

L5: Heart Failure

(etiology+diagnosis)



objectives

1. Definition of heart failure.
2. To know Pathophysiology of heart failure.
3. Describe the causes of heart failure.
4. To know classification heart failure.
5. Diagnosis of heart failure.

Definition Of Heart Failure

- Congestive Heart Failure is a **clinical syndrome** resulting from the heart's inability to meet the body's circulatory demands under normal physiological conditions.
- is a complex clinical syndrome that can result from any **structural or functional*** cardiac disorder that impairs the ability of the ventricle to **fill with or eject** blood.
- It is the final common pathway for a wide variety of **cardiac diseases**.
- The overall 5-year mortality for all patients with CHF is about 50%.

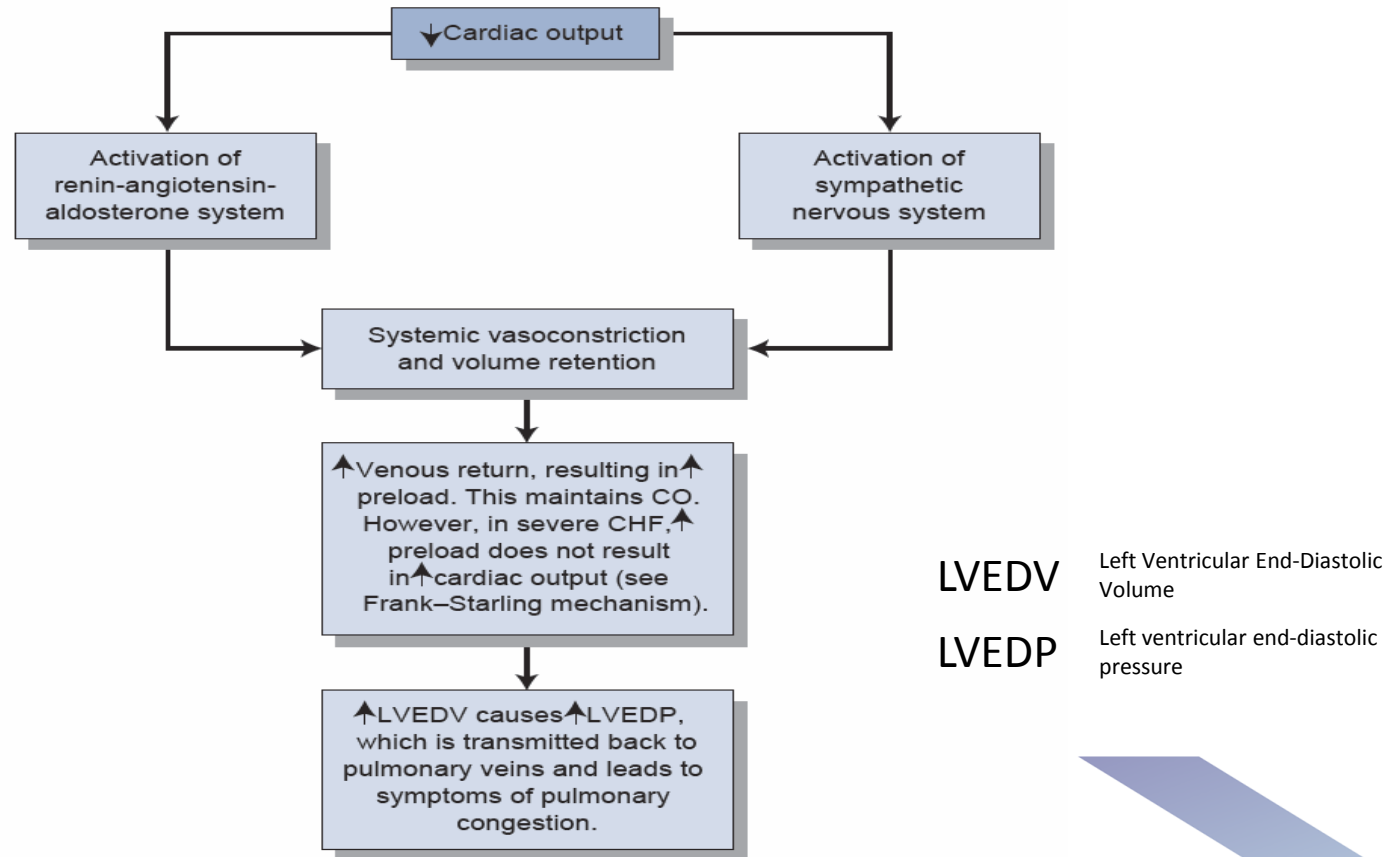
*structural : CAD, myositis, cardiomyopathy.

