

Heart Failure Prognosis & Management

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Heart failure prevalence is expected to continue to increase¹



21 MILLION

ADULTS WORLDWIDE ARE LIVING WITH HEART FAILURE AND THIS NUMBER IS EXPETED TO RISE^{1,2}



AGING POPULATION²



INCREASING PREVALENCE OF RISK FACTORS²

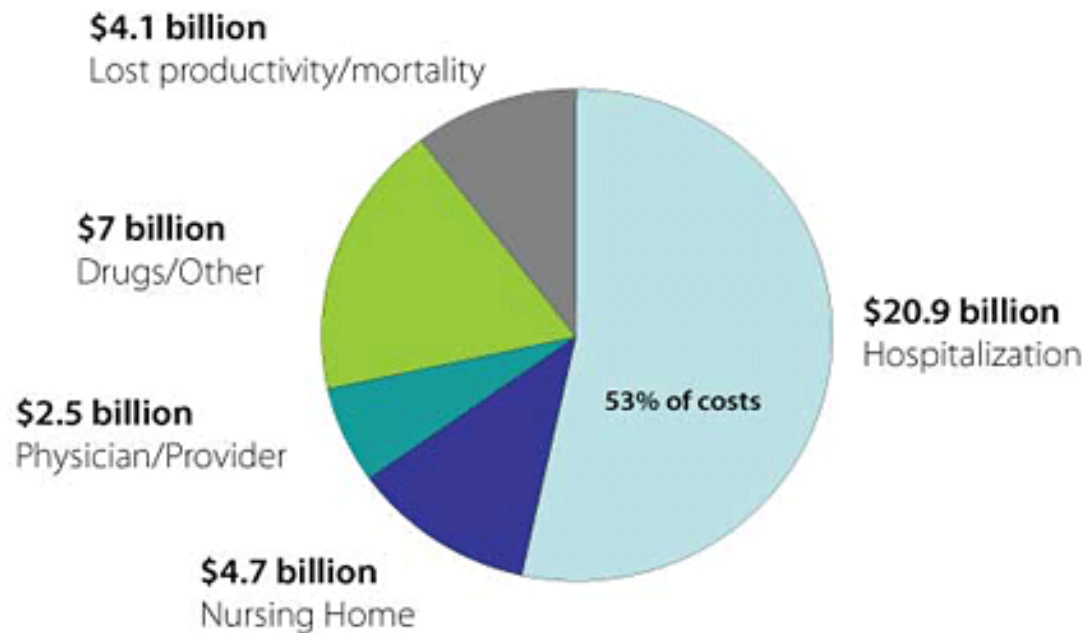


IMPROVED POST-MI SURVIVAL²

A person at age 40 has a **1 in 5** lifetime risk of developing heart failure, and more than 1 million hospitalisations due to heart failure are reported annually in Europe.^{1,4}

MI = myocardial infarction

1. Mozaffarian D, Benjamin EJ, Go AS, et al; for American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2015 update: a report from the American Heart Association. *Circulation*. 2015;131(4):e29-e322. 2. Mosterd A, Hoes AW. Clinical epidemiology of heart failure. *Heart*. 2007;93(9):1137-1146. 3. Velagaleti RS, Vasan R. Epidemiology of heart failure. In: Mann DL, ed. *Heart Failure: A Companion to Braunwald's Heart Disease*. 2nd ed. St Louis: Saunders; 2011. 4. Ponikowski P, Anker SD, AlHabib KF, et al. Heart failure: preventing disease and death worldwide. *ESC Heart Failure*. 2014;1(1):4-25.



Estimated 2010 total heart failure costs: \$39.2 billion

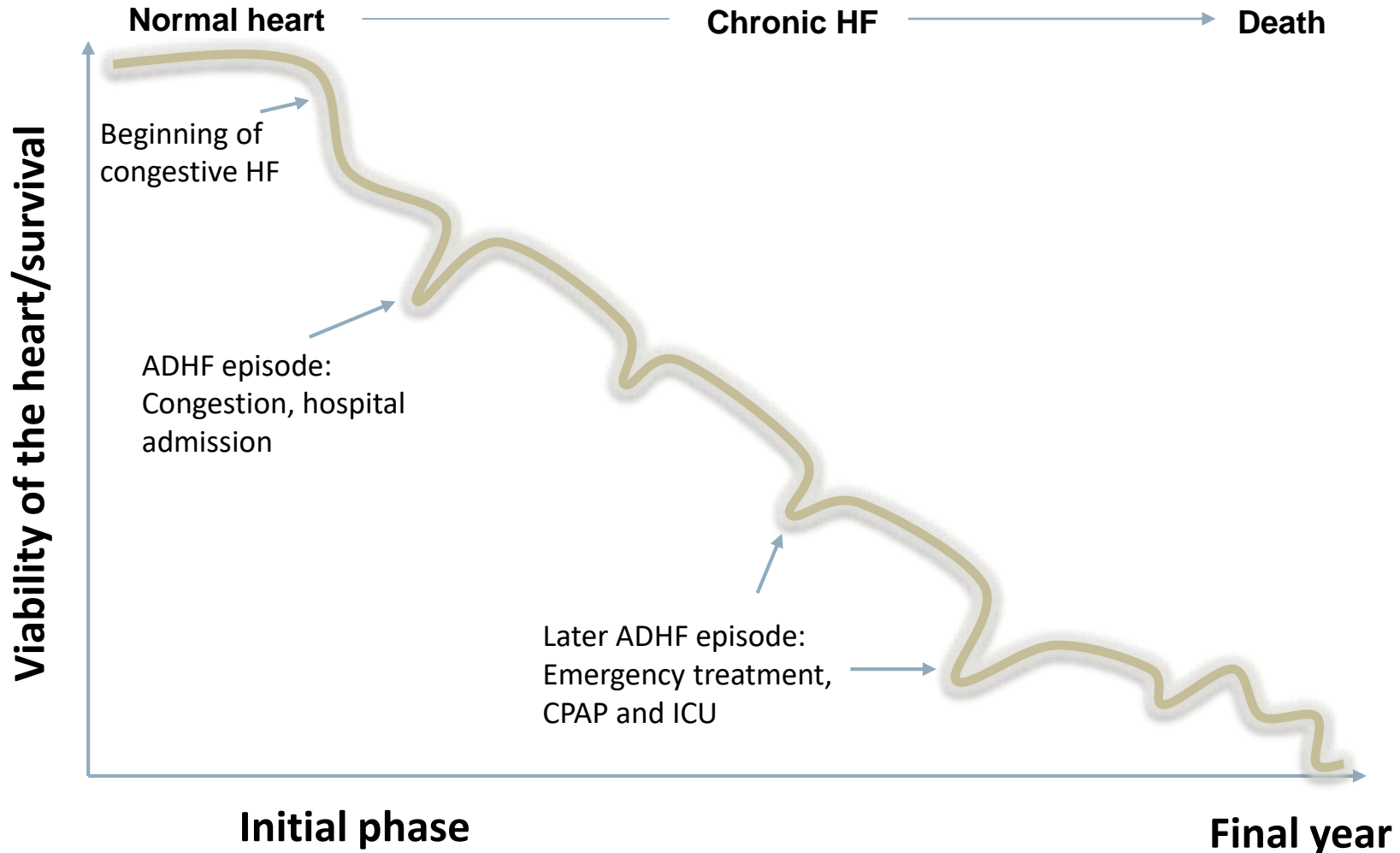
~50% OF PATIENTS DIE WITHIN
5 YEARS OF DIAGNOSIS

