Heart Failure: Understanding the Plumbing and Electricity Failures of the Heart

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I have no disclosures for this presentation.
Objectives

- Review basic cardiac anatomy and physiology
- Discuss cardiac conduction system
- Summarize normal echocardiographic findings
- Differentiate systolic/diastolic dysfunction
- Understand why time of discharge is more important than admission in regards to treating heart failure
- Evaluate current heart failure pharmacological strategies
- Emphasize patient education to prevent re-admissions
- Apply Get With the Guidelines recommendations to patients being discharged home
How Do We Present This to Patients?
Common Echocardiographic Findings

- **Ejection Fraction**: Normal: >55%, mildly abnormal: 45-54%, moderately abnormal: 30-44%, severely abnormal: < 30%
- No valvular stenosis/regurgitation
Common Echocardiographic Findings

- Relative wall thickness: (cm)
  - Women: Normal: 0.22-0.42, mildly abnormal: 0.43-0.47, moderately abnormal: 0.48-0.52, severely abnormal: ≥ 0.53
  - Men: Normal: 0.24-0.42, mildly abnormal: 0.43-0.46, moderately abnormal: 0.47-0.51, severely abnormal: ≥ 0.52
Common Echocardiographic Findings

- LV diastolic diameter: (cm)
  - Women: Normal: 3.9-5.3, Mildly abnormal: 5.4-5.7, Moderately abnormal: 5.8-6.1, Severely abnormal: ≥ 6.2
  - Men: Normal: 4.2-5.9, Mildly abnormal: 6.0-6.3, Moderately abnormal: 6.4-6.8, Several abnormal: ≥ 6.9
Common Echocardiographic Findings

- **Right Ventricular Function:**
  - TAPSE: Normal 1.5-2.0 Mildly abnormal 1.3-1.5 Moderately abnormal: 1-1.2, Severely abnormal < 1.0

What is heart failure?
Progressive
Preventable
Syndrome
Heart Failure Facts

- Approximately 5.1 million people in the U.S. have HF.
- 1:9 deaths in 2009 included HF as contributing cause
- ½ people who develop HF die within 5 years of diagnosis
- **Costs ~ $32 billion/year**
  - Includes health care services, missed days at work, and medications

http://www.cdc.gov/DHDSP/data_statistics/fact_sheets/fs_heart_failure.htm
Heart Failure Death Rates, 2007-2009
Adults Ages 35+, by County

Rates are spatially smoothed to enhance the stability of rates in counties with small populations.

ICD-10 codes for heart failure: 150; deaths with heart failure mentioned in any of the 20 listed causes of death on the death certificate.

Data Source: National Vital Statistics System and the U.S. Census Bureau

http://www.cdc.gov/DHDSP/data_statistics/fact_sheets/fs_heart_failure.htm
Heart muscle pumps blood out of the left ventricle.

Weakened heart muscle cannot pump enough blood.
Types of Heart Failure
Systolic Dysfunction

- Pump problem
- Dilated/floppy LV
- LVEF < 45%
- LVEDD pressure and volume increase
- “Congestion”
- Easier to spot

Diastolic Dysfunction

- Relaxation Problem
- More common in women than men
- Stiff LV
- Can lead to systolic dysfunction
- Usually normal ejection fraction but cannot also been seen concomitantly with systolic dysfunction
- LVEDD pressure increase > volume overload too
- May be difficult to detect unless in extremis, especially if pt has preserved LVEF
Right Sided

- Backward failure of RV
- Peripheral edema
- Ascites
- Hepatic enlargement/Jugular vein distention

Left Sided

- Backward failure of LV
- Respiratory symptoms
- Pulmonary edema
- Cyanosis

- Biventricular Failure
  - Mixed signs from RV/LV failure
Causes of Heart Failure

- Ischemic heart disease: 62%
- Cigarette smoking: 16%
- HTN: 10%
- Obesity: 8%
- Diabetes: 3%
- Valvular heart disease: 2%

- Rare Causes:
  - HIV
  - Connective tissue disease
  - Alcohol/illicit drug abuse
  - Infiltrations of cardiac muscle (amyloidosis)
  - Viral myocarditis
Heart Failure Classifications