Functional: anemia, hyperthyroidism, arrhythmia(↓filling)



Almost all forms of heart disease can lead to heart failure. An accurate aetiological diagnosis is important because treatment of the underlying cause may reverse heart failure or prevent its progression.

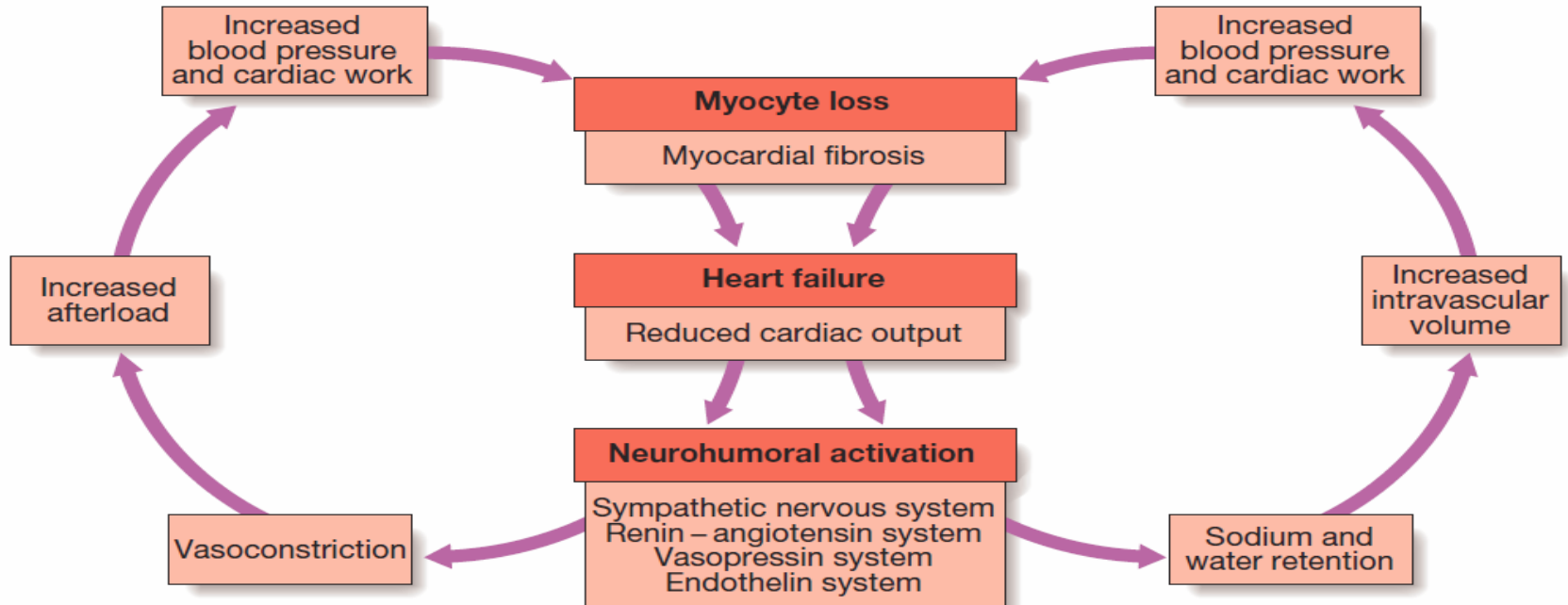
Pathophysiology



Frank–Starling relationship

- In a normal heart, increasing preload results in greater contractility.
- When preload is low (at rest), there is little difference in performance between a normal and a failing heart. However, with exertion a **failing heart** produces relatively **less contractility** and symptoms occur