~1^{IN}4 HEART FAILURE PATIENTS
DIE WITHIN 1 YEAR OF DIAGNOSIS

~25%

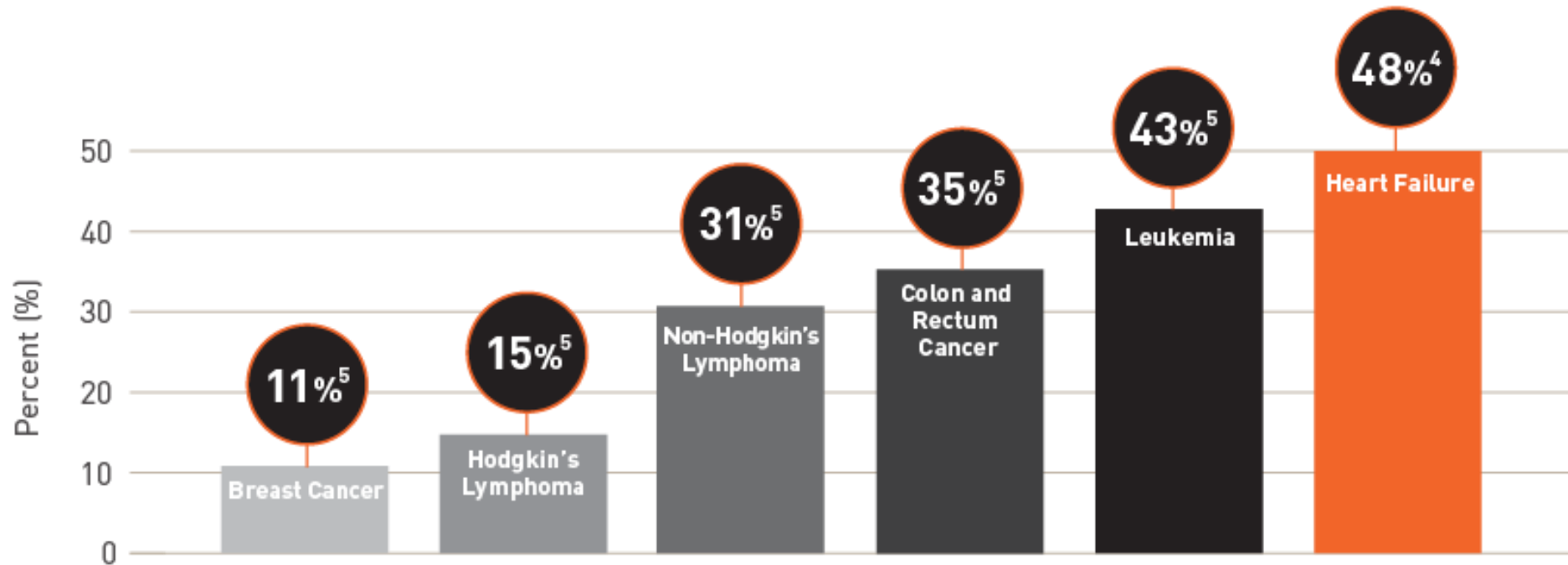
**OF HEART FAILURE PATIENTS
ARE READMITTED WITHIN
1 MONTH OF DISCHARGE⁵**

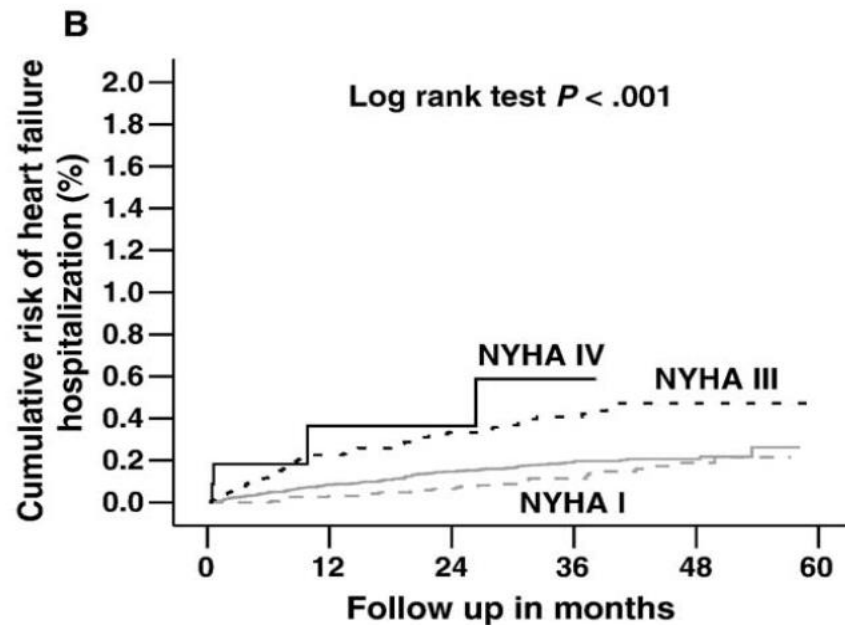
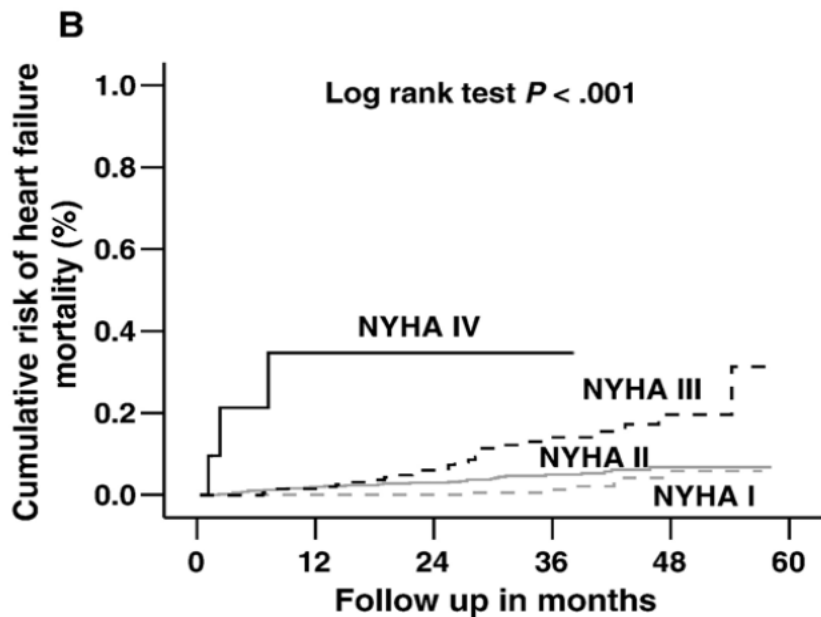
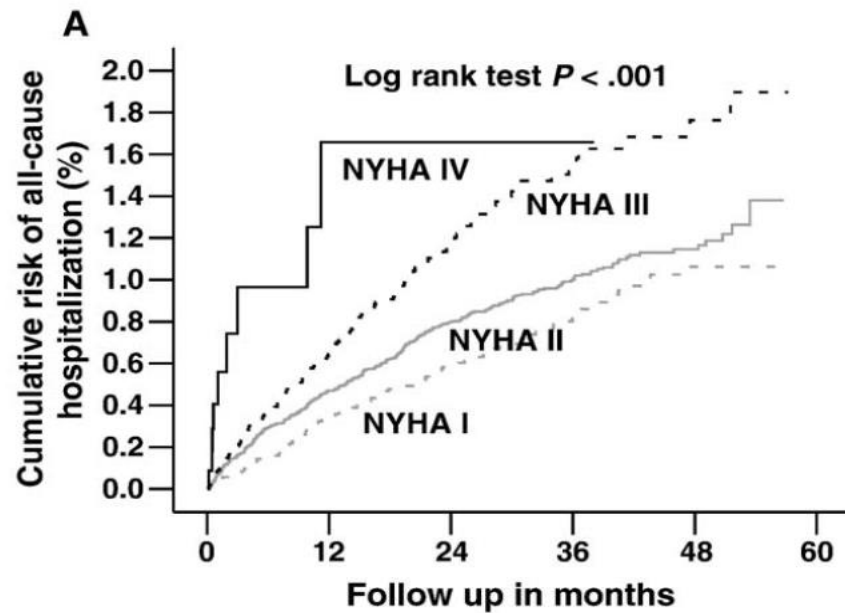
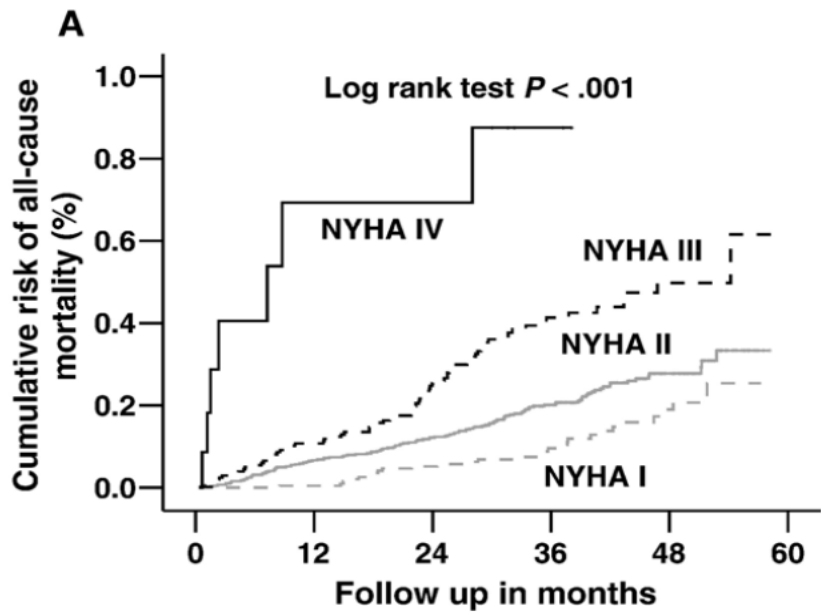
Heart failure progressive clinical course



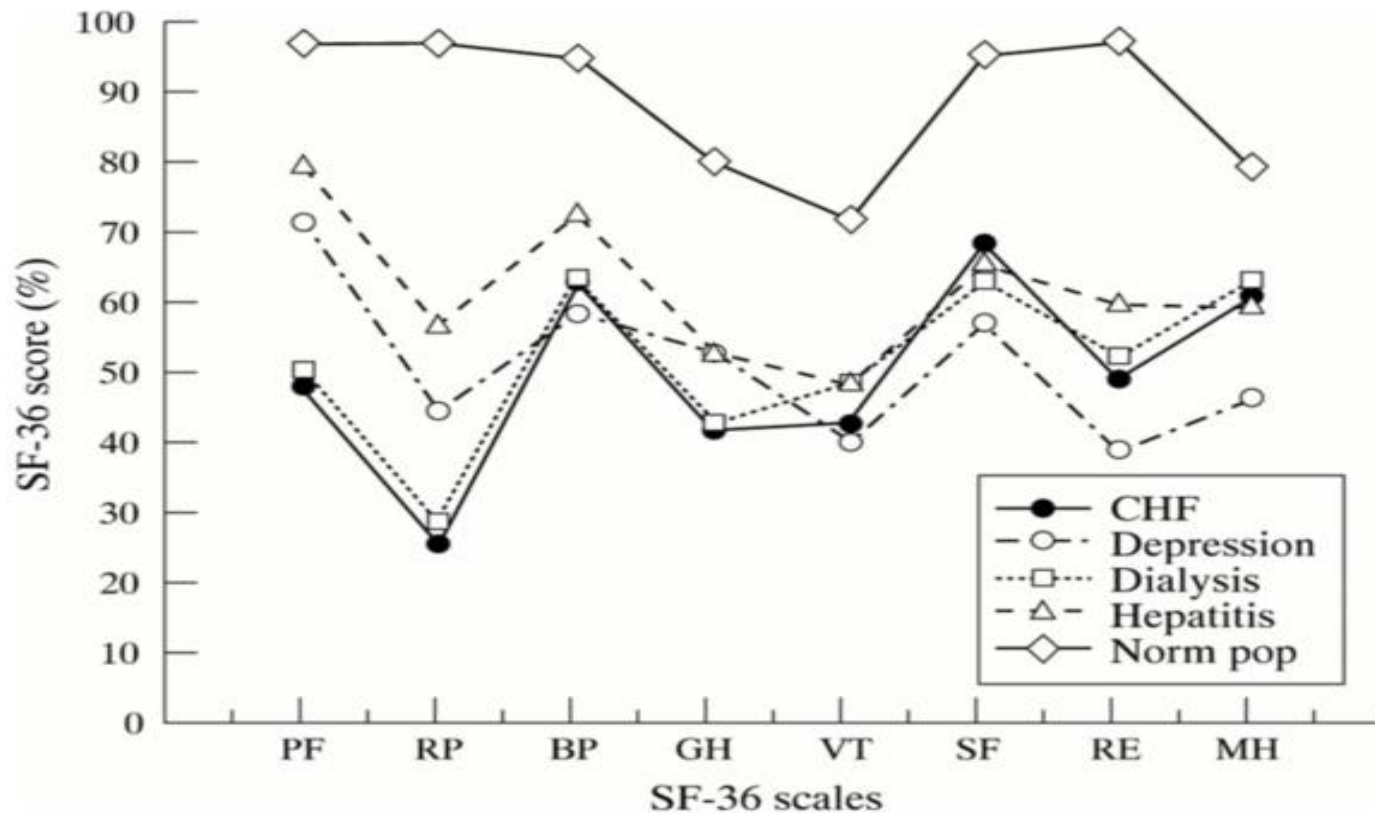
Heart failure is deadlier than many cancers

