" on inotropes
Level 4: Symptoms at rest
Level 5: "Housebound"
Level 6: "Walking Wounded"
Level 7: Advanced Disease

LVAD
Major Divisions of HF

Normal

“HFpEF”

“HFrEF”

Thick walls

Dilated LV

HFpEF: heart failure with preserved ejection fraction ("diastolic" heart failure). LVEF 50% or more.

HFrEF: heart failure with reduced ejection fraction ("systolic" heart failure). LVEF 40% or less.

HFrEF (LVEF <40%)

LV can't squeeze
LV is dilated

HFpEF (LVEF >50%)

LV can't relax
LV walls are thick

Both types of HF are common
The Natural History of HF


Clinical Stability

Onset of HF

Clinical Course

Periods of relative stability
Risk of sudden death
Recurrent Decompensations
Pump Failure: transplant, LVAD, palliative care

When patients get admitted

Acute HF Management

Balloon pumps
Diuretics
Impella
Cardiomems
Inotropes
ECMO
ESCAPE Trial: Swan-guided management for acute HF – NO improvement in outcomes

So when do we use Swan-Ganz Catheters?

ACC/AHA guidelines: class I recommendation:
The etiology of high filling pressures cannot be determined from clinical assessment

ACC/AHA guidelines: class IIa recommendation:
Acute HF with persistent symptoms and/or when hemodynamics are uncertain

Heart Failure Exacerbation: Profiles

<table>
<thead>
<tr>
<th>Congestion (PCWP)</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>“warm-dry”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“warm-wet”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High JVP, HJR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peripheral edema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ascites, Rales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orthopnea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Square Root Sign on Valsalva</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perfusion (CO/CI)</th>
<th>L</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>“cold-dry”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“cold-wet”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cool extremities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low pulse pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low BP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulsus Alternans</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Heart Failure “Profiles” are used to describe a patient's condition, or the severity of a HF exacerbation, and how we treat them.

**Profile A: “warm and dry”**

**Profile B: “warm and wet”**

**Profile C: “cold and wet”**

- Altered mental status, cool extremities
- **INADEQUATE PERFUSION!!!!**

In acute HF, warm v. cold is a MAJOR distinction.

**Peripheral Edema**

- Abdominal swelling
- Visible neck veins

**How HF patients are treated**

- **Profile B** “warm, wet”
  - Diuresis/Fluid removal
  - Fluid Removal

- **Profile C** “cold, wet”
  - Diuresis: Lasix, Bumex
  - Dialyse (if renal failure)
  - Inotropes (dobutamine)
  - Inadequate perfusion
  - Hemodynamic Support
  - Mechanical Support

Please consider referring patients early if there is any concern!!!
Inotropes for Acute Decompensated HF

Cell membrane

β receptor

AMP

PKA-inactive

PKA

Sarcoplasmic Reticulum

Ca
t

Ca
t

Ca
t

Troponin-C

Dobutamine

Milrinone

Site of action (Central)
Beta-1 agonist (++++)
PDE-3 Inhibitor

Effect
Promotes Ca
t release from Sarcoplasmic Reticulum

Site of action (Peripheral)
Beta-2 agonist (+++)
PDE-3 Inhibitor

Effect
Peripheral vasodilatation ⬢ reduce TPR

Side Effects
Tachycardia, arrhythmia
Arrhythmia
Be careful in AKI

Advantage of inotropes in acute HFrEF: BOTH increase C.O. and reduce TPR

Types of Temporary Forms of Mechanical Support

Balloon Pump
Impella
ECMO

~1 L/min support
2-5 L/min support
4-5L/min support
<table>
<thead>
<tr>
<th>Device</th>
<th>Level of Support</th>
<th>Duration of Support</th>
<th>Adverse Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>IABP</td>
<td>0.5-1.0 l/min</td>
<td>7-14 days</td>
<td>Thrombocytopenia (4%)</td>
</tr>
<tr>
<td>Impella 2.5</td>
<td>1.0-2.5 l/min</td>
<td>7 days</td>
<td>Vascular access</td>
</tr>
<tr>
<td>Impella 5.0</td>
<td>~4-5.0 l/min</td>
<td>7 days</td>
<td>Vascular access</td>
</tr>
<tr>
<td>VA-ECMO</td>
<td>~4-5.0 l/min</td>
<td>7-14 days</td>
<td>Vascular access</td>
</tr>
</tbody>
</table>

**Durable LVAD – structural components, design**

- LVAD
- Driveline
- Controller
- Batteries

**The Left Ventricular Assist Device (LVAD): Structural Components and Design**

LVADs normalize (resting) cardiac output: provides 4-10L/min of flow

“Total cardiac output” is the summation of blood leaving the left ventricle AND the LVAD
56yo man with known heart failure presents to ED with SOB x 5 days.

