HEART FAILURE

RAMI DWAIRI, MD

- the heart cannot maintain adequate output, or can do so only at the expense of elevated ventricular filing pressure.

- In mild to moderate forms of heart failure, symptoms occur only when the metabolic demand increases during exercise or some other form of stress.
- In severe heart failure, symptoms may be present at rest. In clinical practice, heart failure may be diagnosed when a patient with significant heart disease develops the signs or symptoms of a low cardiac output, pulmonary congestion or systemic venous congestion at rest or on exercise.

- Left heart failure This is characterised by a reduction in left ventricular output and an increase in left atrial and pulmonary venous pressure. If left heart failure occurs suddenly – for example, as the result of an acute MI – the rapid increase in left atrial pressure causes pulmonary edema. If the rise in atrial pressure is more gradual, as occurs with mitral stenosis, there is refex pulmonary vasoconstriction, which protects the patient from pul monary edema. However, the resulting increase in pulmonary vascular resistance causes pulmonary hypertension, which in turn impairs right ventricular function.
- Right heart failure: This is characterised by a reduction in right ventricular output and an increase in right atrial and systemic venous pressure. The most common causes are chronic lung disease, pulmonary embolism and pulmonary valvular stenosis. The term 'cor pulmonale' is used to describe right heart failure that is secondary to chronic lung disease.
- Biventricular heart failure: both sides of the heart are affected. This may occur because the disease process, such as dilated cardiomyopathy or coronary heart disease, affects both ventricles or because disease of the left heart leads to chronic elevation of the left atrial pressure, pulmonary hypertension and right heart failure.

- **Ventricular dysfunction** is the most common cause of heart failure. This can occur because of impaired systolic contraction due to myocardial disease, or diastolic dysfunction where there is abnormal ventricular relaxation due to a stiff, non-compliant ventricle. This is most commonly found in patients with left ventricular hypertrophy. Systolic dysfunction and diastolic dysfunction often coexist, particularly in patients with coronary artery disease. Ventricular dysfunction reduces cardiac output, which, in turn, activates the sympathetic nervous system (SNS) and renin–angiotensin–aldosterone system (RAAS). Under normal circumstances, activation of the SNS and RAAS supports cardiac function but, in the setting of impaired ventricular function, the consequences are negative and lead to an increase in both afterload and preload. A vicious circle may then be established because any additional fall in cardiac output causes further activation of the SNS and RAAS, and an additional increase in peripheral vascular resistance

- High-output failure Sometimes cardiac failure can occur in patients without heart disease due to a large arteriovenous shunt, or where there is an excessively high cardiac output due to severe anemia or thyrotoxicosis.

- Valvular disease Heart failure can also be caused by valvular disease in which there is impaired filling of the ventricles due to mitral or tricuspid stenosis; where there is obstruction to ventricular outflow, as occurs in aortic and pulmonary stenosis and hypertrophic cardiomyopathy; or as the result of ventricular overload secondary to valvular regurgitation.

FACTORS THAT MAY PRECIPITATE OR AGGRAVATE HEART FAILURE

- Myocardial ischemia or infarction
- Intercurrent illness
- Arrhythmia
- Inappropriate reduction of therapy
- Administration of a drug with negative inotropic (β-blocker) or fluid-retaining properties (non-steroidal anti-inflammatory drugs, glucocorticoids)
- Pulmonary embolism
- Conditions associated with increased metabolic demand (pregnancy, thyrotoxicosis, anemia)
- Intravenous fluid overload

COMPLICATIONS OF HEART FAILURE

- Renal failure is caused by poor renal perfusion due to low cardiac output and may be exacerbated by diuretic, ACE inhibitor and angiotensin receptor blocker (ARB) therapies.
- Hypokalemia may be caused by potassium-losing diuretics, and also by hyperaldosteronism due to activation of the renin–angiotensin system and impairment of aldosterone metabolism from hepatic congestion.
- Hyperkalemia may be due to the effects of drugs that promote renal resorption of potassium, in particular the combination of ACE inhibitors, ARBs and mineralocorticoid receptor antagonists. These effects are amplified if there is renal dysfunction due to low cardiac output or atherosclerotic renal vascular disease.
- Hyponatremia is a feature of severe heart failure and is a poor prognostic sign. It may be caused by diuretic therapy, inappropriate water retention due to high vasopressin secretion, or failure of the cell membrane ion pump due to intracellular energy depletion.