FIVE-YEAR DEATH RATES

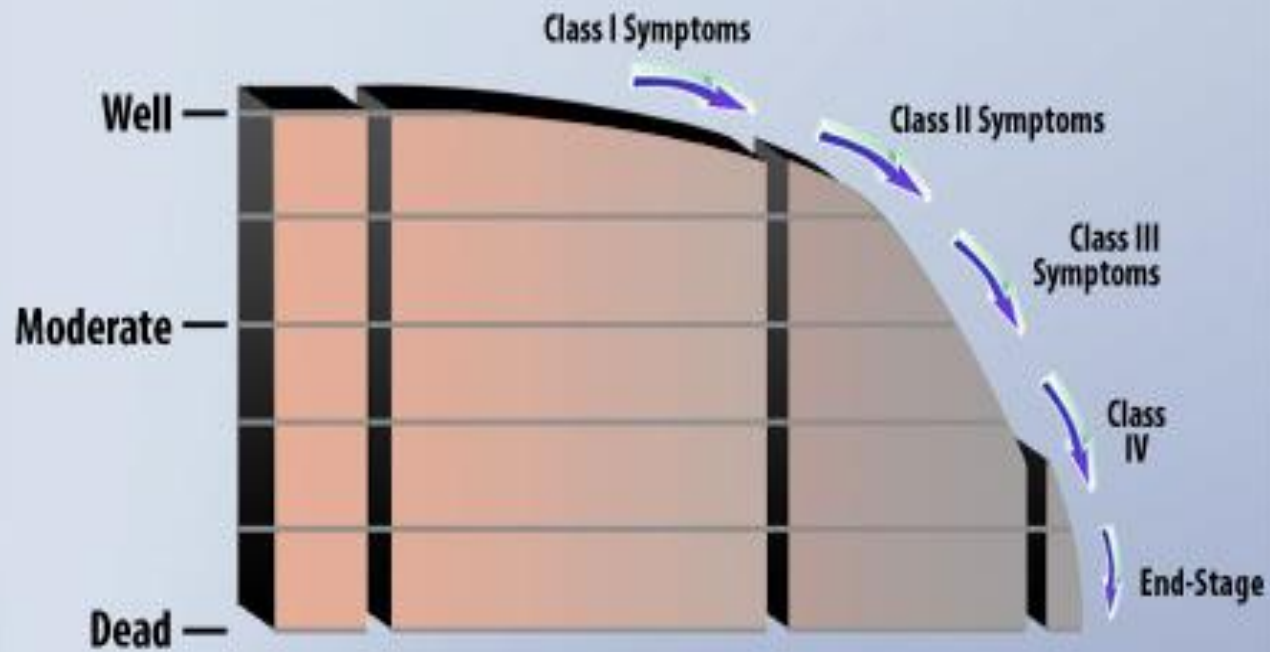




Quality of Life in Heart Failure



New York Heart Association (NYHA) Classifications



Definition

- Heart failure is a complex clinical syndrome

Can result from:

- structural or functional cardiac disorder
- impairs the ability of the ventricle to **fill** with or **eject** blood

- Inability of the heart to pump blood at an output sufficient to meet the body's demands

- Characterized by:
- signs and symptoms of intravascular and interstitial volume overload and/or
- manifestations of inadequate tissue perfusion

- Heart failure may result from an acute insult to cardiac function, such as a large myocardial infarction, valvular diseases, myocarditis, and cardiogenic shock
- More commonly, from a chronic process

Common Causes

- Coronary artery disease
- Hypertension
- Dilated cardiomyopathy
- Valvular heart disease

Common Causes

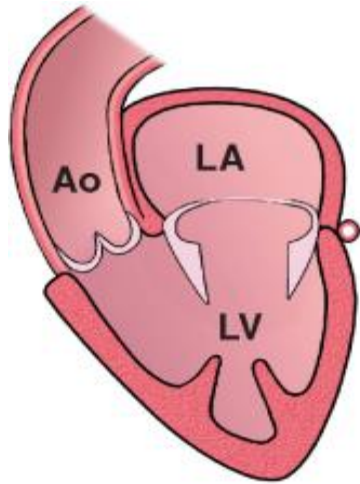
- Coronary artery disease
- Hypertension
- Valvular heart disease
- Dilated cardiomyopathy
- Cor-pulmonale

Cardiomyopathy

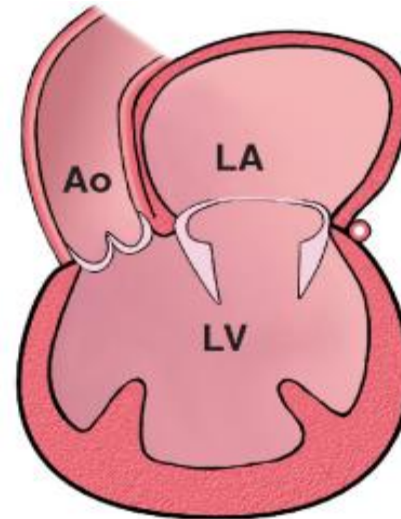
- "heart muscle diseases of unknown cause"
- Diseases of the myocardium associated with cardiac dysfunction

Classification

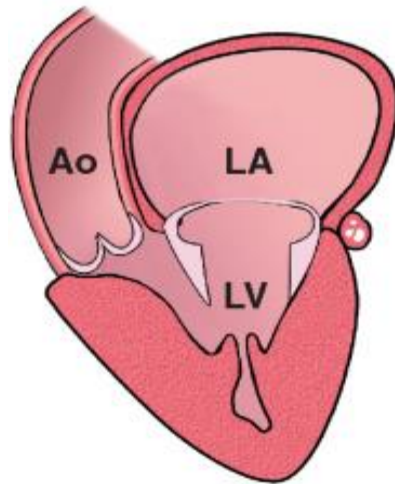
- Dilated cardiomyopathy (DCM)
- Hypertrophic cardiomyopathy (HCM)
- Restrictive cardiomyopathy (RCM)
- Arrhythmogenic right ventricular cardiomyopathy/dysplasia (ARVC/D)
- Unclassified cardiomyopathies



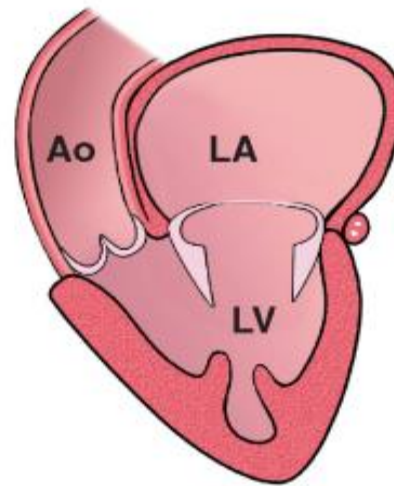
Normal



Dilated cardiomyopathy



Hypertrophic cardiomyopathy



Restrictive cardiomyopathy

Dilated Cardiomyopathy

- Dilated cardiomyopathy is characterized by ventricular dilation and impaired contractile performance, which may involve the left or both ventricles

- May develop as a consequence of prior myocarditis or as a result of a recognized toxin, infection, predisposing cardiovascular disease (e.g., hypertension, ischemic or valvular heart disease)
- When no cause or associated disease is identified, dilated cardiomyopathy has been termed **idiopathic**
- 50 to 60% of such patients have familial disease, and disease-causing mutations currently can be identified in 10 to 20% of such families.

- A trigger with immune-mediated pathogenesis in genetically predisposed individuals
- One third of probands and family members develop low-titer, organ-specific autoantibodies to cardiac α -myosin
- Viral persistence has also been implicated as an ongoing trigger of immune-mediated damage

Alcoholic Cardiomyopathy

- Alcohol and its metabolite, acetaldehyde, are cardiotoxins acutely and chronically.
- Myocardial depression is initially reversible but, if sustained, can lead to irreversible vacuolization, mitochondrial abnormalities, and fibrosis
- The amount of alcohol necessary to produce symptomatic cardiomyopathy in susceptible individuals is not known
- Abstinence leads to improvement in at least 50% of patients with severe symptoms, some of whom normalize their left ventricular ejection fractions

Chemotherapy

- **Doxorubicin** (Adriamycin) cardiotoxicity causes characteristic histologic changes on endomyocardial biopsy, with overt heart failure in 5 to 10% of patients who receive doses greater than or equal to 450 mg/m² of body surface area
- **Cyclophosphamide** and **ifosfamide** can cause acute severe heart failure and malignant ventricular arrhythmias
- **5-Fluorouracil** can cause coronary artery spasm and depressed left ventricular contractility.
- **Trastuzumab** has been associated with an increased incidence of heart failure

Skeletal Myopathies

- Duchenne's muscular dystrophy and Becker's X-linked skeletal muscle dystrophy typically include cardiac dysfunction
- Maternally transmitted mitochondrial myopathies such as Kearns-Sayre syndrome frequently cause cardiac myopathic changes

Peripartum Cardiomyopathy

- Peripartum cardiomyopathy appears in the last month of pregnancy or in the first 5 months after delivery in the absence of preexisting cardiac disease
- Lymphocytic myocarditis, found in 30 to 50% of biopsy specimens, suggests an immune component
- The prognosis is improvement to normal or near-normal ejection fraction during the next 6 months in more than 50% of patients.

Hypertrophic Cardiomyopathy

- Genetically determined myocardial disease
- Defined clinically by the presence of unexplained left ventricular hypertrophy
- Pathologically by the presence of myocyte disarray surrounding increased areas of loose connective tissue

- Usually familial, with autosomal dominant inheritance.
- Abnormalities in sarcomeric contractile protein genes account for approximately 50 to 60% of cases

Pathology

- Typically, heart weight is increased and the interventricular septum is hypertrophic,
- Any pattern of thickening may occur
- Histologically, the hallmark of hypertrophic cardiomyopathy is myocyte disarray.

- Clinical expression of left ventricular hypertrophy usually occurs during periods of rapid somatic growth,
- May be during the first year of life or childhood but more typically during adolescence and, occasionally, in the early 20s

- Most patients are asymptomatic or have only mild or intermittent symptoms.
- Symptomatic progression is usually slow, age related, and associated with a gradual deterioration in left ventricular function over decades

- Symptoms may develop at any age, even many years after the appearance of LVH
- Occasionally, sudden death may be the initial presentation

Restrictive Cardiomyopathy

- Characterized by impaired filling and reduced diastolic volume of the left and/or right ventricle despite normal or near-normal systolic function and wall thickness

- Primary forms are uncommon,
- Secondary forms, the heart is affected as part of a multisystem disorder,
- Usually present at the advanced stage of an infiltrative disease (e.g., amyloidosis or sarcoidosis) or a systemic storage disease (e.g., hemochromatosis).

- Restrictive cardiomyopathy may be familial
- Part of the genetic and phenotypic expression of hypertrophic cardiomyopathy caused by sarcomeric contractile protein gene abnormalities

- Secondary forms:
 - amyloidosis, hemochromatosis, several of the glycogen storage diseases, and Fabry's disease
- Reported in association with skeletal myopathy and conduction system disease as part of the phenotypic spectrum caused by mutations in lamin A or C.