PMH:
1. ICM: NYHA II, LVEF 25%, s/p AICD 2012
2. HTN
3. Hyperlipidemia

Physical exam:
VS: T 98.9   P 97   BP 98/60    RR 18    O2 96%
GEN: NAD
NEURO: A/D x 3
HEENT: JVP elevated to mid-neck at a 30 degree HUT
CV: RRR, s1, s2, +s3, 2/6 holosystolic murmur along L sternal border
LUNGS: coarse breath sounds b/l
ABD: normal bs, soft, NT, ND
EXT: warm, 2+ LEE proximally to upper calves
CXR: bilateral infiltrates

Medications:
ASA 81mg/day
Lisinopril 20mg/day
Carvedilol 25mg BID
Spironolactone 25mg/day
Lasix 20mg BID

Profile B HF Exacerbation
(warm-wet)
56yo man with known heart failure presents to ED with SOB x 5 days. Diagnosis: Profile B heart failure exacerbation – “warm and wet.”

Hospital course: started on Lasix 80mg IV TID
Diuresis x 3 days. Net negative 6L fluid.
Discharged home after 3 days. Ambulatory throughout unit on day of discharge.

63yo F with NICM presents to ED via EMS with 8 days progressive SOB, syncope x 1 and 10lbs weight gain

PMH:
1. NICM, NYHA III, s/p CRT-D 2010, LVEF 20%, reduced RV function
2. Breast CA 2002 s/p Adriamycin
3. DM

Medications:
- Losartan 6.25mg/day
- Lasix 20mg BID
- Hydralazine 12.5mg TID

Physical Examination:
VS: T 96.9    P 115   BP 78/60    RR 24    O2 91% RA
GEN: Distressed, history obtained from husband (pt on BIPAP)
NEURO: Awake, difficulty following commands
HEENT: JVP to 10cm at a 30 degree angle
CV: tachycardic, regular, s1/s2, +s3, 2/6 holosystolic murmur LSB
LUNGS: Coarse, but also diffuse wet crackles b/l
EXT: cool shins, feet; 3+ LEE to thighs

Labs
- Na 131, K 3.9
- Cr 1.9 (b/l 0.9)
- BNP 1659
- Tn 0.08

Profile C HF exacerbation (cold-wet)

Discharged on oral medications after 13 day hospitalization.

63yo F with NICM presents to ED via EMS with 8 days progressive SOB, syncope x 1 and 10lbs weight gain. Admitted with profile C HF exacerbation (cold, wet).

Hospital course:

- AICD interrogation: multiple short runs of NSVT. No ICD shocks.
- Inotropic support: milrinone x 7 days. Levophed to support BP
- Diuresis: Lasix drip for several days. 14 L fluid removed prior to discharge.
- Discharged on oral medications after 13 day hospitalization.
48yo man with ischemic heart failure, LVEF 30%, Cardiomems placed 11/2017, flown from Colorado Springs via helicopter in cardiogenic shock.

Presentation to outside hospital (OSH):

VS: T 97.2 P 119 BP 70/40 RR 28 SpO2 85% on RA
GEN: severe distress, unable to complete sentences
HEENT: JVP to mandible
CV: tachycardic, S3, loud holosystolic murmur
Lungs: diffuse rales; hypoxia, tachypneic
EXT: Cold. 3+ LEE proximally to knees.

Labs
Na 116, K 3.2
Cr 1.8 (b/l 1.1)
BNP 2087
Tn 0.09

OSH course:
Intubated for respiratory failure
Hemodynamic support: dopamine 5, increased to 10mcg/kg/min
Emergently flown to UCH, Cardiac ICU

Hospital course at UCH:

Ectopy, ventricular arrhythmias on dopamine
Dic dopamine. Changed to Dobutamine/levophed
Refractory hypotension. BP 85/65 on escalating doses of dobutamine/levophed
Patient to cath lab for placement of an Impella
Impella in place x 4 days. Transitioned back to Dobutamine only.
Dobutamine discontinued 5 days later.
Patient eventually transitioned to LTAC.

Summary thoughts:
1. HF is increasingly common, deadly and imposes a major burden on society
2. HF is heterogeneous (HFrEF, HFpEF) and can present as a mild exacerbation or frank cardiogenic shock
3. HF profiles help determine how patients should be managed (medical Rx v. MCS)
4. Consider early referrals (outpatient or inpatient basis) for ongoing HF management
A unique geography: US txplt centers

DocLine 844-285-4555

William.Cornwell@uchsc.edu