Congestive Heart Failure
Overview

- Epidemiology
- Definition of Heart Failure (HF)
- Types of HF
- Classes of HF
- Common diagnostic tests/procedures
- Treatment options
  - Chronic
  - Acute
Impact of Heart Failure

- Nearly 5 million adults in the U.S. are currently living with HF
- Approximately 550,000 new cases are diagnosed in the U.S. each year
- HF is responsible for 11 million physician visits each year, and more hospitalizations than all forms of cancer combined
- HF costs the nation an estimated $30.7 billion each year
Risk Factors

- Diseases that damage the heart, which increase the risk of HF
  Some of these diseases include:
    - Coronary heart disease and heart attacks
    - Hypertension
    - Diabetes
- In the U.S., most cases are due to damage from an MI (myocardia infarction) or from long-standing hypertension
Demographics

- HF affects people of all ages, from children and young adults to the middle-aged and the elderly
- Almost 1.4 million person with HF are under 60 years of age
- More than 5% of person age 60 to 69 have HF
- The incidence of HF is equally frequent in men and women
- African Americans are 1.5 times more likely to develop HF than Caucasians
Life expectancy

- Depends on many factors and there is no one answer for an individual patient
- For patients with severe or advanced HF
  - Only around 10 to 20% of patients will be alive after one year.
Heart Failure

- The heart muscle is **unable to pump enough blood** to meet the body’s needs for blood and oxygen
  - Not supplying the cells with enough blood
  - Cannot keep up with its workload
  - The body may not get the oxygen it needs
At first the heart tries to make up for this by:

1. **Enlarging**
   - The heart stretches to contract more strongly and keep up with the demand

2. **Developing more muscle mass**
   - Due to contracting cells of the heart get bigger, this allows for the heart pump more strongly

3. **Pumping faster**
   - This helps increase the output
Normal vs Heart Failure

[Diagram showing normal and enlarged heart with labels: Left ventricle and Enlarged heart]

American Heart Association

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Pathophysiology of HF

- Compensatory mechanisms
  - Renin angiotensin aldosterone system (RAAS)
  - Sympathetic nervous system (SNS)
  - Vasopressin
Diagnostic test for HF

- Echocardiography (ECHO)
  - An ultrasound of the heart
  - Provides an estimate of left ventricular ejection fraction (LVEF)
- LVEF
  - Measurement of how much blood is pumped out of the left ventricle with each contraction
# Ejection Fraction

<table>
<thead>
<tr>
<th>EF</th>
<th>Term</th>
<th>Primary Problem</th>
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<tbody>
<tr>
<td>55-70%</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>≥50%</td>
<td>Heart Failure with Preserved EF (HFpEF) Diastolic Dysfunction</td>
<td>Impaired ventricular relaxation and filling during diastole</td>
</tr>
<tr>
<td>40-49%</td>
<td>Heart Failure with mid-range HF (HFmrEF)</td>
<td>Likely mixed systolic and diastolic dysfunction</td>
</tr>
<tr>
<td>&lt;40%</td>
<td>Heart Failure with Reduced EF (HFrEF) Systolic Dysfunction</td>
<td>Impaired ability to eject blood during systole</td>
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## Preserved vs Reduced Ejection Fraction

<table>
<thead>
<tr>
<th>Preserved EF</th>
<th>Reduced EF</th>
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<tbody>
<tr>
<td>• EF ≥ 50%</td>
<td>• EF ≤ 40%</td>
</tr>
<tr>
<td>• Diastolic dysfunction (systolic function intact)</td>
<td>• Clinical diagnosis of HF</td>
</tr>
<tr>
<td>• Usually older women with a hx of hypertension, obesity, CAD, diabetes, atrial fibrillation and hyperlipidemia</td>
<td>• Systolic dysfunction</td>
</tr>
</tbody>
</table>
Signs & Symptoms of HF

- General Signs and symptoms
  - Dyspnea (shortness of breath at rest or upon exertion)
  - Cough
  - Swollen ankles
  - Fatigue, weakness
  - Reduction in exercise capacity
Labs

- B-type natriuretic peptide: normal is <100 pg/mL
- N-terminal pro B-type natriuretic peptide: normal is <300 pg/mL
- Both are increased in HF
## Classification of Heart Failure

<table>
<thead>
<tr>
<th>ACCF/AHA Stages of HF</th>
<th>NYHA Functional Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> At high risk for HF but without structural heart disease or symptoms of HF.</td>
<td>None</td>
</tr>
<tr>
<td><strong>B</strong> Structural heart disease but without signs or symptoms of HF.</td>
<td>I No limitation of physical activity. Ordinary physical activity does not cause symptoms of HF.</td>
</tr>
</tbody>
</table>
| **C** Structural heart disease with prior or current symptoms of HF. | I No limitation of physical activity. Ordinary physical activity does not cause symptoms of HF.  
 II Slight limitation of physical activity. Comfortable at rest, but ordinary physical activity results in symptoms of HF.  
 III Marked limitation of physical activity. Comfortable at rest, but less than ordinary activity causes symptoms of HF.  
 IV Unable to carry on any physical activity without symptoms of HF, or symptoms of HF at rest. |
| **D** Refractory HF requiring specialized interventions. | |

