

Chronic Heart Failure

(See also *Harrison's Principles of Internal Medicine*, 17th Edition, Chapter 227)

Definition

- Heart failure (HF)
 - An abnormality of cardiac structure or function that prevents the heart from ejecting or filling, causing dyspnea, fatigue, weakness and circulatory congestion
- Chronic HF
 - Heart failure that develops or progresses slowly and in which vascular congestion is common but arterial pressure is well maintained until very late
 - Exacerbations are precipitated by infection, tachycardia, non-compliance with medications, emotional stress, and arrhythmias.
- Refractory HF
 - Inadequate response to usual treatment

Forms of HF

- Systolic versus diastolic failure
 - Systolic failure: inability of the ventricle to contract normally, with symptoms resulting from inadequate cardiac output
 - Ejection fraction <40%
 - Diastolic failure: inability of the ventricle to relax and fill normally, with symptoms from elevated filling pressures
 - Ejection fraction >50%
 - Systolic and diastolic failure coexist in most patients with HF.
- Low-output versus high-output HF
 - Low-output HF: cardiac output at rest <2.2 L/min per m² (lower limit of normal) and fails to increase normally with exertion
 - Seen after myocardial infarction (MI), hypertension, dilated cardiomyopathy, and valvular or pericardial disease
 - Often accompanied by vasodilation and warm extremities
 - High-output HF: cardiac output >3.5 L/min per m² or upper limit of normal (before development of HF)
 - Seen in hyperthyroidism, anemia, pregnancy, arteriovenous fistulas, beriberi, and Paget's disease, usually with underlying heart disease
- Left-sided versus right-sided HF
 - Left-sided HF: left ventricle is hemodynamically overloaded and/or weakened, resulting in pulmonary congestion (dyspnea, orthopnea).
 - Right-sided HF: abnormality primarily affecting right ventricle, resulting in edema, congestive hepatomegaly and systemic venous distention

Epidemiology

- All types of HF
 - In the U.S.
 - Affects 4.5 million patients
 - About 0.5 million new cases annually
 - 1 million hospital admissions annually
 - >50,000 deaths annually
 - Increasing in prevalence and incidence in North America and Europe
 - More common in elderly persons
- Diastolic HF
 - More common in women than men
 - Seen especially in elderly women with hypertension

Risk Factors

- Hypertension
- Coronary artery disease
- Diabetes mellitus
- Dilated or hypertrophic cardiomyopathy
- Valvular heart disease
- Cardiotoxins

Etiology

- Ventricles respond to chronic hemodynamic overload with development of hypertrophy.
- Chronic pressure overload leads to development of concentric ventricular hypertrophy.
 - Ratio between wall thickness and ventricular cavity size increases.
- When elevated stroke volume is required for prolonged periods (e.g., valvular regurgitation, high-output states), the ventricle dilates and develops eccentric hypertrophy
 - Ratio between wall thickness and ventricular cavity diameter remains relatively constant
- In both eccentric hypertrophy and concentric hypertrophy, wall tension is initially maintained.
 - Cardiac function may remain stable for years; initially, progression of HF is usually slow, then accelerates.
 - Ultimate deterioration of myocardial function (or new insult, such as MI) leads to HF.
 - The ventricle dilates, and the ratio between wall thickness and cavity size decreases, increasing stress on the myocardium.
 - The ventricle undergoes remodeling to more spherical shape, further increasing stresses on the wall and sometimes causing mitral regurgitation, which may initiate a vicious circle.
 - Endogenous neurohormonal systems are activated, and cytokines appears to be involved.

Symptoms & Signs

Symptoms

- Dyspnea with exertion (early) or at rest (late)
- Orthopnea
 - Dyspnea when recumbent; relief with sitting upright or use of several pillows

- Paroxysmal nocturnal dyspnea
 - Attacks of severe shortness of breath and coughing at night; usually awakens patient
 - Coughing and wheezing often persist even with sitting upright.
 - Cardiac asthma: nocturnal dyspnea, wheezing and cough due to bronchospasm
- Fatigue and weakness
- Abdominal symptoms
 - Anorexia
 - Nausea
 - Abdominal pain and fullness
- Cerebral symptoms
 - Altered mental status due to reduced cerebral perfusion
 - Confusion
 - Difficulty concentrating
 - Impaired memory
 - Headache
 - Insomnia
 - Anxiety
- Nocturia