- Impaired liver function is caused by hepatic venous congestion and poor arterial perfusion, which frequently cause mild jaundice and abnormal liver function tests
- Thromboembolism. Deep vein thrombosis and pulmonary embolism may occur due to the effects of low cardiac output and enforced immobility. Systemic embolism, including stroke, occurs in patients with atrial fibrillation or flutter
- Atrial and ventricular arrhythmias are very common and may be related to electrolyte changes such as hypokalemia and hypomagnesemia, myocardial fibrosis and the pro-arrhythmic effects of sympathetic activation. Atrial fibrillation occurs in approximately 20% of patients with heart failure and causes further impairment of cardiac function.
- Sudden death occurs in up to 50% of patients with heart failure and is most often due to ventricular fibrillation.

Left ventricular dysfunction

- LVEF ≤40%: Heart failure with reduced ejection fraction (HFrEF)
- LVEF 41 to 49%: Heart failure with mid-range ejection fraction (HFmrEF)
- LVEF ≥50%: Heart failure with preserved ejection fraction (HFpEF)

CLASSIFICATION

The New York Heart Association (NYHA) classification system categorizes heart failure on a scale of I to IV, as follows:

- Class I: Patients with cardiac disease but without resulting limitations of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea, or anginal pain.
- Class II: Patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea, or anginal pain.
- Class III: Patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less-than-ordinary physical activity causes fatigue, palpitation, dyspnea, or anginal pain.
- Class IV: Patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms of cardiac insufficiency or of the anginal syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased.

The American College of Cardiology/American Heart Association (ACC/AHA) staging system is defined by the following four stages:

- Stage A: High risk of heart failure but no structural heart disease or symptoms of heart failure
- Stage B: Structural heart disease but no symptoms of heart failure
- Stage C: Structural heart disease with prior or current symptoms of HF
- Stage D: Refractory heart failure requiring specialized interventions

CLINICAL PRESENTATION

Symptoms and physical examination

- **left-sided HF**

- Weakness and dyspnea with exertion (sometimes even at rest); paroxysmal nocturnal dyspnea (is a sensation of shortness of breath that awakens the patient); orthopnea (is the sensation of breathlessness in the recumbent position, relieved by sitting or standing); cough; wheezing; pink, frothy sputum , Fatigue , Syncope , Systemic hypotension , Cool extremities , Slow capillary refill, Peripheral cyanosis , Pulsus alternans, Mitral regurgitation , Bilateral pulmonary crackles (rales),S3 gallop, displaced point of maximal impulse (usually below the 5th intercostal space, lateral to the midclavicular line, and palpable across 2 intercostal spaces).

- **right-sided HF** Abdominal pain and bloating (due to distention from ascites), nausea and vomiting, anorexia, constipation Peripheral edema, jugular venous distention, hepatosplenomegaly, hepatojugular reflux (distention of the neck veins when pressure is applied over the liver), ascites **,** Tricuspid regurgitation **,** Kussmaul's sign (is the paradoxical increase in jugular venous pressure with inspiration), Pulsatile liver.

INITIAL TESTING

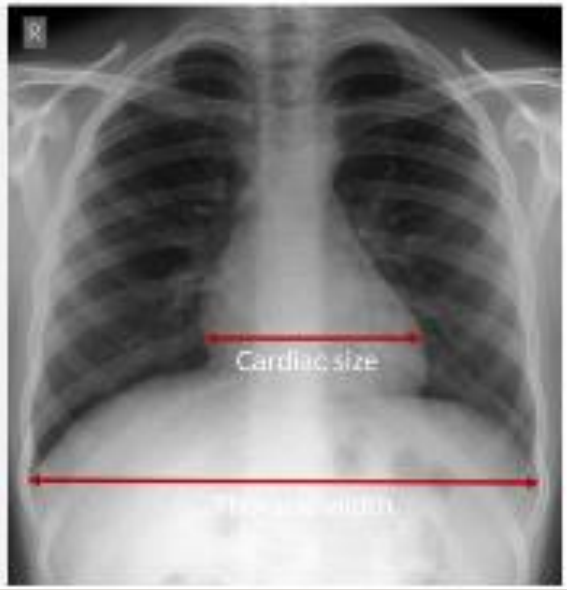
- **Electrocardiogram** — Most patients with HFrEF have a significant abnormality on an electrocardiogram (ECG).
- **Initial blood tests**