Pathophysiology from Davidson's



Stimulation of the renin–angiotensin–aldosterone system leads to vasoconstriction, sodium and water retention, and sympathetic nervous system activation. This is mediated by angiotensin II, a potent constrictor of arterioles, in both the kidney and the systemic circulation. Activation of the sympathetic nervous system may initially sustain cardiac output through increased myocardial contractility (inotropy) and heart rate (chronotropy). Prolonged sympathetic stimulation also causes negative effects, including cardiac myocyte apoptosis, hypertrophy and focal myocardial necrosis. Sympathetic stimulation also causes peripheral vasoconstriction and arrhythmias. Sodium and water retention is promoted by the release of aldosterone, endothelin-1 (a potent vasoconstrictor peptide with marked effects on the renal vasculature) and, in severe heart failure, antidiuretic hormone (ADH). Natriuretic peptides are released from the atria in response to atrial stretch, and act as physiological antagonists to the fluid-conserving effect of aldosterone.

Cause of Heart Failure

1. Reduced ventricular contractility

- MI (segmental dysfunction)
- Myocarditis/cardiomyopathy (global dysfunction)

2. Ventricular outflow obstruction

- Hypertension, aortic stenosis (left heart failure)
- Pulmonary hypertension, pulmonary valve stenosis (right heart failure)

3. Ventricular inflow obstruction

- Mitral stenosis
- tricuspid stenosis

4. Ventricular volume overload

- Left ventricular volume overload (e.g. mitral or aortic regurgitation)
- Ventricular septal defect
- Right ventricular volume overload (e.g. atrial septal defect)
- Increased metabolic demand (high output)

5. Arrhythmia

- Atrial fibrillation
- Tachycardia
- Cardiomyopathy
- Complete heart block

6. Diastolic dysfunction

- Constrictive pericarditis
- Restrictive cardiomyopathy
- Left ventricular hypertrophy and fibrosis
- Cardiac tamponade

Types of heart failure

1- Left, right and biventricular heart failure

<ul style="list-style-type: none"> • <i>Left-sided heart failure</i> 	<ul style="list-style-type: none"> -There is a reduction in left ventricular output and an increase in left atrial and pulmonary venous pressure and causes pulmonary congestion or pulmonary oedema. -a more gradual increase in left atrial pressure leads to reflex pulmonary vasoconstriction, which protects the patient from pulmonary oedema. -This increases pulmonary vascular resistance and causes pulmonary hypertension, which can, in turn, impair right ventricular function.
<ul style="list-style-type: none"> • <i>Right-sided heart failure</i> 	<ul style="list-style-type: none"> -There is a reduction in right ventricular output and an increase in right atrial and systemic venous pressure. -Causes of isolated right heart failure include chronic lung disease (cor pulmonale), pulmonary embolism and pulmonary valvular stenosis.
<ul style="list-style-type: none"> • <i>Biventricular heart failure</i> 	<ul style="list-style-type: none"> -because of dilated cardiomyopathy or ischaemic 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.