Physical findings

- Pulmonary rales with or without expiratory wheeze
- Lower-extremity edema
- Hydrothorax (pleural effusion)
- Ascites
 - Most common in constrictive pericarditis and tricuspid valve disease
- Congestive hepatomegaly
 - Positive abdominojugular reflux
- Jugular venous distention
- Third and fourth heart sounds: often present but not specific
- Elevated diastolic arterial pressure
- Depression
- Sexual dysfunction
- Findings in late/severe HF
 - Pulsus alternans
 - Regular rhythm with alternation in strength of peripheral pulses
 - Most common in cardiomyopathy, hypertensive, and ischemic heart disease
 - Diminished pulse pressure
 - Jaundice
 - Decreased urine output
 - Cardiac cachexia

Differential Diagnosis

- Pulmonary disease with dyspnea
 - Obstructive airway disease
 - Diffuse parenchymal lung disease
 - Pulmonary vascular occlusive disease
 - Disease of chest wall and respiratory muscles
 - Cardiac asthma: wheezing secondary to bronchospasm occurring at night

- Other conditions leading to peripheral edema
 - Varicose veins, cyclic edema, or gravitational effects: no jugular venous hypertension
 - Renal disease: abnormal renal function tests, urinalysis
 - Elevation of venous pressure is uncommon.
- Hepatic cirrhosis
 - Enlargement of liver
 - Ascites
 - Normal jugular venous pressure
 - Negative abdominojugular reflux

Diagnostic Approach

- Approach to patient
 - Detailed clinical examination
 - Two-dimensional echocardiography with Doppler flow studies
 - Electrocardiography (ECG)
 - Chest radiography
 - Brain natriuretic peptide (BNP) measurement
- Framingham criteria for diagnosis of congestive heart failure (CHF)
 - To establish a clinical diagnosis of CHF by these criteria, at least 1 major and 2 minor criteria are required.
 - Major criteria
 - Paroxysmal nocturnal dyspnea
 - Neck vein distention
 - Rales
 - Cardiomegaly
 - Acute pulmonary edema
 - S₃ gallop
 - Increased venous pressure
 - Positive hepatojugular reflux
 - Minor criteria
 - Extremity edema
 - Night cough
 - Dyspnea on exertion
 - Hepatomegaly
 - Pleural effusion
 - Vital capacity reduced by one-third from normal
 - Tachycardia (≥ 120 beats/min)
 - Major or minor criterion
 - Weight loss ≥ 4.5 kg over 5 days of treatment

Laboratory Tests

- ECG
 - Aids in determining etiology; e.g. abnormal Q waves in old MI, left ventricular hypertrophy in hypertension
- BNP measurement
 - >200 pg/mL supports diagnosis
 - <40 pg/mL rarely seen in HF
 - Useful in diagnosis, prognosis, and monitoring therapy
 - Helps in differentiating between cardiac and pulmonary causes of dyspnea

- Urinalysis
 - Albuminuria
 - High specific gravity
 - Low sodium level
- Renal function
 - Prerenal azotemia
- Electrolytes
 - Hypokalemia from thiazide diuretics
 - Hyperkalemia from potassium-retaining diuretics
 - Dilutional hyponatremia in late HF
- Liver function testing
 - Hepatic enzymes; frequently elevated
 - Elevated direct and indirect bilirubin level (late finding)

Imaging

- 2-dimensional echocardiography with Doppler flow
 - To determine underlying causes
 - To assess severity of ventricular systolic and/or diastolic dysfunction, valvular dysfunction
 - Question diagnosis if all cardiac chambers normal in volume, shortening and wall thickness
- Chest radiography
 - To detect cardiomegaly and pulmonary congestion

Diagnostic Procedures

- ECG rarely normal in systolic HF

Classification

- Stage A
 - At high risk for HF, but no evident structural heart disease or symptoms of HF
 - Examples
 - Hypertension
 - Coronary artery disease
 - Diabetes mellitus
- Stage B
 - Structural heart disease without symptoms of HF
 - Examples
 - Previous MI
 - Left ventricular systolic dysfunction, as in longstanding hypertension
 - Asymptomatic valvular disease
 - Dilated, hypertrophic, or restrictive cardiomyopathy
- Stage C
 - Structural heart disease with prior or current symptoms of HF
 - Shortness of breath
 - Fatigue
 - Reduced exercise tolerance

- Stage D
 - Refractory HF requiring specialized interventions
 - Marked symptoms at rest despite maximal medical therapy (e.g., recurrent hospitalizations or unable to be safely discharged from hospital without specialized interventions)