__ Natriuretic peptide (NP [BNP or NT-proBNP]) levels provide evidence as to whether HF is present. In patients with dyspnea at rest, the negative predictive value of a normal plasma NP level is high. NP levels are often (but not exclusively) elevated in patients with HFrEF, but may be normal in a substantial number of patients with HFpEF. Thus, the presence of an elevated NP level increases the likelihood that HF is present, but a normal level does not exclude it, particularly in patients with a normal LVEF or obesity. Conversely, elevations can be caused by elevated right heart pressures, renal dysfunction, or many systemic diseases.

- Cardiac troponin T or I in patients with acute decompensated HF and/or suspected acute coronary syndrome.
- A complete blood count, which may suggest concurrent or alternate conditions. Anemia or infection can exacerbate preexisting HF.
- Serum electrolytes, blood urea nitrogen, and creatinine may indicate associated conditions. Hyponatremia generally indicates severe HF, though other causes should be considered. Renal impairment may be caused by and/or contribute to HF exacerbation. Baseline evaluation of electrolytes and creatinine is also necessary when initiating therapy with diuretics and/or angiotensin converting enzyme inhibitors.
- Liver function tests, which may be affected by hepatic congestion.
- Fasting blood glucose to detect underlying diabetes mellitus

CHEST RADIOGRAPH — THE CHEST RADIOGRAPH IS A USEFUL INITIAL DIAGNOSTIC TEST, PARTICULARLY IN THE EVALUATION OF PATIENTS WHO PRESENT WITH DYSPNEA, TO DIFFERENTIATE HF FROM PRIMARY PULMONARY DISEASE.

FINDINGS SUGGESTIVE OF HF INCLUDE CARDIOMEGALY (CARDIAC TO THORACIC WIDTH RATIO ABOVE 50 PERCENT), KERLEY B-LINES, AND PLEURAL EFFUSIONS.



The cardiothoracic ratio should be less than 0.5.

A cardiothoracic ratio of greater than 0.5 (in a good quality film) suggests cardiomegaly.

DIAGNOSIS

The approach to the patient with suspected HF includes the history and physical examination as well as diagnostic tests to help establish the diagnosis, assess acuity and severity, and initiate assessment of etiology.

- **Echocardiography** –An echocardiogram alone does not establish or exclude the diagnosis of HF but is helpful to identify findings consistent with HF and to identify potential causes of HF (eg, left ventricular [LV] systolic dysfunction, LV diastolic dysfunction, valve dysfunction).
- **Natriuretic peptide levels** – Natriuretic peptide levels should be interpreted in the context of other clinical information; they may lend weight to the diagnosis of HF or trigger consideration of HF but should **NOT** be used in isolation to diagnose or exclude HF.

- **Role of exercise testing** – Evaluation to distinguish cardiac from other causes may include a cardiopulmonary exercise test.
- **Hemodynamic testing** – A hemodynamic exercise test is not required for diagnostic evaluation of most patients with suspected HF. However, in selected patients with suspected HF with uncertain diagnosis despite noninvasive evaluation, cardiology consultation and right heart catheterization for assessment of cardiac filling pressures at rest and exercise is useful as the clinical gold standard to make or exclude the diagnosis of HF.

TREATMENT & MANAGEMENT

Non-pharmacologic therapies

- Treat hypertension and lipid disorders
- Encourage smoking cessation
- Discourage heavy alcohol intake and illicit drug use
- Control and/or prevent diabetes mellitus
- Encourage physical activity
- Encourage weight reduction if obese or overweight
- Dietary sodium should be restricted to 2-3 g/day
- Fluid restriction to 2 L/day is recommended for patients with evidence of hyponatremia (Na < 130 mEq/dL) and for those whose fluid status is difficult to control despite sodium restriction and the use of high-dose diuretics.