NYHA

- I: No limitations
- II: Slight limitation; comfortable at rest/mild exertion
- III: Moderate limitation; only comfortable with rest
- IV: Severe limitation: any activities brings on symptoms

American College of Cardiology

- A: Pre-heart failure: High risk for HF development. No structural deficits
- B: Structural disorder, no symptoms
- C: Structural disorder with symptoms, controlled with HF meds/treatment
- D: Advanced disease, requiring hospital based support, transplant, or palliative care
Symptoms

- F
- A
- C
- E
- S
Heart Failure Treatments
Prevention

- Smoking cessation
- Weight reduction
- Dietary restrictions
- Exercise
- Moderation/cessation of alcohol consumption
- HTN management
- Diabetes management
Medications
Medications

- Beta blockers
- ACE Inhibitors
- ARBs
- Aldosterone antagonists
- Diuretics
- Digoxin
- Aspirin
- Statins/Lipid Lowering Agents
- Hydralazine/nitrates

*Focus on medication optimization*
Beta Blockers

Mechanisms of Action:

- ↓ heart rate > ↑ ejection fraction
- ↓ renin secretion > ↓ cardiac oxygen demand by ↓ extracellular volume and ↑ oxygen carrying capacity of blood
Renin-angiotensin-aldosterone system

Liver → Angiotensinogen → Angiotensin I → Angiotensin II

Decrease in renal perfusion (juxtaglomerular apparatus) → Renin

Lungs → Surface of pulmonary and renal endothelium: ACE

Kidney

Sympathetic activity

Tubular Na⁺ Cl⁻ reabsorption and K⁺ excretion. H₂O retention

Adrenal gland: cortex

Aldosterone secretion

Arteriolar vasoconstriction. Increase in blood pressure

Pituitary gland: posterior lobe

ADH secretion

Collecting duct: H₂O absorption

Water and salt retention. Effective circulating volume increases. Perfusion of the juxtaglomerular apparatus increases.
Beta Blockers

- Bisoprolol (Zebeta), carvedilol (Coreg), and metoprolol: Reduce mortality and hospitalizations in pts with Class II-IV systolic HF
- Start low and slow
- Are not contraindicated in patients with co-existing COPD or in decompensated HF

http://www.e-mjm.org/2012/v67n1/Beta-Blockers_for_Heart_Failure.pdf
# Beta Blocker Dosing

<table>
<thead>
<tr>
<th>Drug</th>
<th>Initial Dose</th>
<th>Interval between dose increases</th>
<th>Maximum dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bisoprolol (Zebeta)</td>
<td>1.25 mg daily</td>
<td>2 weeks</td>
<td>10 mg daily</td>
</tr>
<tr>
<td>Carvedilol (Coreg)</td>
<td>3.125 mg BID</td>
<td>2 weeks</td>
<td>25 mg BID</td>
</tr>
<tr>
<td>Metoprolol succinate (Toprol)</td>
<td>12.5 mg daily</td>
<td>2 weeks</td>
<td>200 mg daily</td>
</tr>
<tr>
<td>Metoprolol tartrate (Lopressor)</td>
<td>5 mg BID</td>
<td>2 weeks</td>
<td>75 mg daily</td>
</tr>
<tr>
<td>Nebivolol (Bystolic)</td>
<td>1.25 mg daily</td>
<td>2 weeks</td>
<td>10 mg daily</td>
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</table>
### ACE Inhibitors/ARBs

<table>
<thead>
<tr>
<th>Trial</th>
<th>Dosages</th>
<th>Major Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>NETWORK</td>
<td>Enalapril 2.5 mg BID vs 5 mg BID vs 10 mg BID</td>
<td>No difference in hospitalizations for HF, trend towards ↓ deaths with increasing dose</td>
</tr>
<tr>
<td>ATLAS</td>
<td>Lisinopril 2.5 -5 mg daily vs 32.5-35 mg daily</td>
<td>Trends toward ↓ total and CV mortality and significant ↓ in mortality and all cause hospitalizations for high dose lisinopril</td>
</tr>
<tr>
<td>CHIPS</td>
<td>Captopril 25 mg BID vs 50 mg BID</td>
<td>Trend towards ↓ hospitalizations for HF and towards ↓ fatal/nonfatal cardiac events for high dose captopril</td>
</tr>
<tr>
<td>HEDS</td>
<td>Enalapril 20 mg vs 60 mg</td>
<td>No significant differences in survival, clinical, and hemodynamic variable</td>
</tr>
</tbody>
</table>

