Heart Failure

Dr. Rafa G. Carretero
Internal Medicine Department
Hospital Universitario de Móstoles

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1 Introduction

Heart failure is a chronic, progressive condition where the heart is unable to pump blood effectively to meet the body's needs, leading to fluid buildup, particularly in the lungs, causing pulmonary edema. This condition is a leading cause of morbidity and mortality, particularly among the elderly, and is often associated with comorbidities such as hypertension, coronary artery disease, and diabetes. The increasing prevalence of heart failure is driven by the aging population and improved survival rates from cardiovascular conditions.

Heart failure is not a disease by itself, but a clinical syndrome with a broad constellation of symptoms secondary to impaired cardiac function. There are numerous etiologies for impaired heart function, both structural and/or functional causes. Usually, heart failure can be divided into 2 broad categories: heart failure with preserved ejection fraction and heart failure with reduced ejection fraction.

1.1 Definition of CHF

- **Core Concept**: Congestive heart failure is a chronic, progressive condition in which the heart is unable to pump blood efficiently to meet the body's metabolic demands. This results in inadequate perfusion of tissues and organs, as well as the accumulation of fluid in the lungs, abdomen, and extremities.

- **Key Points**:
  - CHF is not a single disease but a **syndrome**—a collection of symptoms and signs caused by various underlying cardiac conditions.
  - It can involve either the **left ventricle**, the **right ventricle**, or both (biventricular failure).
  - The term *congestive* refers to the fluid buildup (congestion) that occurs due to the heart's inability to pump effectively.

2 Epidemiology

HF is a major public health issue worldwide, affecting approximately **26 million people globally**. It is one of the leading causes of hospitalization, particularly in individuals over the age of 65. The prevalence of CHF increases with age, affecting **1-2% of the general population** but rising to **>10% in those over 70 years old**. Men and women are equally affected, though the underlying causes may differ (e.g., men are more likely to have ischemic heart disease, while women are more likely to have hypertension-related CHF).

CHF is associated with **high healthcare costs** due to frequent hospitalizations, long-term medications, and the need for advanced therapies like implantable devices or heart transplants. In the U.S. alone, the annual cost of managing CHF is estimated to be **$30 billion**.

CHF is a **leading cause of morbidity and mortality** worldwide, with a 5-year survival rate of approximately **50%**, which is worse than many cancers. It significantly impacts patients' quality of life, causing symptoms like shortness of breath, fatigue, and swelling, which limit daily activities.

3 Etiology

There are many causes of heart failure—the most common of which is coronary artery disease. Identifying the risk factors for heart failure is important because this condition is preventable. Some causes:

- Coronary artery disease (CAD)
- Diabetes mellitus
- Hypertension
- Valvular heart disease
- Myocarditis
- Infiltrative disorders (ie, amyloidosis, sarcoidosis)
- Medications and toxins (ie, cocaine, alcohol)

4 Pathophysiology

Heart failure is a complex clinical syndrome that occurs when the heart is unable to pump or receive blood effectively, leading to inadequate perfusion of organs and tissues. The pathophysiology of heart failure involves various mechanisms, and it often develops as a result of underlying cardiovascular diseases or conditions that involve the heart.

First we have triggering factors, such as coronary artery disease, tachyarrhythmias, valvular heart disease, myocarditis, hypertension, obesity, and diabetes. These factors trigger a cascade of mechanisms unfolds within the heart, leading to functional or structural impairments.

Conversely, there are mechanisms trying to adapt to the dysfunction, giving rise to the clinical presentation of the heart failure spectrum. These mechanisms ultimately result in permanent morphological alterations in the left ventricle.

In heart failure with **reduced ejection fraction**, the left ventricle enlarges and weakens. Heart failure with **preserved ejection fraction** is associated with hypertrophy and the inability of filling the left ventricle with blood.

4.1 Mechanisms of HF

HF can be broadly categorized into two types based on the heart's pumping ability:

1. **Heart Failure with Reduced Ejection Fraction (HFrEF)**:
    - Also known as **systolic heart failure**.
    - Characterized by a reduced ejection fraction (EF $< 40\%$).
    - The heart cannot contract effectively, leading to decreased cardiac output.
    - Common causes: Ischemic heart disease, dilated cardiomyopathy.
2. **Heart Failure with Preserved Ejection Fraction (HFpEF)**:
    - Also known as **diastolic heart failure**.
    - Characterized by a preserved or normal ejection fraction (EF $\geq 50\%$).
    - The heart cannot relax or fill properly during diastole, leading to increased filling pressures.
    - Common causes: Hypertension, left ventricular hypertrophy, restrictive cardiomyopathy.