PRIMARY THERAPY FOR PATIENTS WITH HFREF

- **Therapy with diuretics** –Patients with HF and volume overload require diuretic therapy.

  Type of agent – In patients with HF who require diuretic therapy, furosemide, torsemide, or bumetanide can be used as the initial therapy; all three are generally effective and well tolerated.

- **Primary components of therapy** – In patients with HFrEF who have New York Heart Association (NYHA) class II to III symptoms, combination therapy with one agent from each of the following classes is necessary:

✓ Angiotensin receptor blocker-neprilysin inhibitor (ARNI; ie, sacubitril-valsartan)

✓ Beta blocker

✓ Mineralocorticoid receptor antagonist (MRA)

✓ Sodium-glucose co-transporter 2 (SGLT2) inhibitor (regardless of comorbid diabetes status)

- For patients who cannot tolerate an ARNI, ACE inhibitor, or ARB for other reasons (eg, hyperkalemia, kidney dysfunction), hydralazine plus isosorbide dinitrate may be used as an alternative.

Beta blocker – Three beta blockers have been shown to be effective in reducing the risk of death in patients with HFrEF: bisoprolol, sustained-release metoprolol (succinate), and carvedilol.

Beta blockers are commonly initiated after optimal treatment for volume overload and soon after the patient has started an ARNI, ACE inhibitor, or ARB monotherapy.

SECONDARY THERAPY FOR PATIENTS WITH HFREF

In patients who cannot tolerate components of the primary regimen for the treatment of HFrEF or who have residual HF symptoms despite optimal therapy, additional therapies may be appropriate.

Initial approach – In patients with heart failure with reduced ejection fraction (HFrEF) who cannot take optimal pharmacologic therapy, the first step in management is to manage the causes of intolerance and, if appropriate, change the therapeutic regimen (eg, reduce diuretic dose, change spironolactone to eplerenone) to allow for use of the primary pharmacologic therapies for HFrEF.

Add a vasodilator in select patients – In patients who are at low risk of hypotension (eg, hypertensive, systolic pressure >110 mmHg), we suggest additional therapy with isosorbide dinitrate plus hydralazine rather than no additional therapy. In patients in whom compliance with isosorbide dinitrate is likely to be low, hydralazine alone or amlodipine are reasonable therapeutic options

Optional therapies – In patients with HFrEF who have persistent NYHA class II or III symptoms despite an optimal regimen of primary medical therapy for HFrEF and maximal vasodilator therapy (eg, isosorbide dinitrate plus hydralazine), additional options for therapy include ivabradine, vericiguat, or digoxin. Optimal medical therapy (eg, primary pharmacologic therapies, maximal vasodilator therapy) without additional pharmacologic therapy is also a reasonable option.

- Neprilysin inhibitors: The only drug currently in this class is sacubitril, a small-molecule inhibitor of neutral endopeptidase, or neprilysin, which is responsible for the breakdown of the endogenous diuretics ANP and BNP as well as vasoactive peptides such as bradykinin and substance P. If used in combination with the ~~ARB it produces additional symptomatic and mortality benefit~~
- Ivabradine acts on the inward current in the SA node, resulting in reduction of heart rate. It reduces hospital admission and mortality rates in patients with heart failure due to moderate or severe left ventricular systolic impairment.
- Digoxin in maintenance doses can be used to provide rate control in patients with heart failure and atrial fibrillation. In patients with severe heart failure (NYHA class III–IV), digoxin reduces the likelihood of hospitalization for heart failure, although it has no effect on long-term survival.
- Amiodarone is a potent anti-arrhythmic drug that has little negative inotropic effect and may be valuable in patients with poor left ventricular function. Amiodarone is used for prevention of symptomatic atrial arrhythmias and of ventricular arrhythmias when other pharmacological options have been exhausted.

Device therapy

Patients with HFrEF who meet specific criteria may benefit from placement of an implantable cardioverter-defibrillator (ICD) or a cardiac resynchronization pacemaker.

Advanced heart failure therapies

Cardiac resynchronisation therapy devices

Coronary revascularisation

Cardiac transplantation

THANK YOU