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Treatment Options
Treatment of Chronic Systolic Heart Failure

Overview

- First-line therapy
  - Angiotensin converting enzyme (ACE) inhibitors or Angiotensin receptor blocker (ARBs) or Angiotensin receptor and Neprilysin inhibitor (ARNI)
  - Beta blockers
  - Aldosterone receptor antagonists (ARAs)

- Alternative/Additive therapies
  - Hydralazine and nitrates
  - Loop diuretics
  - Digoxin
  - Ivabradine
### Treatment of HFrEF Stage C and D

**Step 1**
- Establish DX of HFrEF; assess volume; initiate GDMT

**Step 2**
- Consider the following patient scenarios

- **NYHA class I-IV**
  - ACEI or ARB AND GDMT beta blocker; diuretic as needed (COR I)

- **NYHA class II-IV**, provided est. CrCl > 30 mL/min & K+ < 5.0 mEq/L
  - Aldosterone antagonist (COR I)

- **NYHA class II-III**, LVEF < 35%; (caveat: > 1 y survival, > 40 d post MI)
  - Hydral-Nitrates \(^1\)
  - ICD \(^1\) (COR I)

- **NYHA class II-III**, NSR & QRS \(>150\) ms with LBBB pattern
  - CRT or CRT-D \(^3\)
  - LVAD \(^2\) (COR IIa)

- **NYHA class II-III**, NSR, heart rate \(\leq 70\) bpm on maximally tolerated dose beta blocker
  - Ivabradine (COR IIa)

**Step 3**
- Implement indicated GDMT. Choices are not mutually exclusive, and no order is inferred

- Discontinue ACEI or ARB; initiate ARNI \(^1\) (COR I)

- Hydral-Nitrates \(^1\)

**Step 4**
- Reassess Symptoms

- Refactory NYHA class III/IV (Stage D)

**Step 5**
- Consider additional therapy

- Palliative care \(^2\) (COR I)

- Transplant (COR I)

- LVAD \(^2\) (COR IIa)

- Investigational studies \(^2\)

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## Drug Treatment

<table>
<thead>
<tr>
<th>Drug Therapy Targets</th>
<th>Mechanism of Action</th>
<th>Benefit with Drug Class</th>
</tr>
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<tbody>
<tr>
<td>ACE inhibitors/ARB</td>
<td>Block neurohormonal activation of the RAAS, resulting in vasodilation and improved EF</td>
<td>Reduces morbidity &amp; mortality, decreases cardiac remodeling, improves LVEF</td>
</tr>
<tr>
<td>ARNI</td>
<td>Counteract effects of RAAS activation and produce vasodilation</td>
<td>Reduces morbidity &amp; mortality</td>
</tr>
<tr>
<td>Beta blockers</td>
<td>Block the activation of the SNS by blocking Epinephrine and Norepinephrine</td>
<td>Reduces morbidity &amp; mortality, provides benefit in controlling heart rate and reducing arrhythmia risk</td>
</tr>
<tr>
<td>ARA</td>
<td>Reduces sodium and water retention</td>
<td>Reduces morbidity &amp; mortality, improve symptoms and ejection fraction</td>
</tr>
<tr>
<td>Hydralazine/Nitrate</td>
<td>A direct arterial vasodilator and venous vasodilation</td>
<td>Improves survival</td>
</tr>
<tr>
<td>Digoxin</td>
<td>Increases cardiac output and decrease heart rate through inhibition of the Na/K ATPase pump</td>
<td>Improves symptoms, exercise tolerance and quality of life, improves symptoms and reduces hospitalizations</td>
</tr>
<tr>
<td>Ivabradine</td>
<td>Reduces heart rate through inhibition of the “funny” current</td>
<td>Reduces hospitalizations</td>
</tr>
<tr>
<td>Loop Diuretics</td>
<td>Increase excretion of Na, K, Cl, Mg, Ca and H2O</td>
<td>Improves symptoms</td>
</tr>
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</table>
Potassium Oral Supplementation

- Loop diuretics cause a decrease in potassium while other HF drugs (RAAS inhibitors, ARAs) increase potassium.
- Maintenance of potassium levels is essential to reduce the pro-arrhythmic risk.
- Range of potassium is 3.5-5 mEq/L.
Digoxin

- Provides a small increase in cardiac output
  - Decreases HR
- Improves symptoms and decreases hospitalizations
- Added in patients who remain symptomatic despite receiving standard treatment of an ACE inhibitor or ARB with a beta blocker
Heart Failure with preserved ejection fraction of $\geq 50\%$ (HFpEF)

- Systolic and diastolic blood pressure should be controlled
  - Less than 130/80 mm Hg
- **Diuretics** should be used for relief of symptoms due to volume overload
- **Aldosterone receptor antagonist** might be considered to decrease hospitalization
  - With HF admission within 1 yr, eGFR $>30$ ml/min, creatinine $<2.5$ mg/dL, potassium $<5$ mEq/L.
Lifestyle Management