Treatment Approach

- Recommended therapy, by disease stage
 - Stage A
 - Treat hypertension.
 - Prescribe angiotensin-converting enzyme (ACE) inhibition, especially in hypertension
 - Encourage smoking cessation.
 - Treat lipid disorders.
 - Encourage regular exercise.
 - Discourage alcohol intake and illicit drug use.
 - Stage B
 - All measures under Stage A
 - Add beta-blocker.
 - Stage C
 - All measures under stages A and B
 - Add diuretic.
 - Add digitalis in systolic HF.
 - Add spironolactone.
 - Restrict dietary salt to <2 g/d (eliminate salt-rich foods and added salt in cooking or at table)
 - Stage D
 - All measures under Stages A, B, and C
 - Dietary salt restriction to <1 g/d
 - Mechanical assist devices
 - Heart transplantation
 - Continuous intravenous inotropic infusions for palliation (does not prolong life)
 - Hospice care

Specific Treatments

General measures

- Treat hypertension.
- Treat lipid disorders.
- Encourage smoking cessation.
- Discourage alcohol intake and illicit drug use.
- Recommend influenza and pneumococcal vaccines.
- Achieve optimal weight.
- Activity
 - Regular isotonic exercise in compensated HF
 - In moderately severe chronic HF: additional rest on weekend, scheduled naps or rest periods, avoidance of strenuous exertion
 - Avoid temperature extremes and tiring trips.

Diet

- Reduce sodium intake (normal diet contains 6–10 g of sodium daily)
 - Intake can be halved by excluding salt-rich foods and eliminating table salt.
 - Can be reduced to one-quarter with the above measures and omitting salt from cooking
 - In severe HF: limit to 1 g/d
 - Late in course: often, both sodium and water intake must be restricted.

Thiazides

- Indications
 - Use thiazides alone in mild Stage C HF and in combination with other diuretics in late, severe Stage C HF or Stage D
- Side effects
 - Hypokalemia
 - Hyponatremia
 - Metabolic alkalosis
 - Fatigue
 - Lethargy
 - Reduced excretion of uric acid or hyperuricemia
 - Impaired glucose tolerance
 - Rashes
 - Thrombocytopenia
 - Granulocytopenia
- Specific agents
 - Hydrochlorothiazide
 - Dosage: 25 mg/d to 25 mg qid
 - Chlorthalidone
 - Convenient
 - Most widely used long-acting thiazide
 - Dosage: 50–100 mg/d

Loop diuretics

- Indications for loop diuretics
 - All forms of HF, particularly in patients with severe or refractory HF and pulmonary edema
- Side effects
 - Metabolic alkalosis
 - Hypokalemia
 - Hyperuricemia
 - Hyperglycemia
 - Weakness
 - Nausea
 - Dizziness
- Specific agents
 - Furosemide
 - IV: initial dose, 20 mg (maximum, 80 mg)
 - PO: initial dosage, 20–40 mg 1–2 times daily (maximum, 400 mg/d)

- Bumetanide
 - IV: initial dose, 0.5 mg (maximum, 2 mg)
 - PO: initial dosage, 0.5–1.0 mg 1–2 times daily (maximum, 10 mg/d)
- Torsemide
 - IV: initial dose, 5 mg (maximum, 20 mg)
 - PO: initial dosage, 10 mg 1–2 times daily (maximum, 200 mg/d)

Other diuretics

- Metolazone
 - Dosage: 2.5 mg 1–2 times daily (maximum, 10 mg/d)
 - Actions and indications similar to thiazides
- Spironolactone
 - Dose: 12.5 to 25 mg/d; max: 25 mg twice daily
 - Use with loop diuretic
 - Weak diuretic, but has been shown to prolong life in Stage C HF
 - Side effects:
 - Hyperkalemia
 - Nausea
 - Epigastric distress
 - Mental confusion
 - Drowsiness
 - Gynecomastia
 - Erythematous eruptions
 - Contraindications to potassium-sparing diuretics
 - Potassium level >5 mmol/L
 - Monitor potassium level.
 - Renal failure
 - Hyponatremia

ACE inhibitors

- ACE inhibitors have a central role in prevention and treatment of HF at all stages.
- Contraindications
 - Do not use in hypotensive, pregnant, or possibly pregnant patients
- Side effects
 - Cough
 - Angioneurotic edema
 - Leukopenia
 - Teratogenic effects in first trimester
- Specific agents
 - Enalapril maleate
 - Initial dosage: 2.5 mg bid (maximum, 10–20 mg bid)
 - Fosinopril sodium
 - Initial dosage: 5–10 mg/d (maximum, 40 mg/d)
 - Lisinopril
 - Initial dosage: 2.5–5.0 mg/d (maximum, 20–40 mg/d)
 - Quinapril hydrochloride
 - Initial dosage: 10 mg bid (maximum, 40 mg bid)
 - Ramipril
 - Initial dosage: 1.25–2.5 mg/d (maximum, 10 mg/d)