CAUSES OF RESTRICTIVE CARDIOMYOPATHIES

INFILTRATIVE DISORDERS

Amyloidosis
Sarcoidosis

STORAGE DISORDERS

Hemochromatosis
Fabry's disease
Glycogen storage diseases

FIBROTIC DISORDERS

Radiation
Scleroderma
Drugs (e.g., doxorubicin, serotonin, ergotamine)

METABOLIC DISORDERS

Carnitine deficiency
Defects in fatty acid metabolism

ENDOMYOCARDIAL DISORDERS

Endomyocardial fibrosis
Hypereosinophilic syndrome (Lofler's endocarditis)

MISCELLANEOUS CAUSES

Carcinoid syndrome

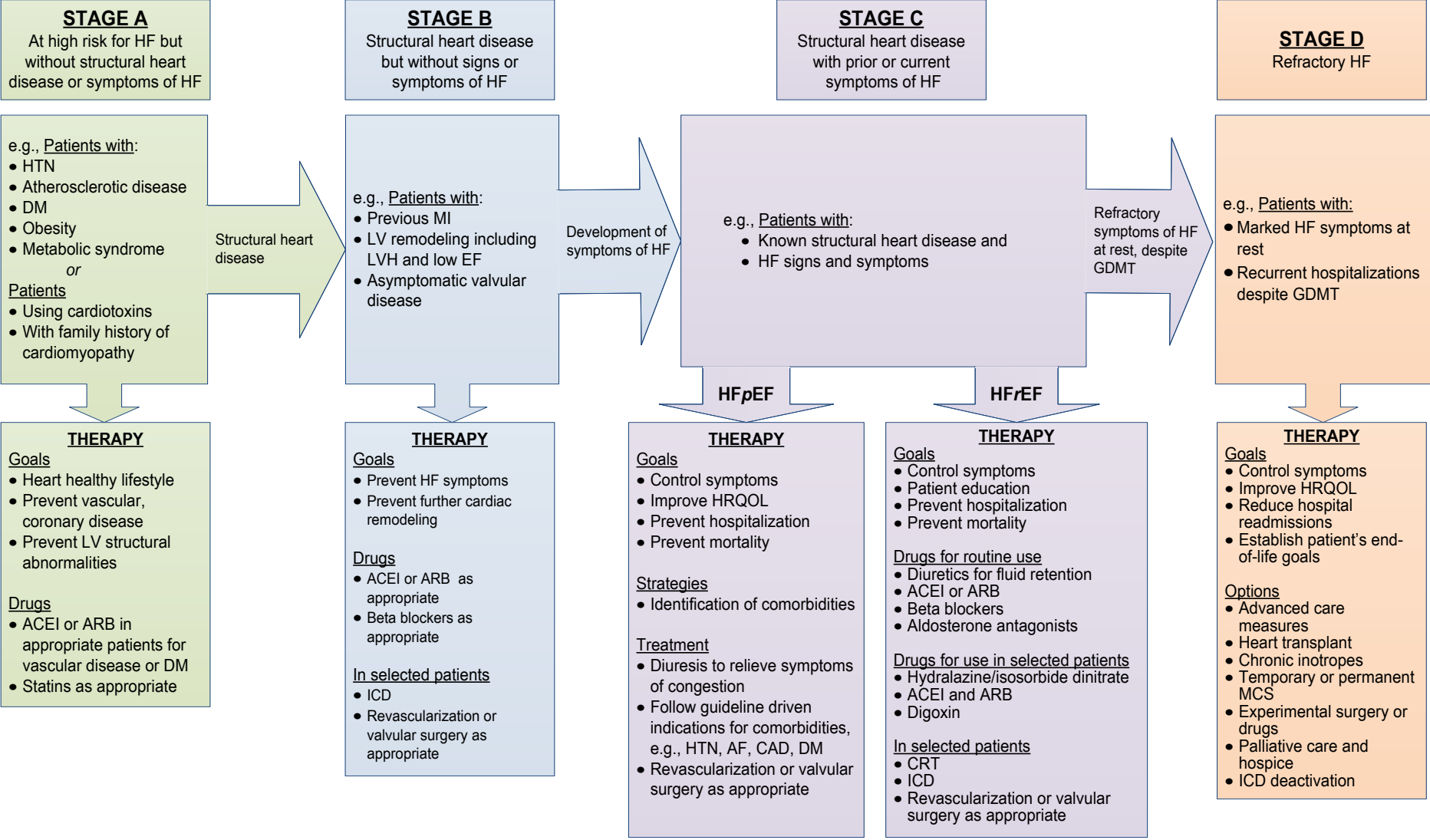
Pathophysiology

- Increased stiffness of the endocardium or myocardium, induces ventricular pressures to rise disproportionately to small changes in volume until a maximum is reached.

Stages, Phenotypes and Treatment of HF

At Risk for Heart Failure

Heart Failure



Nomenclature

- Heart failure vs.
- Cardiomyopathy
- LV dysfunction
- Pulmonary edema

Classification

- Left vs. Right
- Systolic vs. Diastolic
- High output vs. low output

Heart Failure Syndrome

- The initial manifestations of hemodynamic dysfunction are a reduction in stroke volume and a rise in ventricular filling pressures under conditions of increased systemic demand for blood flow
- This stimulates a variety of interdependent compensatory responses involving the cardiovascular system, neurohormonal systems, and alterations in renal physiology

Modified Framingham clinical criteria for the diagnosis of heart failure

Major
Paroxysmal nocturnal dyspnea
Orthopnea
Elevated jugular venous pressure
Pulmonary rales
Third heart sound
Cardiomegaly on chest x-ray
Pulmonary edema on chest x-ray
Weight loss ≥ 4.5 kg in five days in response to treatment of presumed heart failure
Minor
Bilateral leg edema
Nocturnal cough
Dyspnea on ordinary exertion
Hepatomegaly
Pleural effusion
Tachycardia (heart rate ≥ 120 beats/min)
Weight loss ≥ 4.5 kg in five days
Diagnosis
The diagnosis of heart failure requires that 2 major or 1 major and 2 minor criteria cannot be attributed to another medical condition.

From Senni, M, Tribouilloy, CM, Rodeheffer, RJ, et al, *Circulation* 1998; 98:2282; adapted from McKee, PA, Castelli, WP, McNamara, PM, Kannel, WB. *N Engl J Med* 1971; 85:1441.

Evaluation

Evidence for Congestion (Elevated Filling Pressure)

- Orthopnea
- High Jugular Venous Pressure
- Increasing S_3
- Loud P_2
- Edema
- Ascites
- Rales (Uncommon)
- Abdominojugular Reflux
- Valsalva Square Wave

Congestion at Rest?

Evidence for Low Perfusion

- Narrow Pulse Pressure
- Pulsus Alterations
- Cool Forearms and Legs
- May Be Sleepy, Obtunded
- ACE Inhibitor-Related
 - Symptomatic Hypotension
- Declining Serum Sodium Level
- Worsening Renal Function

Low Perfusion at Rest?

	No	Yes
No	Warm and Dry A	Warm and Wet B
Yes	Cold and Dry L	Cold and Wet C

NYHA Classification

Class I	No limitations of activities; no symptoms with ordinary activities
Class II	Slight or mild limitation of activity; comfortable with rest or mild exertion
Class III	Marked limitation of activity; comfortable only at rest
Class IV	Any physical activity brings on discomfort, and symptoms occur at rest

Investigations to consider in all patients

Transthoracic echocardiography is recommended to evaluate cardiac structure and function, including diastolic function (Section 4.1.2), and to measure LVEF to make the diagnosis of HF, assist in planning and monitoring of treatment, and to obtain prognostic information.

A 12-lead ECG is recommended to determine heart rhythm, heart rate, QRS morphology, and QRS duration, and to detect other relevant abnormalities (*Table 5*). This information also assists in planning treatment and is of prognostic importance. A completely normal ECG makes systolic HF unlikely.

Measurement of blood chemistry (including sodium, potassium, calcium, urea/blood urea nitrogen, creatinine/estimated glomerular filtration rate, liver enzymes and bilirubin, ferritin/TIBC) and thyroid function is recommended to:

- (i) Evaluate patient suitability for diuretic, renin–angiotensin–aldosterone antagonist, and anticoagulant therapy (and monitor treatment)
- (ii) Detect reversible/treatable causes of HF (e.g. hypocalcaemia, thyroid dysfunction) and co-morbidities (e.g. iron deficiency)
- (iii) Obtain prognostic information.

A complete blood count is recommended to:

- (i) Detect anaemia, which may be an alternative cause of the patient's symptoms and signs and may cause worsening of HF
- (ii) Obtain prognostic information.

Measurement of natriuretic peptide (BNP, NT-proBNP, or MR-proANP) should be considered to:

- (i) Exclude alternative causes of dyspnoea (if the level is below the exclusion cut-point—see *Figure 1*—HF is very unlikely)
- (ii) Obtain prognostic information.

A chest radiograph (X-ray) should be considered to detect/exclude certain types of lung disease, e.g. cancer (does not exclude asthma/ COPD). It may also identify pulmonary congestion/oedema and is more useful in patients with suspected HF in the acute setting.

Investigations to consider in selected patients

CMR imaging is recommended to evaluate cardiac structure and function, to measure LVEF, and to characterize cardiac tissue, especially in subjects with inadequate echocardiographic images or where the echocardiographic findings are inconclusive or incomplete (but taking account of cautions/contraindications to CMR).

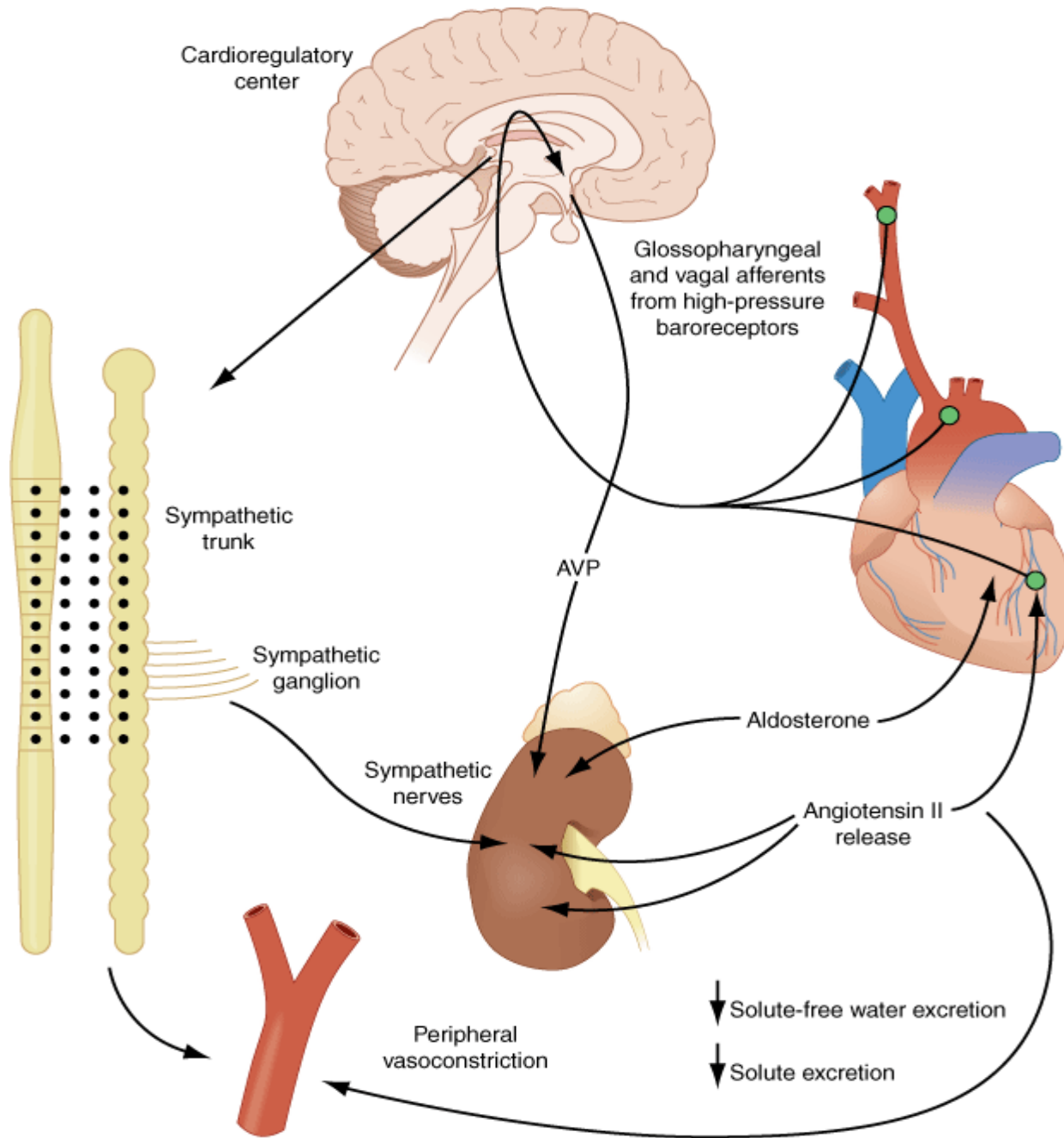
Coronary angiography is recommended in patients with angina pectoris, who are considered suitable for coronary revascularization, to evaluate the coronary anatomy.