- Body weight
- Sodium Restricted diet, <1500 mg/day
- Fluid restriction (1.5-2 L/day)
- Limit alcohol intake
- Avoid illicit drug use, stop smoking
- Exercise training or regular physical activity
Acute Decompensated Heart Failure

- Worsening symptoms
  - Sudden weight gain
    - Weight gain of more than 5 lbs in 1 week
  - Increasing shortness of breath and fatigue
  - Inability to lie flat without becoming short of breath

- Due to Nonadherence with medications and/or lifestyle recommendations
Treating Acute Decompensated Heart Failure

Patients with edema, jugular venous distention and/or ascites
- Volume overloaded
  - Loop diuretics, vasodilators can be added (NTG, nitroprusside, nesiritide)

Patients with decreased renal function, altered mental status and/or cool extremities
- Hypoperfusion
  - Inotropes (dobutamine, milrinone); may consider adding a vasopressor if pt is hypotensive

Some patients experience both
- Volume overloaded and hypoperfusion
  - A combination of agents

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## Clinical Pearls

<table>
<thead>
<tr>
<th>Drug class</th>
<th>Target Dosing</th>
<th>Black Box Warnings</th>
<th>Contraindications</th>
<th>Monitoring Parameters</th>
</tr>
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<tr>
<td><strong>ACE inhibitors</strong></td>
<td>Lisinopril 20-40mg daily Enalapril 10-20mg bid</td>
<td>can cause injury and death to the developing fetus</td>
<td>History of angioedema, use with aliskiren in pts with diabetes, use within 36 hrs of Entresto</td>
<td>Potassium, renal function</td>
</tr>
<tr>
<td><strong>ARBs</strong></td>
<td>Candesartan 32mg daily Losartan 50-150 mg daily Valsartan 160mg bid</td>
<td>Same BBW as above</td>
<td>use with aliskiren in pts with diabetes</td>
<td>Potassium, renal function</td>
</tr>
<tr>
<td><strong>ARNI</strong></td>
<td>Entresto 200mg bid</td>
<td>Same BBW as above</td>
<td>Use with ACE inhibitors or ARBs, hx of angioedema, use with aliskiren with diabetes</td>
<td>Potassium, renal function, requires renal adjustment</td>
</tr>
<tr>
<td><strong>Beta Blockers</strong></td>
<td>Zebeta 10 mg daily Toprol XL 200 mg daily Coreg IR 3.125 mg BID</td>
<td>Do not discontinue abruptly</td>
<td>Severe bradycardia, 2nd or 3rd degree heart block or sick sinus syndrome or cardiogenic shock</td>
<td>Heart rate (decrease dose if HR &lt; 55 bpm), BP</td>
</tr>
<tr>
<td>Drug class</td>
<td>Target Dosing</td>
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<td>Warnings</td>
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<td>--------------------------------------------</td>
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<tr>
<td>ARA</td>
<td>Spironolactone 25 mg daily Eplerenone 25 mg daily</td>
<td>Hyperkalemia, anuria, CrCl ≤ 30 mL/min, Addison’s disease</td>
<td>Do not initiate tx in HF pts with K &gt; 5 mEq/L or SCr &gt; 2 mg/dL (females) or SCr &gt; 2.5 mg/dL (males)</td>
<td>Potassium, renal function, fluid status</td>
</tr>
<tr>
<td>Hydralazine/Nitr</td>
<td>Bidil 300 mg/day in divided doses Isosorbide mononitrate 120 mg in divided doses</td>
<td>Mitral valve rheumatic heart disease, CAD; for nitrates use with PDE-5 inhibitors and riociguat</td>
<td>Drug-Induced lupus erythematosus (hydralazine)</td>
<td>Heart rate, Blood pressure</td>
</tr>
<tr>
<td>Digoxin</td>
<td>0.125-0.25 mg daily</td>
<td>Ventricular fibrillation</td>
<td>2nd/3rd degree heart block without a pacemaker, Wolff-Parkinson-White syndrome with Afb, electrolyte imbalances</td>
<td>Heart rate, ECG, electrolytes, renal function, dig level</td>
</tr>
<tr>
<td>Ivabradine</td>
<td>2.5-7.5 mg bid Target resting heart rate between 50-60 bpm</td>
<td>Acute decompensated HF, BP &lt; 90/50 mmHg, sick sinus syndrome or 3rd degree AV block without pacemaker, resting heart rate &lt;60 bpm, severe hepatic impairment</td>
<td>Bradycardia, risk of QTc prolongation, fetal toxicity (females should use effective contraception)</td>
<td>Heart rate, ECG</td>
</tr>
<tr>
<td>Loop Diuretics</td>
<td>Furosemide Bumetanide Ethacrynic Acid Torsemide</td>
<td>Anuria</td>
<td>Sulfa allergy (does not apply to ethacrynic acid), electrolyte abnormalities</td>
<td>Renal function, fluid status, electrolytes</td>
</tr>
</tbody>
</table>
References


4. HFSA 2010 guideline on evaluation and management of patients with acute decompensated heart failure; 16(6): e134