Angiotensin receptor blockers

- Indications for angiotensin receptor blockers
 - Intolerance to ACE inhibitors
- Specific agents
 - Losartan
 - Initial dosage, 25 mg qd; target dosage, 50 mg bid
 - Valsartan
 - Initial dosage, 40 mg bid; target dose, 160 mg bid
 - Candesartan
 - Initial dosage, 4 mg qd, target dose, 32 mg qd

Beta blockers

- Indications for beta blockers: patients in Stage C HF
 - Stabilize first with ACE inhibitor, diuretics, and possibly digoxin.
 - Begin with low doses.
 - Titrate slowly.
 - Observe closely for hypotension, bradycardia, and worsening HF.
- Contraindications
 - Unstable HF
 - Hypotension
 - Severe fluid overload
 - Recent receipt of intravenous inotropic agents
 - Sinus bradycardia
 - Atrioventricular block
 - Bronchospastic disorders
- 15% of patients cannot tolerate beta blockade.
- 15% cannot tolerate target doses.
 - Low-dose beta blockade is preferable to no therapy.
- Specific agents
 - Bisoprolol
 - Initial dosage, 1.25 mg/d (maximum, 10 mg/d)
 - Carvedilol
 - Initial dosage, 3.125 mg bid (maximum, 25–50 mg bid)
 - Metoprolol CR/XL
 - Initial dosage, 12.5–25 mg/d (maximum, 200 mg/d)

Digoxin

- Indications for digoxin
 - Systolic HF complicated by atrial flutter and fibrillation and rapid ventricular rate
 - Especially useful in this setting
 - Systolic HF and sinus rhythm
 - Reduces symptoms of HF and need for hospitalization
 - Does not improve survival
- Little or no value in HF with sinus rhythm and the following conditions
 - Any form of diastolic HF
 - Hypertrophic cardiomyopathy
 - Myocarditis
 - Mitral stenosis
 - Chronic constrictive pericarditis

- Oral dosage: 0.50 mg/d for 2–3 days, then 0.125 mg every other day to 0.25 mg/d (maximum, 0.50 mg/d to avoid toxic effects)
- Complications: digitalis intoxication
 - Serious and potentially fatal
 - Risk factors
 - Advanced age
 - Hypokalemia
 - Hypomagnesemia
 - Hypoxemia
 - Renal insufficiency
 - Hypercalcemia
 - Acute MI
 - Quinidine, verapamil, amiodarone, and propafenone therapy
 - Reduce digoxin dose by half when patient is receiving these drugs.
 - Signs and symptoms
 - Anorexia
 - Nausea and vomiting
 - Exacerbations of HF
 - Weight loss
 - Cachexia
 - Neuralgias
 - Gynecomastia
 - Yellow vision
 - Delirium
- Most frequent disturbances of cardiac rhythm
 - Nonparoxysmal atrial tachycardia and/or variable atrioventricular block
 - Ventricular premature beats, bigeminy
 - Ventricular tachycardia or rarely ventricular fibrillation
- Treatment
 - Discontinue digoxin therapy.
 - β -adrenoceptor blocker or lidocaine
 - Oral potassium replacement (if hypokalemic)
 - Fab fragments of purified, intact digitalis antibodies (if life threatening)

Other vasodilators

- Indications
 - Chronic HF with systemic vasoconstriction despite ACE inhibitor therapy
- Specific agents
 - Isosorbide dinitrate
 - Initial dosage, 10 mg tid daily (maximum, 80 mg tid)
 - Sublingual isosorbide
 - Dosage: 2.5 mg as needed or before exercise to decrease dyspnea
 - Hydralazine
 - Initial dosage, 25 mg tid (maximum, 150 mg qid)

Ventricular resynchronization (biventricular pacing)

- Indications: chronic HF with impaired intraventricular conduction (QRS interval > 120 msec)
 - Increases ejection fraction
 - Increases distance walked in 6 minutes
 - Improved New York Heart Association class

- Improved quality of life and survival
- Need for hospitalization and/or intravenous medication for worsening HF halved