Types of heart failure

2- Diastolic and systolic dysfunction. –next slide-	3-High-output failure. –slide 10-	4-Acute and chronic heart failure.
<p>Heart failure may develop as a result of impaired myocardial contraction (systolic dysfunction) but can also be due to poor ventricular filling and high filling pressures stemming from abnormal ventricular relaxation (diastolic dysfunction). The latter is caused by a stiff, non-compliant ventricle and is commonly found in patients with left ventricular hypertrophy. Systolic and diastolic dysfunction often coexist, particularly in patients with coronary artery disease.</p>	<p>A large arteriovenous shunt, beri-beri, severe anaemia or thyrotoxicosis can occasionally cause heart failure due to an excessively high cardiac output.</p>	<p>-Heart failure may develop suddenly, as in MI, or gradually, as in progressive valvular heart disease. -When there is gradual impairment of cardiac function, several compensatory changes may take place. -A minor event, such as an intercurrent infection or development of atrial fibrillation, may precipitate overt or acute heart failure. -Acute left heart failure occurs, either de novo or as an acute decompensated episode, on a background of chronic heart failure: so-called acute-on-chronic heart failure.</p>

Systolic & Diastolic dysfunction

1. Systolic dysfunction

Owing to **impaired contractility** (i.e., the abnormality is **decreased ejection fraction less than 50%**)

Causes include:

- **Ischemic heart disease or after a recent MI**—infarcted cardiac muscle does not pump blood (decreased ejection fraction).
- **Hypertension resulting in cardiomyopathy**
- Valvular heart disease
- Myocarditis (postviral)
- Less common causes: Alcohol abuse, radiation, hemochromatosis, thyroid disease

2. Diastolic dysfunction*

Owing to **impaired ventricular filling** during diastole (either impaired relaxation or increased stiffness of ventricle or both). Diastolic dysfunction is **less common** than systolic dysfunction. (Echocardiogram shows impaired relaxation of left ventricle)

Causes include:

- **HTN leading to myocardial hypertrophy**—most common cause of diastolic dysfunction
- **Valvular diseases** such as aortic stenosis, mitral stenosis, and aortic regurgitation
- Restrictive cardiomyopathy (e.g., amyloidosis, sarcoidosis, hemochromatosis)



Often, both **systolic** and **diastolic** dysfunctions are present simultaneously.

High-Output Heart Failure

In high-output heart failure, an increase in cardiac output is needed for the requirements of **peripheral tissues for oxygen**.

Causes include:

- Chronic anemia
- Pregnancy
- Hyperthyroidism
- AV fistulas
- Wet beriberi (caused by thiamine [vitamin B1] deficiency)
- Paget's disease of bone
- Mitral regurgitation
- Aortic insufficiency

The conditions listed above rarely cause heart failure by themselves. However, if these conditions develop in the presence of **underlying heart disease, heart failure can result quickly**.

Causes of left ventricular failure

Volume over load: Regurgitate valve, High output status*

Pressure overload : Systemic hypertension, Outflow obstruction, aortic stenosis

Loss of muscles(Myocyte loss): Post MI, Chronic ischemia Connective tissue diseases Infection, Poisons (alcohol** ,cobalt , Doxorubicin)

Restricted Filling : Pericardial diseases, Restrictive cardiomyopathy, tachyarrhythmia

REMEMBER LEFT VENTRICULAR FAILURE IS A TRUE LIFE THREATENING EMERGENCY

*High output status: anemia , pregnancy, hyperthyroidism.

** alcohol > dilated cardiomyopathy

Signs & Symptoms

Symptoms of left-sided heart failure

- **Dyspnea:** difficulty breathing secondary to pulmonary congestion/edema
- **Orthopnea:** difficulty breathing in the recumbent position; relieved by elevation of the head with pillows
- **Paroxysmal nocturnal dyspnea (PND):** awakening after 1 to 2 hours of sleep due to acute shortness of breath (SOB)
- **Nocturnal cough (nonproductive):** worse in recumbent position (same pathophysiology as orthopnea)
- **Confusion and memory impairment:** occur in advanced CHF as a result of inadequate brain perfusion.
- **Diaphoresis and cool extremities at rest:** occur in desperately ill patients (NYHA class IV) *check slide 11*

Symptoms/signs of right-sided heart failure

- **Peripheral pitting edema :** pedal edema **lacks specificity** as an isolated finding . In the elderly, it is more likely to be secondary to venous insufficiency.
- **Nocturia :** due to increased venous return with elevation of legs
- **Jugular venous distention (JVD)**
- **Hepatomegaly/hepatojugular reflex**
- **Ascites**
- **Right ventricular heave**



-Given enough time, left-sided heart failure will **always** lead to right-sided heart failure and vice versa
 -Patients may present with sign/symptoms of both right- and left-sided HF.

