Heart Failure

Khalid AlHabib
Professor of Cardiac Sciences
Cardiology Consultant

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 diseas, myocarditis, and cardiogenic shock

- More commonly, from a chronic process

Common Causes

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

Nomenclature

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

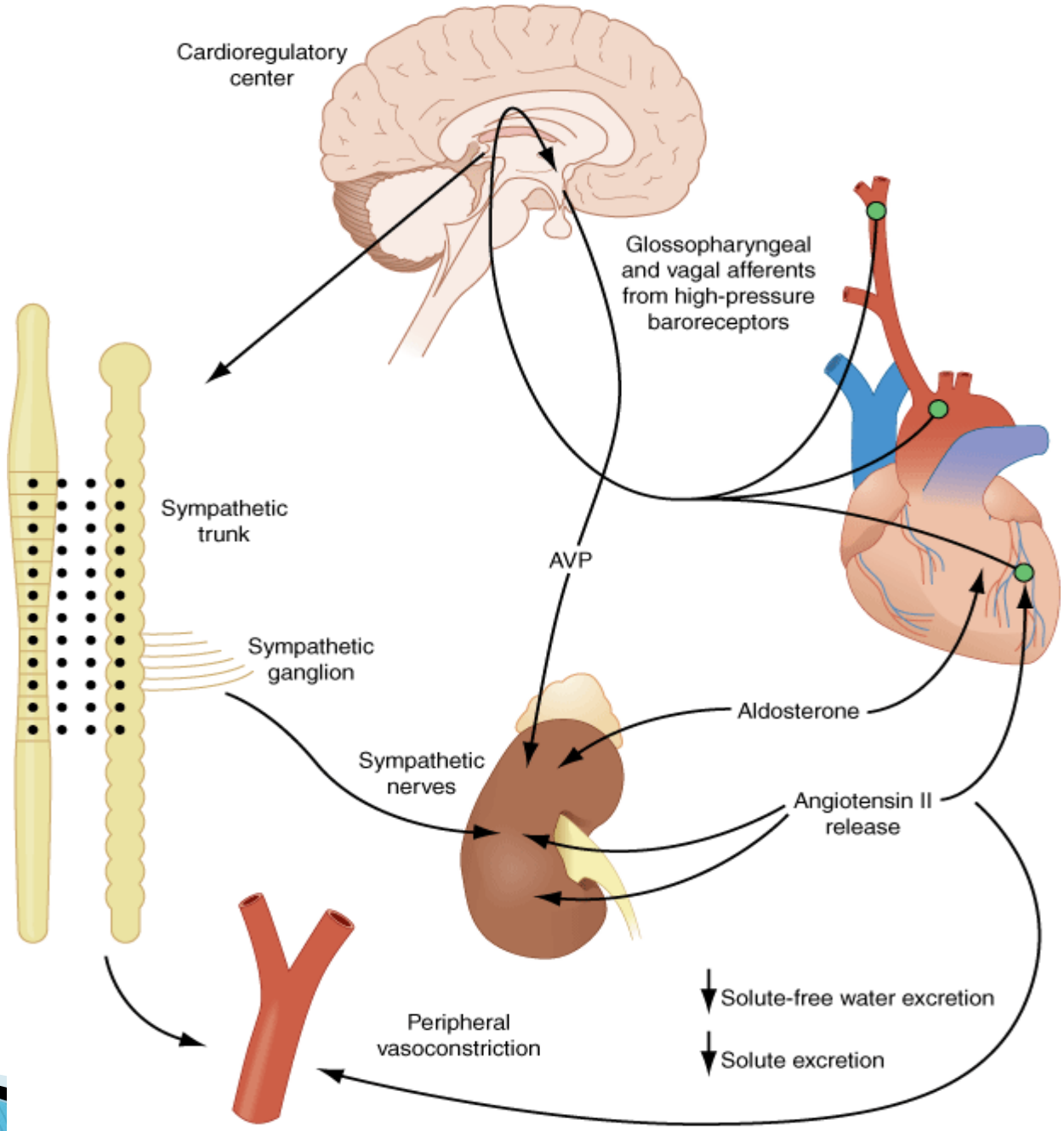
Classification

- 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



Source: Fauci AS, Kasper DL, Braunwald E, Hauser SL, Longo DL, Jameson JL, Loscalzo J: *Harrison's Principles of Internal Medicine*, 17th Edition: http://www.accessmedicine.com

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.