Management of arrhythmias

- Premature ventricular contractions and asymptomatic ventricular tachycardia (VT) are common in advanced HF.
- Sudden death due to ventricular fibrillation causes half of all deaths in advanced HF.
- Treatment of arrhythmias
 - Correction of electrolyte and acid–base disturbances (especially hypokalemia and digitalis intoxication)
 - Amiodarone (class III antiarrhythmic): drug of choice in HF with atrial fibrillation but not for preventing sudden death
 - Class I antiarrhythmics (quinidine, procainamide, flecainide) are contraindicated in HF.
 - Automatic implantable cardioverter-defibrillator (ICD) has been shown to prolong life.
 - After resuscitation from sudden death
 - Syncope or presyncope due to ventricular arrhythmia
 - Asymptomatic VT
 - VT can be induced during electrophysiologic testing.
 - Systolic HF with ejection fraction <35%
 - ICD is often combined in a single device with ventricular resynchronization.

Anticoagulants

- Warfarin
 - May be indicated in severe HF
- Heparin followed by warfarin
 - HF and
 - Atrial fibrillation
 - Previous venous thrombosis
 - Pulmonary or systemic emboli

Refractory HF

- Therapeutic options
 - Combination diuretics
 - Left ventricular or biventricular pacing
 - Additional vasodilators
 - Intravenous nitroglycerin or nesiritide
 - Mechanical circulatory support
 - Cardiac transplantation
 - Novel cardiac surgery, often accompanies multivessel coronary artery bypass grafting
 - Ventricular remodeling surgery
 - Mitral valve repair
 - Mechanical removal of extracellular fluid (rare; done in severe HF)
 - Thoracentesis
 - Paracentesis
- Exhaustion of all therapeutic options
 - Comfort care; possible hospice

- Continuous infusions of inotropic agents
 - Relieve symptoms, may stabilize patient awaiting transplantation but may shorten life (see Acute Heart Failure for dosing)
 - Dopamine if hypotension is present
 - Dobutamine in normotensive patients
- Consider continued infusions of inotropic agents, diuretics, anxiolytics, and analgesics.

Monitoring

- Serial BNP measurements
- Daily measurement of weight to aid in adjustment of diuretic dosage
- Education of patient and family about condition and critical importance of close attention to compliance
- Supervision of outpatient care by specially trained nurse or physician assistant

Complications

- Arrhythmias
- Sudden death, most due to ventricular fibrillation
 - Responsible for ~50% of all deaths
 - Can be prevented by ICD
- Pulmonary emboli secondary to venous thrombosis and systemic emboli secondary to intracardiac thrombi
 - Patients with HF and atrial fibrillation, previous venous thrombosis, and pulmonary or systemic emboli are at especially high risk and require anticoagulation.

Prognosis

- Poor prognosis is associated with:
 - Severely depressed ejection fraction (<15%)
 - Reduced maximal oxygen uptake (<12 mL/kg per min)
 - Inability to walk on a level and at a normal pace for more than 3 minutes
 - Reduced serum sodium concentration (<133 mEq/L)
 - Reduced serum potassium concentration (<3 mEq/L)
 - Markedly elevated BNP level (>500 pg/mL)
 - Frequent ventricular extrasystoles
- Natural history of HF: progressive but not predictable
 - Annual mortality rate
 - Asymptomatic patients: <5%
 - Mild disease: 10%
 - Moderate disease: 20–30%
 - Severe disease: 30–80%
 - Mechanism of death
 - Sudden death: 50%
 - Worsening HF (pump failure): 40%
 - Other: 10%
 - Survival rate of up to 80% at 2 years for patients rendered free of congestion
 - Survival rate may be as low as 50% at 6 months in patients with refractory symptoms.

Prevention

- For persons at risk for HF:
 - Treat hypertension.
 - Prescribe ACE inhibitors.
 - Encourage smoking cessation.
 - Treat lipid disorders.
 - Encourage regular exercise.
 - Discourage alcohol intake and illicit drug use.

ICD-9-CM

- 428.9 Heart failure, unspecified

See Also

- Acute Heart Failure
- Approach to Weight Loss
- Cor Pulmonale
- Dilated Cardiomyopathy
- Dyspnea
- Edema
- Heart Transplantation
- Myocarditis
- Pulmonary Arterial Hypertension, Secondary
- Pulmonary Edema

Internet Sites

- Professionals
 - Homepage
American Heart Association
- Patients
 - Heart Failure
American Heart Association
 - Heart failure
MedlinePlus

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PEARLS

- HF is the price paid for success.
 - As new treatments have reduced the mortality of acute MI, patients become candidates for later development of HF.
- Suspect HF in middle-aged or elderly patients who develop "asthma" for the first time.