Signs & Symptoms

Signs of left-sided heart failure :

- **Displaced PMI** (Point of Maximum Impulse) (usually to the left) due to **cardiomegaly**
- **Pathologic S3** (ventricular gallop) :
 - ✓ Rapid filling phase “into” a noncompliant left ventricular chamber
 - ✓ May be normal finding in children; in adults, usually associated with CHF
 - ✓ May be difficult to hear, but is among the **most specific** signs of CHF
 - ✓ Heard best at apex with bell of stethoscope
- **S4 gallop** :
 - ✓ Sound of atrial systole as blood is ejected into a noncompliant, or stiff, left ventricular chamber
 - ✓ Heard best at left sternal border with bell of stethoscope
- **Crackles/rales at lung bases** :
 - ✓ Caused by fluid spilling into alveoli; indicates pulmonary edema
 - ✓ Rales heard over lung bases suggest at least moderate severity of left ventricular heart failure
- **Dullness to percussion** and decreased tactile fremitus of lower lung fields caused by **pleural effusion**
- **Increased intensity of pulmonic component of second heart sound** indicates **pulmonary HTN** (heard over left upper sternal border).

New York Heart Association (NYHA) Classification

- | | |
|-------------------|---|
| • NYHA class I: | Symptoms only occur with vigorous activities , such as playing a sport. Patients are nearly asymptomatic. |
| • NYHA class II: | Symptoms occur with prolonged or moderate exertion , such as climbing a flight of stairs or carrying heavy packages. Slight limitation of activities. |
| • NYHA class III: | Symptoms occur with usual activities of daily living , such as walking across the room or getting dressed. Markedly limiting. |
| • NYHA class IV: | Symptoms occur at rest . Incapacitating. |

How To Diagnose

Framingham Criteria

Major criteria	Minor criteria
Paroxysmal nocturnal dyspnea (PND)	Bilateral ankle edema
Neck vein distention, ↑JVP	Nocturnal cough
Rales	Dyspnea on ordinary exertion
Radiographic cardiomegaly (increasing heart size on chest radiography)	Decrease in vital capacity by one third from maximum recorded
Acute pulmonary edema	Hepatomegaly
S3 gallop	Pleural effusion
Increased central venous pressure (>16 cm H ₂ O at right atrium)	Tachycardia (heart rate >120 beats/min.)
Hepato-jugular reflux	
Weight loss >4.5 kg in 5 days in response to treatment	



Diagnosis of CHF requires the simultaneous presence of at **least 2 major criteria** or **1 major criterion in conjunction with 2 minor criteria**.

How To Diagnose


Differential diagnosis

- ✓ Pericardial diseases.
- ✓ Liver diseases.
- ✓ Nephrotic syndrome.
- ✓ Protein losing enteropathy.

Laboratory Findings

- ✓ Anemia
- ✓ Hyperthyroid
- ✓ Chronic renal insufficiency,
- ✓ electrolytes abnormality
- ✓ Pre-renal azotemia.
- ✓ Hemochromatosis

Investigation

 is very useful and should be considered in all patients with heart failure*

1. Chest x-ray (CXR)


- ✓ **Cardiomegaly**
- ✓ **Kerley B lines** are short horizontal lines near periphery of the lung near the costophrenic angles, and indicate pulmonary congestion secondary to dilation of pulmonary lymphatic vessels.
- ✓ Prominent interstitial markings
- ✓ **Pleural effusion**
- ✓ Evidence of pulmonary venous congestion (dilated or upper lobe veins → perivascular edema)