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC59639/table/T1/
ACE/ARB Mechanisms of Action

ACE Inhibitors
- Blocks conversion of angiotensin I to angiotensin II
- Lowers arteriolar resistance, increases venous capacity
- Lowers resistance in blood vessels to kidneys
- Leads to increased excretion of sodium in urine
- Bradykinin increases because of less inactivation by ACE
- Has been shown to help with cardiac cachexia

ARB
- Block activation of angiotensin II AT1 receptors
- Do not inhibit bradykinin breakdown or other kinins
Bradykinin

- Inflammation mediator
- Potent endothelium-dependent vasodilator
- Causes contraction of non-vascular smooth muscle in bronchus and gut
- Causes natriuresis: excretion of sodium in urine
- Overactivation: Angioedema
- Bradykinin response: Dry cough
ACE Inhibitors/ARBs

- ACE inhibitors should be used first when at all possible.
- Okay to uptitrate ACE inhibitors and beta blockers at the same time.
- ARBs okay if patients have angioedema/severe cough with ACEi.
- If hyperkalemia/renal insufficiency, problematic > will probably also be seen in ARB therapy.
- Consider ARB as first line if:
  - Heart failure post MI
  - Chronic HF and reduced LVEF
  - Candesartan must useful in HF

http://www.heartfailureguideline.org/ace_inhibitors/73
Aldosterone Antagonists

- Inhibits sodium resorption in collecting duct in kidneys
- Interferes with Na/K exchange > reduces urine K+ excretion
- Increases (mildly) diuresis
- Used for additive diuretic effect for symptom relief
Aldosterone Antagonists

- Recommended for NYHA Class IV (or Class III, previously class IV) HF from LVEF < 35% while receiving standard therapy, including diuretics
- Consider in pts following acute MI with clinical HF sx, history of diabetes, and LVEF < 40%
- Should also be on ACEi/ARB and beta blocker
- Not recommended if creatinine greater than 2.5 mg/dL (creatinine clearance < 30 mL/min) or serum K+ > 5 OR in conjunction with other potassium sparing diuretics
- Unless severe hypokalemia, supplemental K+ not recommended
- Frequent monitoring of K+ required

http://www.heartfailureguideline.org/aldosterone_antagonists/77
Hydralazine/Nitrate

- **Hydralazine**: Afterload reduction agent
  - Erratic GI absorption
- **Nitrate**: Preload reduction agent
- Combo should be used in patients who do not tolerate ARB therapy
- Recommended as part of standard therapy in addition to beta blockers and ACEi in African American patients with HF and reduced LVEF
- May be considered in non-African American patients who remain symptomatic despite optimized standard therapy

http://www.heartfailureguideline.org/oral_nitrates_and_hydralazine/79
Diuretics

- Recommended for volume overload
- Loop diuretics should be used instead of thiazides
- Torsemide: Consider in pts who have poor absorption of oral meds or erratic diuretic effect, particularly those with right-sided HF and refractory fluid retention
- Cautious use of metolazone/chlorothiazides
- Education about volume overload reporting!!

http://www.heartfailureguideline.org/diuretic_therapy/81
Digoxin

- Very weak inotropic effect
- Dose of digoxin should be based on
  - Lean body mass
  - Renal function
  - Review of other meds
- Therapeutic Level: < 1.0 ng/ML, generally 0.7 to 0.9 ng/mL
- Usually dose no more than 0.125 mg daily
- Considered for control of ventricular response in atrial fibrillation associated with HF
- High doses for rate control not advisable

http://www.heartfailureguideline.org/digoxin/82
Aspirin/Lipid Lowering Agents

- **ASA:**
  - Recommended in pts with HF secondary to ischemic cardiomyopathy
  - Otherwise, not recommended for general HF management

- **Lipid Lowering Agents**
  - Not recommended for general HF management
  - Recommended for pts with ischemic cardiomyopathy and those with hypercholesterolemia

[http://www.heartfailureguideline.org/anticoagulation_and_antiplatelet_drugs/83](http://www.heartfailureguideline.org/anticoagulation_and_antiplatelet_drugs/83)
Further Optimization