Myocardial perfusion/ischaemia imaging (echocardiography, CMR, SPECT, or PET) should be considered in patients thought to have CAD, and who are considered suitable for coronary revascularization, to determine whether there is reversible myocardial ischaemia and viable myocardium.

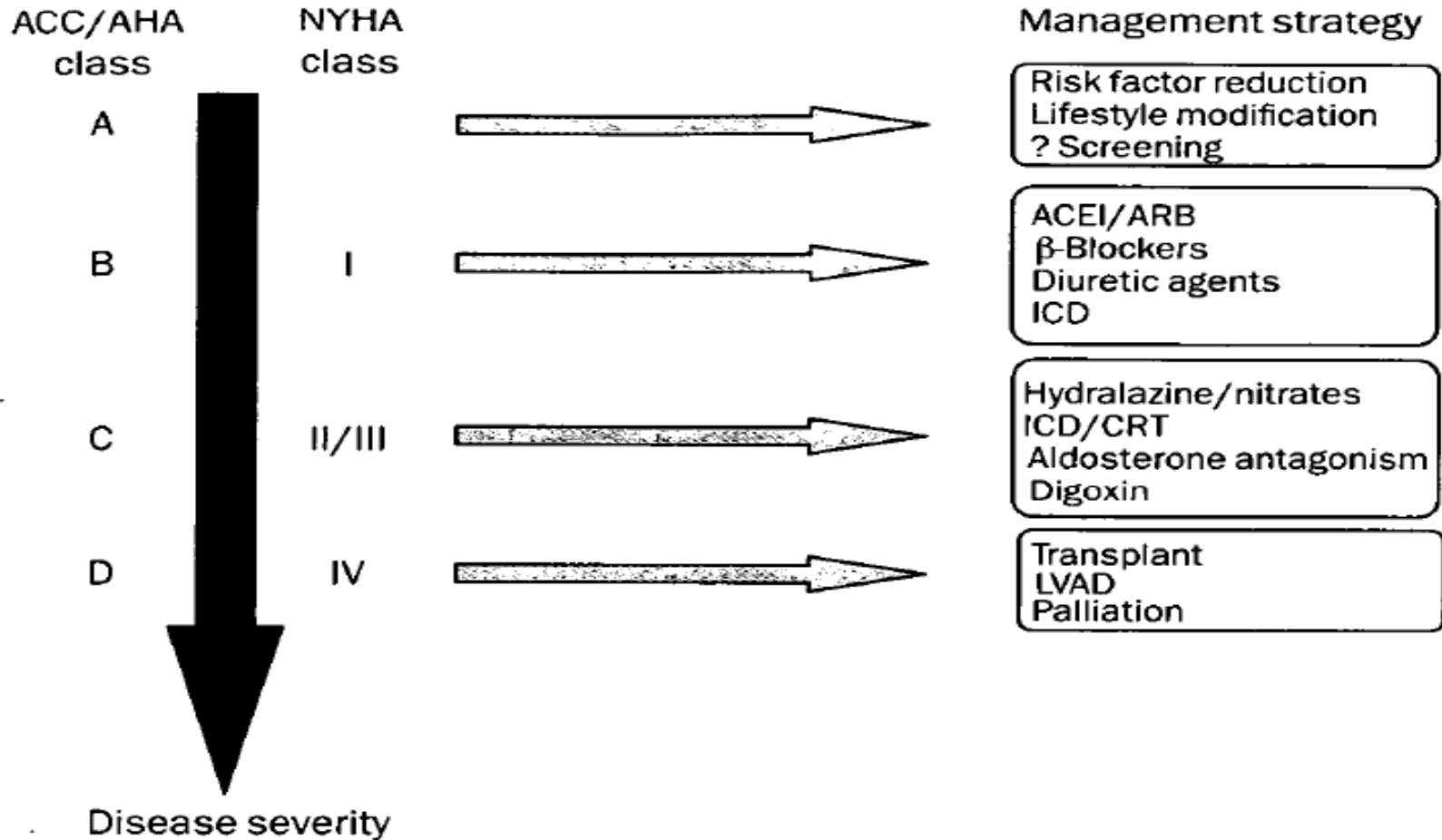
Left and right heart catheterization is recommended in patients being evaluated for heart transplantation or mechanical circulatory support, to evaluate right and left heart function and pulmonary arterial resistance.

Exercise testing should be considered:

- (i) To detect reversible myocardial ischaemia
- (ii) As part of the evaluation of patients for heart transplantation and mechanical circulatory support
- (iii) To aid in the prescription of exercise training
- (iv) To obtain prognostic information.



Therapy



HFrEF Stage C
NYHA Class I – IV
Treatment:

Class I, LOE A
ACEI or ARB AND
Beta Blocker

For all volume overload,
NYHA class II-IV patients

For persistently symptomatic
African Americans,
NYHA class III-IV

For NYHA class II-IV patients.
Provided estimated creatinine
>30 mL/min and K+ <5.0 mEq/dL