Tests to order for a new patient with CHF:

- Chest x-ray (pulmonary edema, cardiomegaly, rule out COPD)
- ECG + CBC (anemia)
- Cardiac enzymes to rule out MI
- Echocardiogram (estimate EF, rule out pericardial effusion)

2. Echocardiogram* (transthoracic)

- ✓ Initial test of choice : should be performed whenever CHF is suspected based on history, examination, or CXR.
- ✓ **Useful in determining whether systolic or diastolic dysfunction predominates**, and determines whether the **cause of CHF is due to a pericardial, myocardial, or valvular process.**
- ✓ Estimates Ejection Fraction (very important): Patients with systolic dysfunction (EF < 40%) should be distinguished from patients with preserved left ventricular function (EF > 40%).
- ✓ Shows chamber dilation and/or hypertrophy **and valvular abnormality.**

 Serum urea, creatinine and electrolytes, haemoglobin, thyroid function, ECG and chest X-ray may help to establish the nature and severity of the underlying heart disease and detect any complications.

Investigation

3. ECG

- ✓ is usually nonspecific but can be useful for detecting chamber enlargement and presence of ischemic heart disease or prior MI or **Arrhythmia**.

4. Radionuclide ventriculo-graphy using technetium-99m (“nuclear ventriculography”)

- ✓ RBCs tagged with radioisotope are imaged during exercise/rest.
- ✓ Provides precise measurement of left and right ventricular EF (and can assess wall motion abnormalities in ischemic heart disease)
- ✓ Can be useful when an echocardiogram is technically suboptimal (e.g., severe pulmonary disease), or when more precise assessment of left ventricular function is desired, but in most cases, this test is not ordered even though it is the most accurate test.

5. Cardiac catheterization

- ✓ can provide valuable quantitative information regarding diastolic and systolic dysfunction, and can clarify the cause of CHF if noninvasive test results are equivocal. Consider coronary angiography to exclude CAD as an underlying cause of CHF.

6. Stress testing

- ✓ Identifies ischemia and/or infarction
- ✓ Quantitates level of conditioning
- ✓ Can differentiate cardiac versus pulmonary etiology of dyspnea
- ✓ Assesses dynamic responses of HR, heart rhythm, and BP

Acute Decompensated Heart Failure (ADHF)

- **Acute dyspnea** associated with **elevated left-sided filling pressures**, with or without pulmonary edema
- Most commonly due to LV systolic or diastolic dysfunction
- Flash pulmonary edema refers to a severe form of heart failure with rapid accumulation of fluid in the lungs.
- **Differential** includes pulmonary embolism, asthma, and pneumonia, all of which can cause **rapid respiratory distress**.
- **Diagnostic tests include** : ECG, chest x-ray, ABG, B-type natriuretic peptide (BNP), echocardiogram, possible coronary angiogram if indicated.
- Hospital admission is indicated.
- Daily assessment of patient weight is a good method of documenting effective diuresis.

Cardiomyopathy

1. Dilated Cardiomyopathy :

- **Most common** type of cardiomyopathy. (diastolic dysfunction → impaired ventricular filling because it's small chamber)
- An insult (e.g., ischemia, infection, alcohol, etc.) causes **dysfunction of left ventricular contractility**.
- Poor prognosis : many die within 5 years of the onset of symptoms

Cardiomyopathy

Causes :

Up to 50% of cases are **idiopathic**.