- If symptoms persist despite being on ACEi/beta blocker, will need to consider adding more meds.
  - MUST evaluate renal function, serum K+, BP, and volume status
- ACEi/ARB/aldosterone therapy not recommended 2/2 to high risk for hyperkalemia
- Addition of ARB: Strength of Evidence=A
- Aldosterone Antagonist:
  - Severe HF: Strength of Evidence=A
  - Moderate HF: Strength of Evidence=C
  - Post-MI HF: Strength of Evidence=A
- Hydralazine/nitrate
  - African Americans: Strength of Evidence=A
  - Others: Strength of Evidence=C

Why focus on discharge?

Patient Effects    Hospital Effects
Health care expenditures were $74.9 billion in 1970, with 7.2% of the nation’s gross domestic product (GDP) being used for these costs, most of which consisted of hospital stays.

By 2019, these expenditures are expected to skyrocket to $4.5 trillion, with the GDP having 19.3% dedicated to health care financing.

(Kovner & Knickman 2011)
Baylor Health Care System (BCHS) and Transitional Care Models (TCM)

- Studied the usefulness of TCM, as well as the fiscal feasibility of maintaining this type of model
- Patients enrolled in a TCM for heart failure
- Reduction in contribution margin of approximately $227 per Medicare patient (C. Fullerton, 2012)

- Study by Stauffer et al. (2011) showed that the use of this same transitional heart failure program reduced 30-day readmissions by 48%.
Patient Education

- **Diet**
  - Fluid restriction
  - Salt intake
  - Fat/alcohol
- **Exercise**
- **Smoking cessation**
- **Daily weights**

- **Symptom Review (More next slide)**
- **Follow up within 7 days**
- **Care coordination**
- **Enrollment in telephonic support program**
- **Referral for heart failure disease management**
- **At least 60 minutes of education by a qualified heart failure educator**
HEART FAILURE ZONES

EVERYDAY
- Weigh yourself in the morning before breakfast, write it down and compare to yesterday’s weight.
- Take your medicine as prescribed.
- Check for swelling in your feet, ankles, legs and stomach.
- Eat low salt food.
- Balance activity and rest periods.

Which Heart Failure Zone are you today? GREEN, YELLOW or RED?

GREEN ZONE
ALL CLEAR - This zone is your goal
Your symptoms are under control. You have:
- No shortness of breath.
- No weight gain more than 2 pounds (it may change 1 or 2 pounds some days).
- No swelling of your feet, ankles, legs or stomach.
- No chest pain.

YELLOW ZONE
CAUTION - This zone is a warning:
- You have a weight gain of 3 pounds in 1 day or a weight gain of 5 pounds or more in 1 week.
- More shortness of breath.
- More swelling of your feet, ankles, legs, or stomach.
- Feeling more tired. No energy.
- Dry hacky cough.
- Dizziness.
- Feeling uneasy, you know something is not right.
- It is harder for you to breathe when lying down.
- You are needing to sleep sitting up in a chair.

RED ZONE
EMERGENCY
Go to the emergency room or CALL 911 if you have any of the following:
- Struggling to breathe. Unrelieved shortness of breath while sitting still.
- Have chest pain.
- Have confusion or can’t think clearly.
Discharge Components

- Emphasize pill counts
- Patient education forms
- Nursing check lists
  - Medications
  - Daily weights
  - Follow up appointment/referrals
  - Contact numbers/information
American Heart Association Program
- More than 1 million HF patients helped
- Reduces re-admission rates
- Protects reimbursement rates
- Focus on quality and evidence-based therapy

- Ensures consistency
- Avoids duplication
- Allows for flexibility and program individualization
- Provides real-time feedback

- Heart Failure 30 Day Measures for Left Ventricular Systolic Dysfunction
  - 30 Day ACEI/ARBs
  - 30 Day Aldosterone Antagonist
  - 30 Day Beta Blocker
  - 30 Day Hydralazine/Nitrate
  - 30 Day Lipid-Lowering Medication
  - 30 Day Diabetic Treatment
  - 30 Day Re-hospitalization
  - 30 Day Mortality Post Discharge
  - 30 Day Mortality Post Discharge
  - 30 Day Mortality: (Unadjusted)
Question/Answer Session