Add

Class I, LOE C
Loop Diuretics

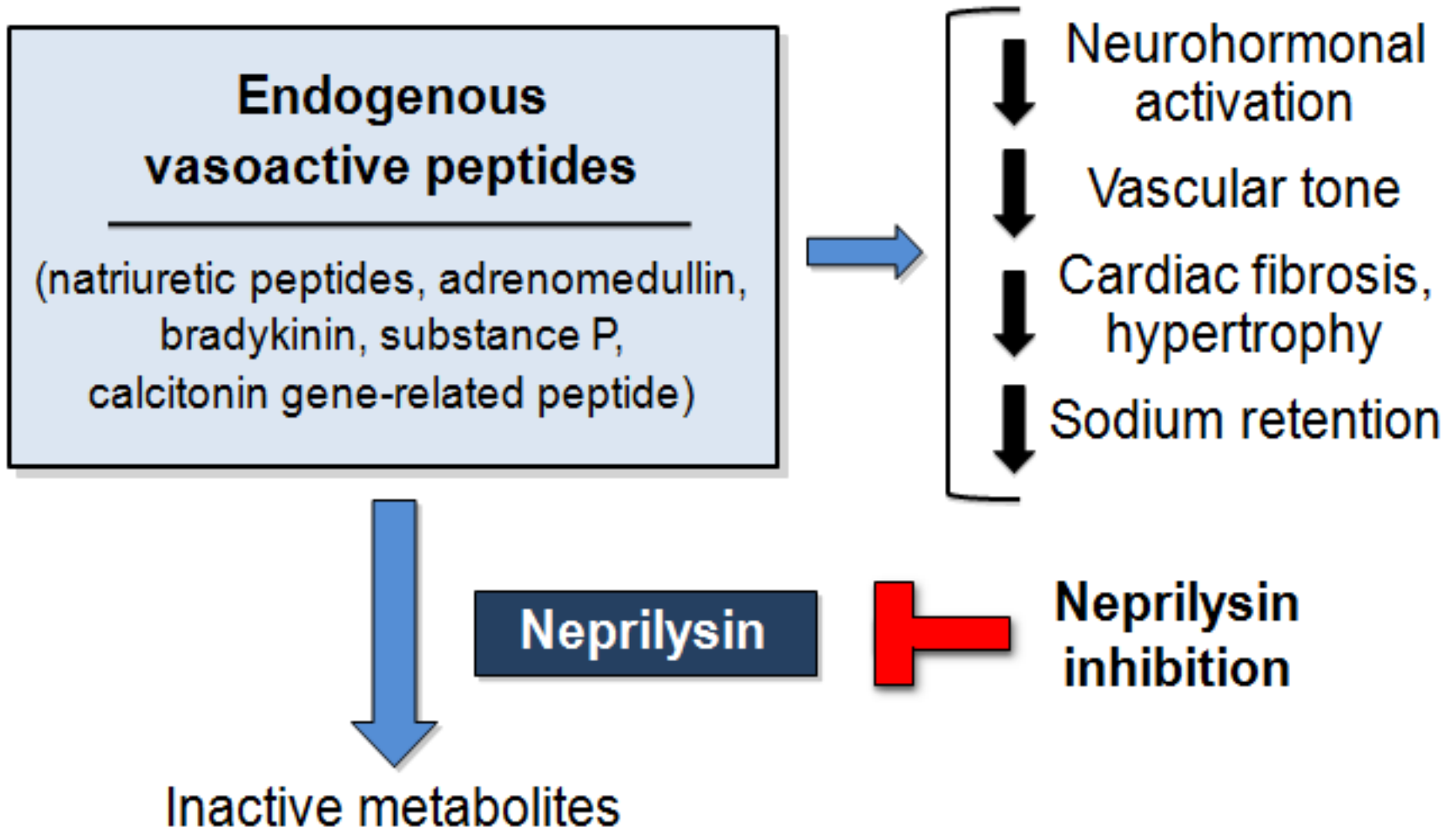
Add

Class I, LOE A
Hydral-Nitrates

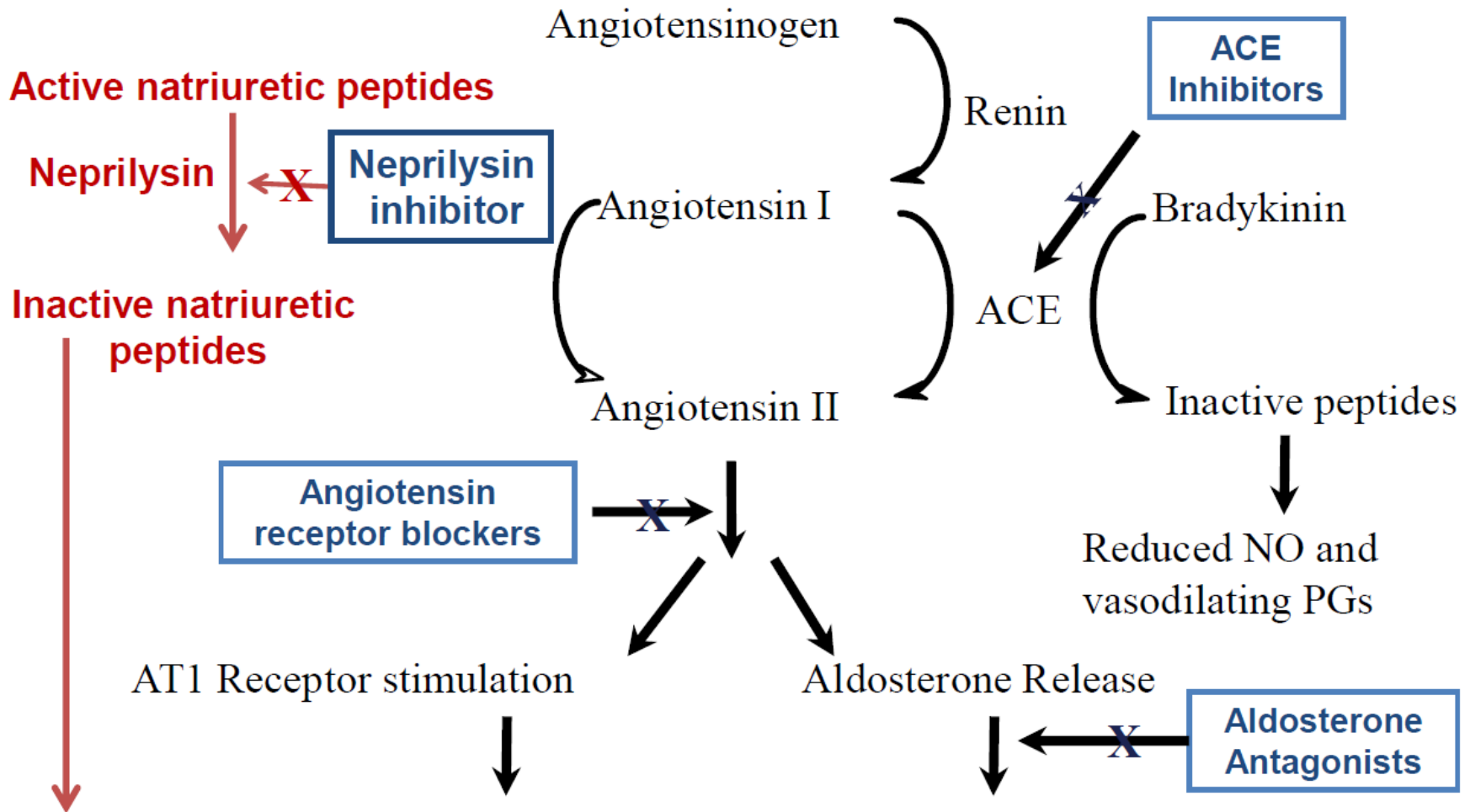
Add

Class I, LOE A
Aldosterone
Antagonist

Natriuretic Peptides



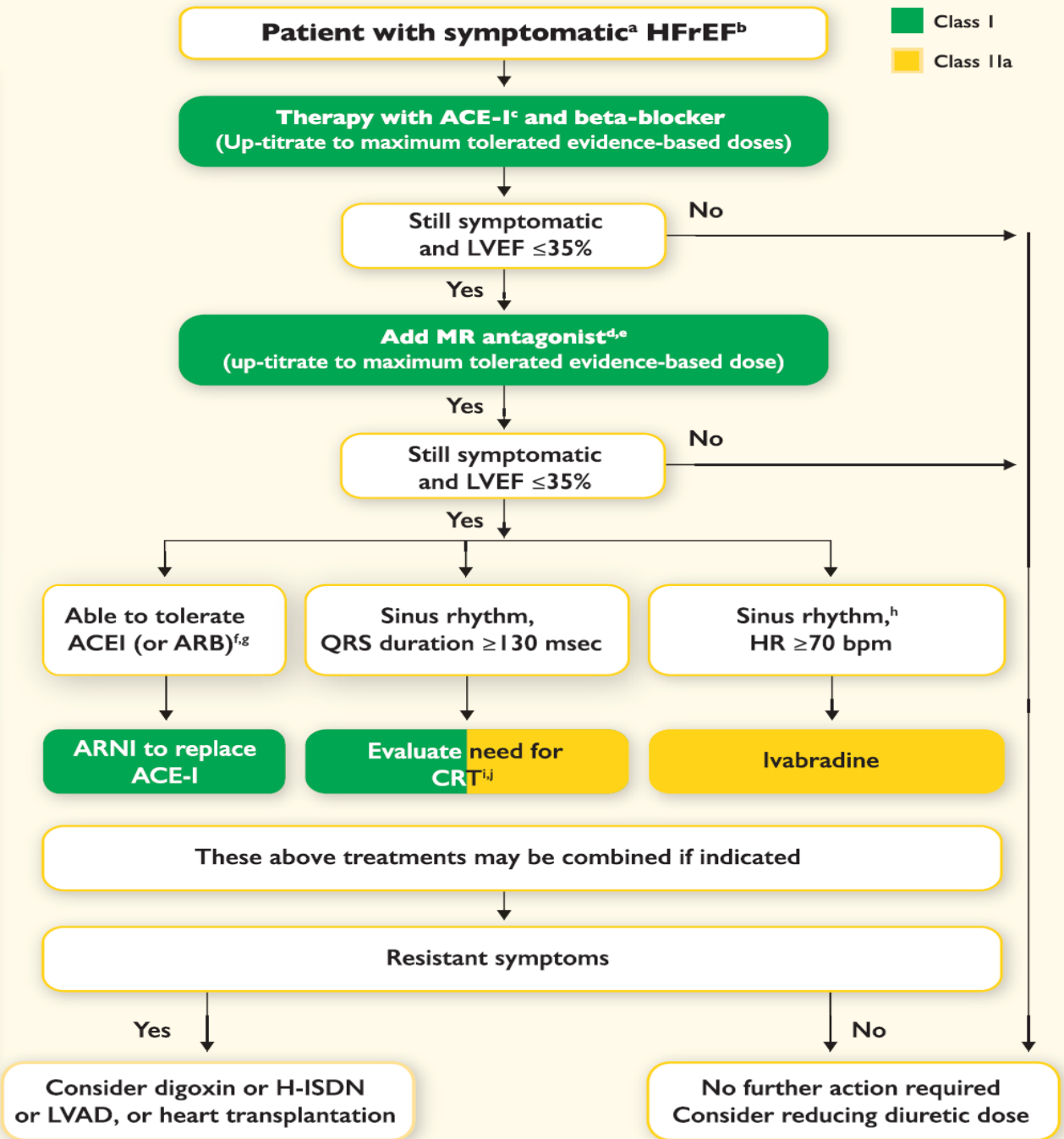
Neurohormonal blockade in HF – revisited



Vasoconstriction, Na retention, myocyte hypertrophy and apoptosis, endothelial dysfunction, sympathetic activation, free radical generation, etc

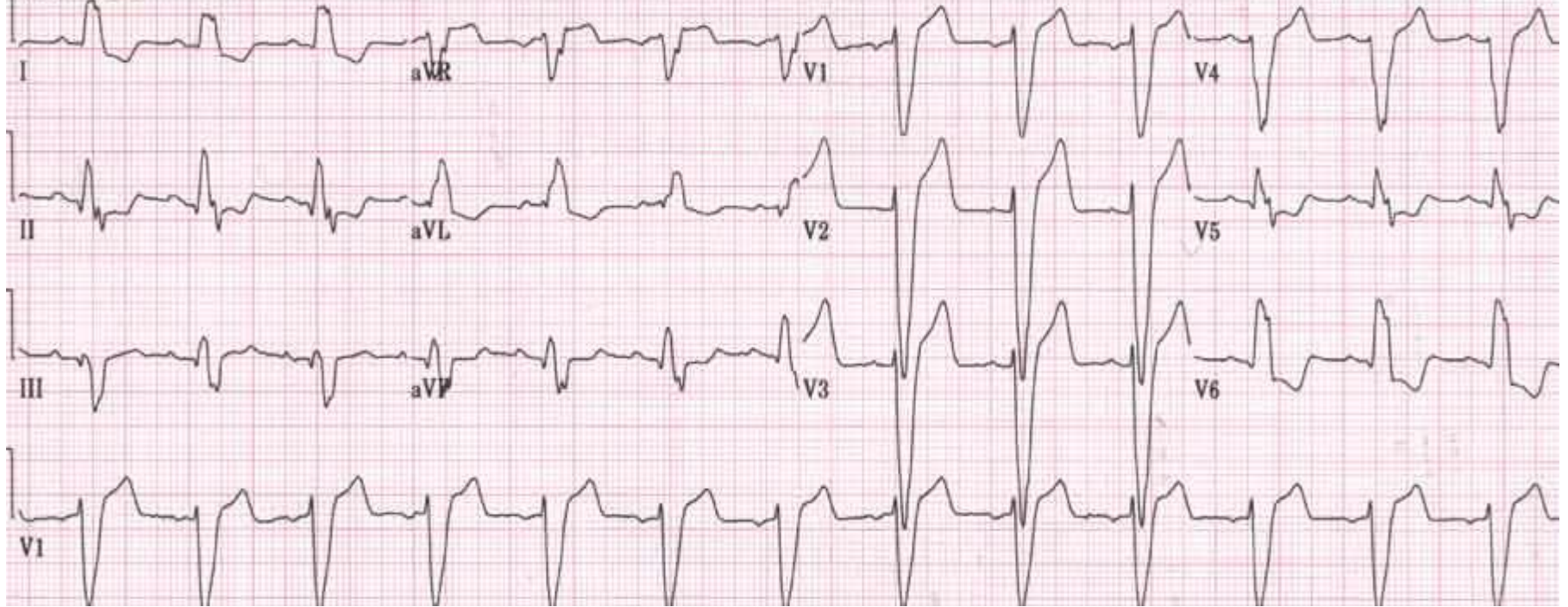
Diuretics to relieve symptoms and signs of congestion