Other causes include:

- ✓ CAD* (with prior MI) is a common cause.
- ✓ Toxic: Alcohol,
- doxorubicin**(Adriamycin):chemotherapy used in breast cancer>**histologic changes on endomyocardial biopsy**
- ✓ Metabolic: Thiamine or selenium deficiency, hypophosphatemia, uremia
- ✓ Infectious: Viral, Chagas' disease, Lyme disease, HIV
- ✓ Thyroid disease: Hyperthyroidism or hypothyroidism
- ✓ Peripartum cardiomyopathy **appears in the last month of pregnancy or in the first 5 months after delivery in the absence of preexisting cardiac disease**
- ✓ Collagen vascular disease: SLE, scleroderma
- ✓ Prolonged, uncontrolled tachycardia
- ✓ Catecholamine induced:
Pheochromocytoma, cocaine
- ✓ Familial/genetic

Clinical features :

- Symptoms and signs of left- and right-sided CHF develop.
- S3, S4, and murmurs of mitral or tricuspid insufficiency may be present.
- Cardiomegaly is commonly seen.
- Many patients with DCM will have a coexisting arrhythmia (atrial or ventricular) related to the dilated ventricle.
- **Sudden death**

Diagnosis :

- ECG, CXR, and echocardiogram results consistent with CHF
- Genetic testing may be warranted if there is a family history of DCM and no other cause can be identified.



Cardiomyopathy

2. Hypertrophic Cardiomyopathy (HCM)

- Most cases are inherited as an **autosomal-dominant** trait. However, spontaneous mutations may account for some cases.

Pathophysiology

- The main problem is **diastolic dysfunction** due to a stiff, hypertrophied ventricle with elevated diastolic filling pressures.
- These pressures increase further with factors that increase HR and contractility (such as exercise) or decrease left ventricular filling (e.g., the Valsalva maneuver).
- Patients may also have a dynamic outflow obstruction due to asymmetric hypertrophy of the interventricular septum.

Cardiomyopathy

Symptoms :

- ✓ Dyspnea on exertion
- ✓ Chest pain (angina)
- ✓ Syncope (or dizziness) after exertion or the Valsalva maneuver
- ✓ Palpitations
- ✓ Arrhythmias (AFib, ventricular arrhythmias)—due to persistently elevated atrial pressures
- ✓ Cardiac failure due to increased diastolic stiffness
- ✓ **Sudden death**: sometimes seen in a young athlete; may be the first manifestation of disease
- Some patients may remain asymptomatic for many years**

Signs :

- ✓ Sustained PMI
- ✓ Loud S4
- ✓ Systolic ejection murmur
 - ❖ Decreases with squatting, lying down, or straight leg raise (due to decreased outflow obstruction)
 - ❖ Intensity increases with Valsalva and standing (decreases LV size and thus increases the outflow obstruction)
 - ❖ Decreases with sustained handgrip (increased systemic resistance leads to decreased gradient across aortic valve)
 - ❖ Best heard at left lower sternal border (LLSB)
- ✓ Rapidly increasing carotid pulse with two upstrokes (bisferious pulse)

Diagnosis :

- ✓ Echocardiogram establishes the diagnosis
- ✓ Clinical diagnosis
- ✓ family history

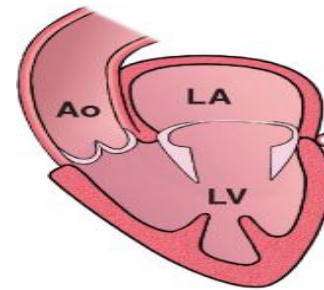
Cardiomyopathy

3. Restrictive Cardiomyopathy

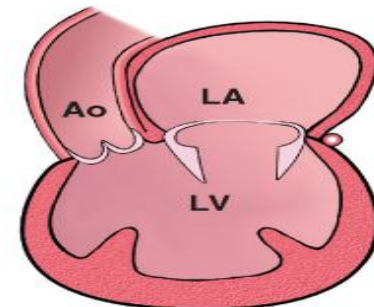
Infiltration of the myocardium results in **impaired diastolic ventricular filling** due to **decreased ventricular compliance**.

Systolic dysfunction is variable and usually occurs in advanced disease.