4.2 Compensatory Mechanisms

When the heart fails, the body activates several compensatory mechanisms to maintain cardiac output and perfusion. However, these mechanisms eventually become maladaptive and contribute to disease progression:

1. Activation of the Sympathetic Nervous System (SNS)
2. Activation of the Renin-Angiotensin-Aldosterone System (RAAS)
3. Release of Natriuretic Peptides
4. Ventricular Remodeling

These changes further impair cardiac function and perpetuate the cycle of heart failure.

4.3 Progression to Decompensation

Over time, the compensatory mechanisms fail, leading to **decompensated heart failure**. Symptoms can be explained due to:

- **Fluid overload**: Pulmonary congestion (dyspnea, orthopnea) and peripheral edema.
- **Reduced cardiac output**: Fatigue, weakness, and organ hypoperfusion.
- **Arrhythmias**: Atrial fibrillation, ventricular tachycardia.

5 Clinical Presentation

CHF presents with a combination of **symptoms** and **signs** resulting from fluid overload (it leads to fluid acumulation) and reduced cardiac output (this leads to inadequate perfusion of organs and tissues).

The main symptoms of heart failure are:

- Dyspnea (shortness of breath). The most common symptom, caused by pulmonary congestion. There are some types of dyspnea:
  - Exertional dyspnea: Difficulty breathing during physical activity.
  - Orthopnea: Shortness of breath when lying flat, relieved by sitting up or using extra pillows.
  - Paroxysmal Nocturnal Dyspnea (PND): Sudden episodes of severe dyspnea at night, often waking the patient from sleep.
- Fatigue and weakness, due to reduced cardiac output and poor perfusion of skeletal muscles, which limits the patient's ability to perform daily activities.
- Fluid retention and edema, shown as:
  - Peripheral edema: Swelling in the legs, ankles, and feet due to increased venous pressure.
  - Ascites: Fluid accumulation in the abdomen, often seen in right-sided heart failure.
  - Weight gain: Rapid weight gain due to fluid retention.

Some signs of heart failure are:

1. Pulmonary Signs such as crackles on lung auscultation, indicating fluid in the alveoli.
2. Elevated jugular venous pressure (JVP): Reflects increased right atrial pressure
3. A third heart sound heard in early diastole, indicative of volume overload.
4. Peripheral signs such as swelling in the lower extremities that leaves an indentation when pressed or hepatomegaly (enlarged liver due to venous congestion).

6 Evaluation and Diagnosis

Following the initial assessment through a **detailed history** and **physical examination**, it is advisable to incorporate further diagnostic investigations. These may include an **electrocardiogram**, complete blood count, and a comprehensive metabolic panel encompassing liver function tests, electrolytes, renal, and thyroid-stimulating hormone function tests.

For a more in-depth cardiac evaluation, essential labs involve measuring **NT pro-brain natriuretic peptide (NT-proBNP)**. A transthoracic **echocardiogram** is crucial for assessing left ventricular ejection fraction, while a **chest x-ray** proves beneficial when suspecting pulmonary vascular congestion.

Further specialized tests may be needed when classifying heart failure based on ejection fraction. These include a stress echocardiogram, exercise treadmill stress test, and a coronary angiogram for suspected ischemia.

7 Treatment

Treatment of heart failure is based on general management and pharmacologic therapy. Regarding general or non-pharmacologic treatment, it involves some lifestyle modifications, such as low-sodium diet, regular exercise, and weight management. Also, physicians should manage comorbidities such as hypertension, diabetes, atrial fibrillation, obesity, valvular disease, or sleep apnea. Controlling these comorbidities can improve the symptoms and/or avoid hospitalizations.

Pharmacologic therapy is based on diuretics, which are essential for HF with volume overload, relieving congestion:

1. SGLT2 Inhibitors (SGLT2i)
2. Mineralocorticoid Receptor Antagonists (MRA)
3. Loop diuretics and/or thiazides.

Other therapies are focused on counteract sympathetic activation:

1. Beta-blockers: Carvedilol, metoprolol succinate, bisoprolol.
2. Sacubitril/valsartan
3. ACE Inhibitors (ACEi) & Angiotensin Receptor Blockers (ARB)