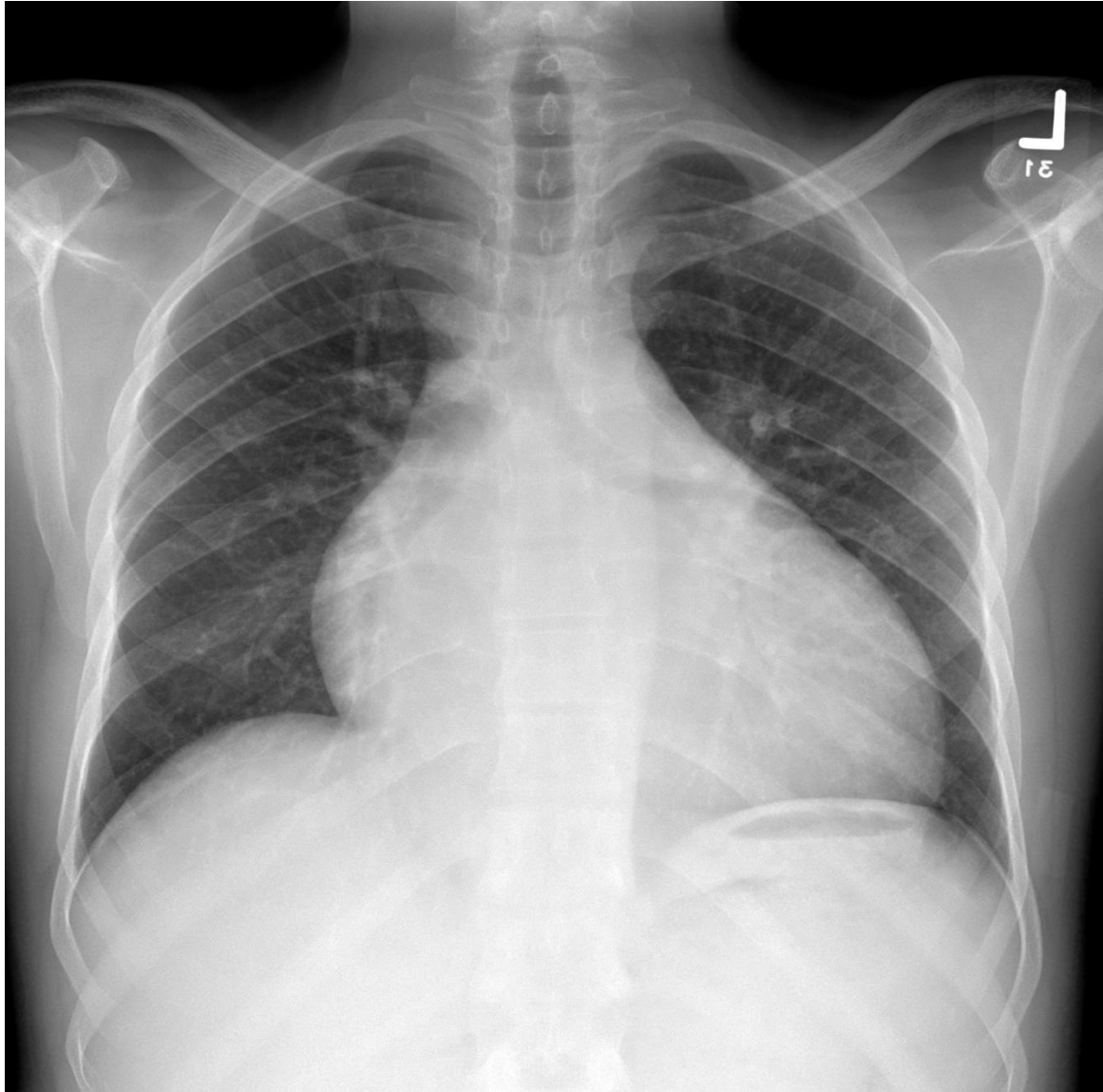
If LVEF \leq 35% despite OMT or a history of symptomatic VT/VF, implant ICD



- 56 Y/O gentleman
- Diagnosed dilated cardiomyopathy
- LVEF 25%
- NYHA class II
- O/E B/P 112/68 HR 82 bpm
- JVP 7 cm water,
- Soft S3 and grade 2 PSM
- Chest clear,
- No LL edema and warm extremities

EMEDU



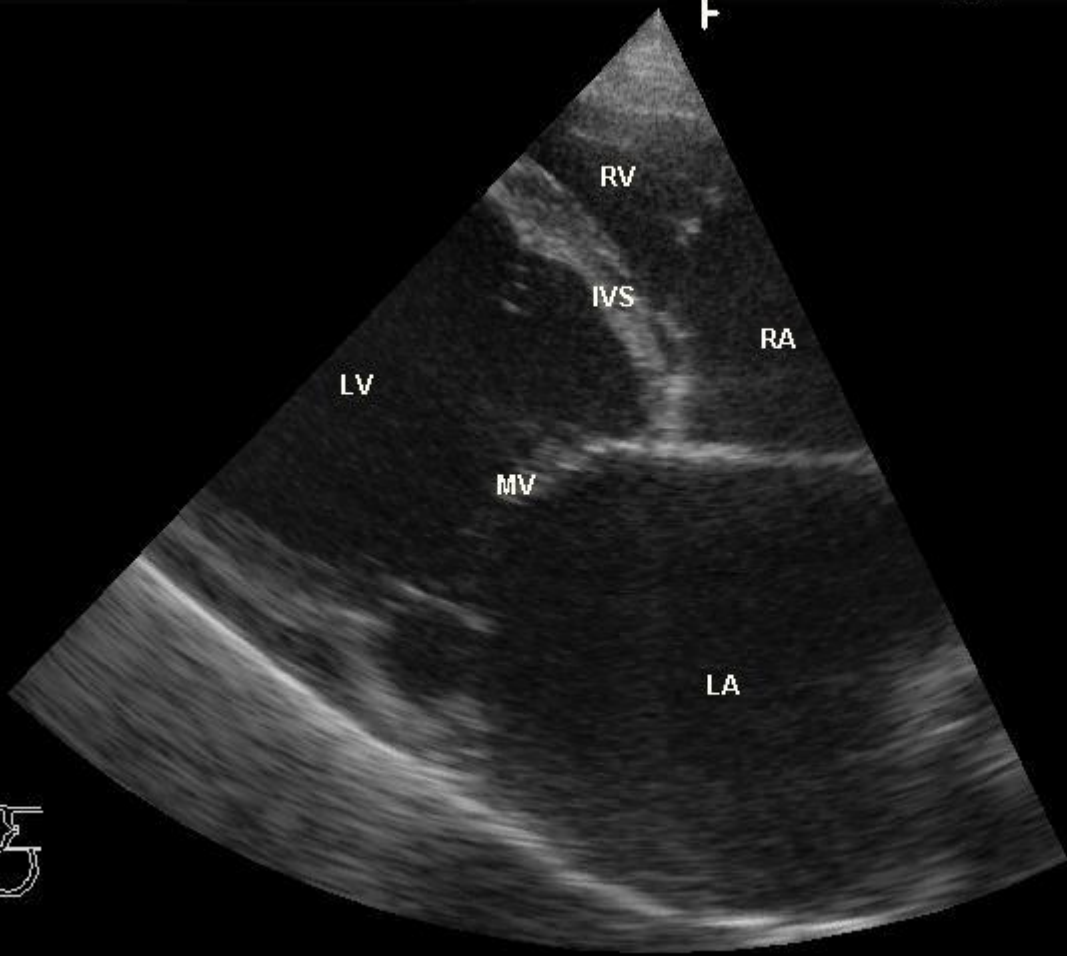


06/01/05 14:28:29
P80 4MHz S611

B5



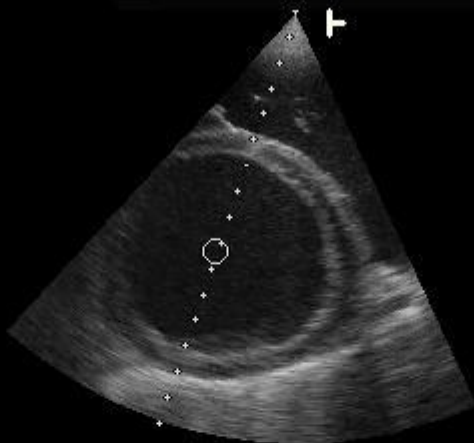
CN15
16cm
DB72
V 84



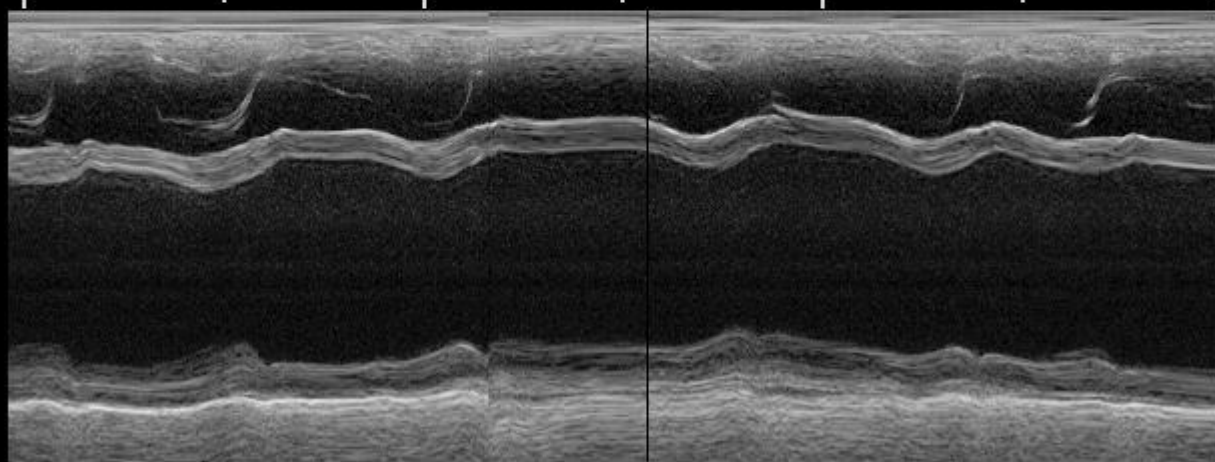
MI < 0.4

06/01/05 14:25:43

P80 4MHz S611



CN0
16cm
DB48
V 62



TIS<0.4

	Starting dose (mg)	Target dose (mg)
ACE inhibitor		
Captopril ^a	6.25 t.i.d.	50 t.i.d.
Enalapril	2.5 b.i.d.	10–20 b.i.d.
Lisinopril ^b	2.5–5.0 o.d.	20–35 o.d.
Ramipril	2.5 o.d.	5 b.i.d.
Trandolapril ^b	0.5 o.d.	4 o.d.
Beta-blocker		
Bisoprolol	1.25 o.d.	10 o.d.
Carvedilol	3.125 b.i.d.	25–50 b.i.d.
Metoprolol succinate (CR/XL)	12.5/25 o.d.	200 o.d.
Nebivolol ^c	1.25 o.d.	10 o.d.
ARB		
Candesartan	4 or 8 o.d.	32 o.d.
Valsartan	40 b.i.d.	160 b.i.d.
Losartan ^{b,c}	50 o.d.	150 o.d.
MRA		
Eplerenone	25 o.d.	50 o.d.
Spirolactone	25 o.d.	25–50 o.d.

Treatments (or combinations of treatments) that may cause harm in patients with symptomatic (NYHA class II–IV) systolic heart failure

Recommendations

Thiazolidinediones (glitazones) should not be used as they cause worsening HF and increase the risk of HF hospitalization.