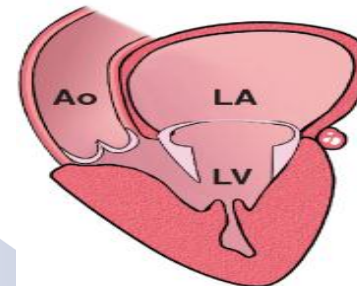
Less common than dilated and hypertrophic cardiomyopathies



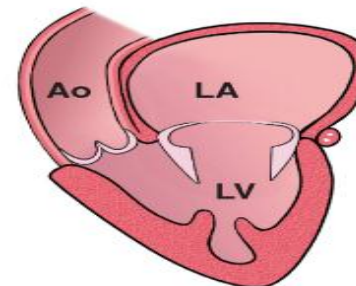
Normal



Dilated cardiomyopathy



Hypertrophic cardiomyopathy



Restrictive cardiomyopathy

Cardiomyopathy

Causes :

- ✓ Amyloidosis
- ✓ Sarcoidosis
- ✓ Hemochromatosis
- ✓ Scleroderma
- ✓ Carcinoid syndrome
- ✓ Chemotherapy or radiation induced
- ✓ Idiopathic

Clinical features :

1. Elevated filling pressures cause dyspnea and exercise intolerance.
2. Right-sided signs and symptoms are present for the same reason.

Diagnosis :

- ✓ Echocardiogram
 - Thickened myocardium and possible systolic ventricular dysfunction
 - Increased right atrium (RA) and left atrium (LA) size with normal LV and RV size
 - In amyloidosis, myocardium appears brighter or may have a sparkled appearance.
- ✓ ECG: Low voltages or conduction abnormalities, arrhythmias, AFib
- ✓ Endomyocardial biopsy may be diagnostic.

MCQs

1. Which of the following is a precipitating cause of high-output cardiac failure:

- A. Alcoholic cardiomyopathy
- B. Hypertension
- C. Myocardial infarction
- D. Multiple PVCs
- E. Thyrotoxicosis

2. A 60-year-old female cigarette smoker complains of fatigue and dyspnea. The most specific evidence for congestive heart failure in this patient would be

- A. Ankle edema
- B. Wheezes
- C. S3 gallop
- D. Weight gain

MCQs

3. A 72-year-old male presents to the ER with history of paroxysmal nocturnal dyspnea and night cough along with physical exam findings of positive hepato-jugular reflux, rales, and S3 gallop. Which of the following is NOT a major criteria for congestive heart failure according to Framingham criteria?

- A. Paroxysmal nocturnal dyspnea
- B. Night cough
- C. Positive hepato-jugular reflux
- D. Rales
- E. S3 gallop

4. A 72-year-old man comes to the office with intermittent symptoms of dizziness on exertion, palpitations and cough occasionally productive of blood. On cardiac auscultation, a low-pitched diastolic rumble murmur is faintly heard at the apex. What is the most likely cause of the murmur?

- A. Rheumatic Fever as a youth.
- B. Long-standing hypertension.
- C. A silent MI within the past year.
- D. A congenital anomaly.
- E. Anemia from chronic blood loss.

MCQs

5. A 72-year-old man presents with shortness of breath that awakens him at night. He is unable to walk more than one city-block before stopping to catch his breath. Physical examination findings includes normal blood pressure, bilateral basilar rales, and neck vein distention the patient has diabetes and a known history of congestive heart failure. His last echocardiogram revealed a left ventricular ejection fraction of 25%. The patient has compliant with his medication regimen that includes an ACE inhibitor, beta-blocker, a loop diuretic, metformin, and glipizide. What is the most likely etiology for the patients' heart failure?

- A. Metabolic.
- B. Infiltrative.
- C. Coronary artery disease
- D. Valvular disease.
- E. Infectious.



Answers: 1-E 2-C 3-B 4-A 5-C



Medicine433



Medicine433

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*Medicine is a science of uncertainty
and an art of probability*



MEDICINE 433