Most CCBs (with the exception of amlodipine and felodipine) should not be used as they have a negative inotropic effect and can cause worsening HF.

NSAIDs and COX-2 Inhibitors should be avoided if possible as they may cause sodium and water retention, worsening renal function and worsening HF.

The addition of an ARB (or renin inhibitor) to the combination of an ACE Inhibitor AND a mineralocorticoid antagonist is NOT recommended because of the risk of renal dysfunction and hyperkalaemia.

Symptomatic Heart Failure + Reduced Ejection Fraction

Detect Co-morbidities and Precipitating Factors

Non-cardiovascular

Anaemia
Pulmonary disease
Renal dysfunction
Thyroid dysfunction
Diabetes

Cardiovascular

Ischaemia/CAD
Hypertension
Valvular dysfunction
Diastolic dysfunction
Atrial fibrillation
Ventricular dysrhythmias
Bradycardia

Diuretic + ACEI (or ARB)
Titrates to clinical stability

β -Blocker

Persisting signs and symptoms?

Yes

No

ADD aldosterone antagonist OR ARB

Persisting symptoms?

Yes

No

QRS >120 ms?

LVEF <35%?

Yes

No

Yes

No

Consider:
CRT-P or CRT-D

Consider: digoxin,
hydralazine/nitrate, LVAD,
transplantation

Consider ICD

No further treatment
indicated

Risk factor modification	<p>Understand the importance of smoking cessation</p> <p>Monitor blood pressure if hypertensive</p> <p>Maintain good glucose control if diabetic</p> <p>Avoid obesity</p>
Diet recommendation	<p>Sodium restriction if prescribed</p> <p>Avoid excessive fluid intake</p> <p>Modest intake of alcohol</p> <p>Monitor and prevent malnutrition</p>
Exercise recommendations	<p>Be reassured and comfortable about physical activity</p> <p>Understand the benefits of exercise</p> <p>Perform exercise training regularly</p>
Sexual activity	<p>Be reassured about engaging in sex and discuss problems with healthcare professionals</p> <p>Understand specific sexual problems and various coping strategies</p>
Immunization	<p>Receive immunization against infections such as influenza and pneumococcal disease</p>
Sleep and breathing disorders	<p>Recognize preventive behaviour such as reducing weight of obese, smoking cessation, and abstinence from alcohol</p> <p>Learn about treatment options if appropriate</p>
Adherence	<p>Understand the importance of following treatment recommendations and maintaining motivation to follow treatment plan</p>

Acute Heart Failure

- **FACTORS THAT MAY PRECIPITATE ACUTE DECOMPENSATION OF CHRONIC HEART FAILURE**

Events usually leading to rapid deterioration

- Rapid arrhythmia or severe bradycardia/conduction disturbance
- Acute coronary syndrome
- Mechanical complication of acute coronary syndrome (e.g. rupture of interventricular septum, mitral valve chordal rupture, right ventricular infarction)
- Acute pulmonary embolism
- Hypertensive crisis
- Cardiac tamponade
- Aortic dissection
- Surgery and perioperative problems
- Peripartum cardiomyopathy

Events usually leading to less rapid deterioration

- Infection (including infective endocarditis)
- Exacerbation of COPD/asthma
- Anaemia
- Kidney dysfunction
- Non-adherence to diet/drug therapy
- Iatrogenic causes (e.g. prescription of an NSAID or corticosteroid; drug interactions)
- Arrhythmias, bradycardia, and conduction disturbances not leading to sudden, severe change in heart rate
- Uncontrolled hypertension
- Hypothyroidism or hyperthyroidism
- Alcohol and drug abuse

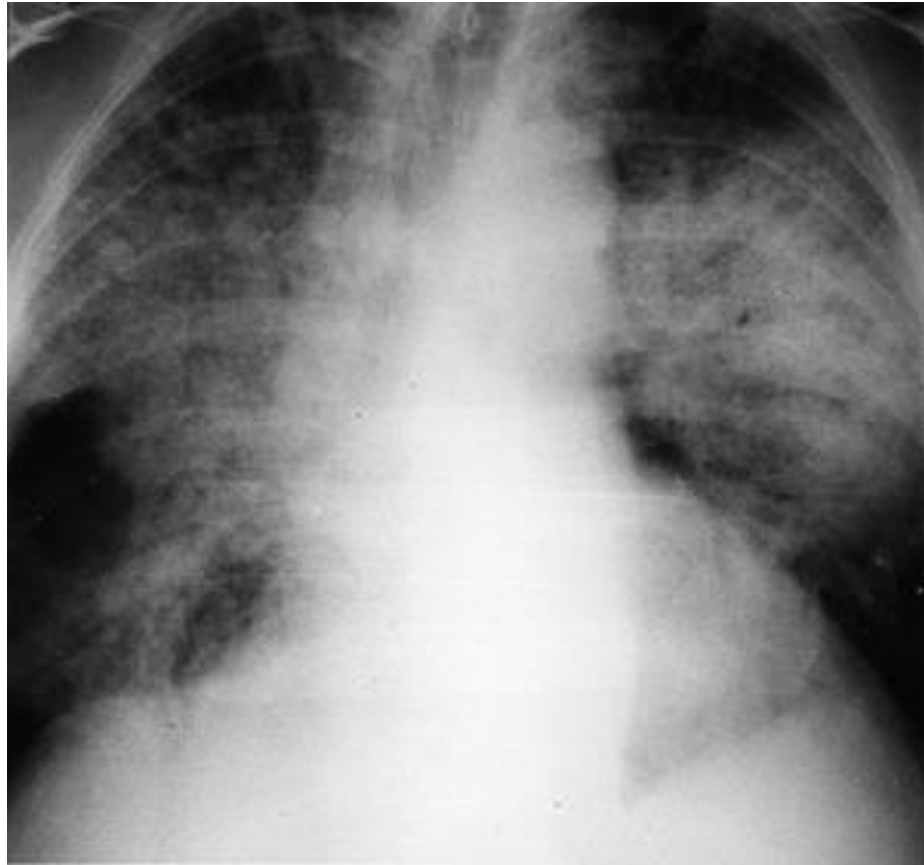
Two Minute Assessment of Hemodynamic Profile

		Congestion at rest?	
		NO	YES
Low perfusion at rest?	NO	<i>Warm & Dry</i> A	<i>Warm & Wet</i> B
	YES	<i>Cold & Dry</i> L	<i>Cold & Wet</i> C

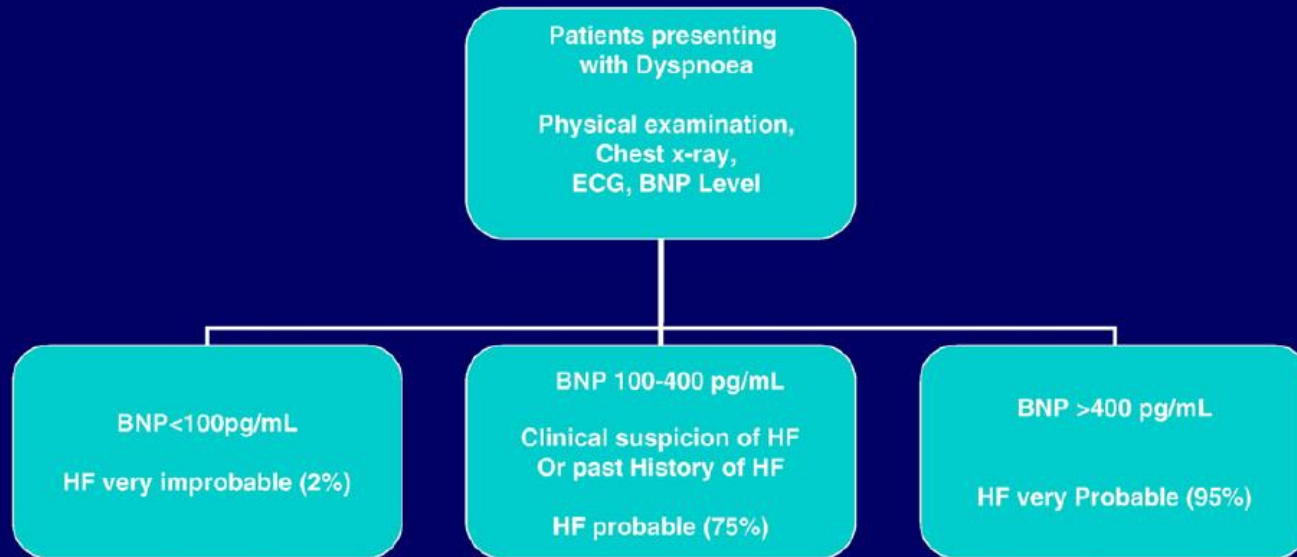
<p><u>Evidence for low perfusion</u> Narrow pulse pressure⁺ Cool extremities⁺ May be sleepy, obtunded Suspect from ACEI hypotension and low Serum Sodium One cause of worsening renal fn</p>	<p><u>Evidence for Congestion</u></p> <p>Orthopnea⁺ Elevated JVP[±] Edema (25%) Pulsatile hepatomegaly Ascites Rales (rare in chronic HF) Louder S3</p> <p>P2 radiation leftward Abdomino-jugular reflex Valsalva square wave</p>
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** Most helpful*





For Heart Failure Diagnosis



Optimal NT-proBNP Cut-points

“Rule in”

Age strata	Optimal cut-point	Sensitivity	Specificity	PPV	NPV	Accuracy
All <50 years (n=183)	450 pg/ml	97%	93%	76%	99%	95%
All 50-75 years (n=554)	900 pg/ml	90%	82%	82%	88%	85%
All >75 years (n=519)	1800 pg/ml	85%	73%	92%	55%	83%
Overall average		92%	84%	88%	66%	93%

“Rule out”

	Optimal cut-point	Sensitivity	Specificity	PPV	NPV	Accuracy
Rule out	300 pg/ml	99%	62%	55%	99%	83%

Suspected acute heart failure

History/examination
(including blood pressure and respiratory rate)

Chest X-ray

Echocardiogram or NP (or both)

Blood chemistry

ECG

Oxygen saturation

Full blood count

**Simultaneously
assess for**

Ventilation/
systemic
oxygenation
inadequate?^a

Life-threatening
arrhythmia/
bradycardia?^b

Blood pressure
<85 mmHg
or shock^c

Acute
coronary
syndrome^d

Acute
mechanical
cause/severe
valvular disease^e

**Urgent
action
if present**

• Oxygen
• NIV
• ETT and
invasive
ventilation

• Electrical
cardioversion
• Pacing

• Inotrope/
vasopressor
• Mechanical
circulatory
support
(e.g. IABP)

• Coronary
reperfusion
• Antithrombotic
therapy

• Echocardiography
• Surgical/
percutaneous
intervention

ECG = electrocardiogram; ETT = endotracheal tube; IABP = intra-aortic balloon pump; NIV = non-invasive ventilation; NP = natriuretic peptide.

^aFor example, respiratory distress, confusion, SpO₂ <90% or PaO₂ <60 mmHg (8.0 kPa).