- FACTORS THAT MAY PRECIPITATE ACUTE DECOMPENSATION OF CHRONIC HEART FAILURE

		Discontinuation of therapy (patient noncompliance or physician initiated)
		Initiation of medications that worsen heart failure (calcium antagonists, β-blockers, nonsteroidal anti-inflammatory drugs, antiarrhythmic agents)
		Iatrogenic volume overload (transfusion, fluid administration)
		Dietary indiscretion
		Pregnancy
		Exposure to high altitude
		Arrhythmias
		Myocardial ischemia or infarction
		Worsening hypertension
		Worsening mitral or tricuspid regurgitation
		Fever or infection
		Anemia

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

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

Evidence for Low Perfusion

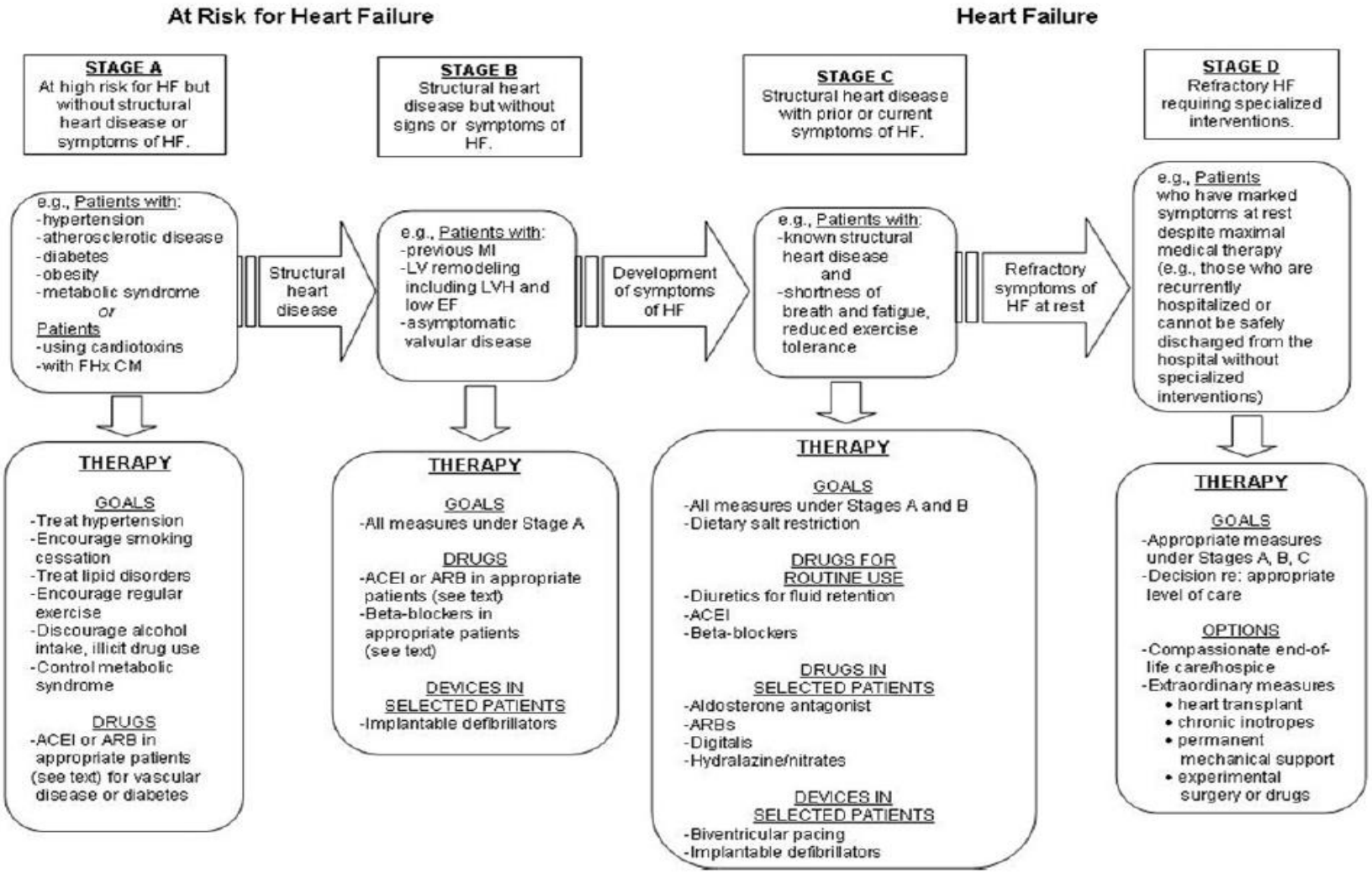
- Narrow Pulse Pressure
- Pulsus Alterations
- Cool Forearms and Legs
- May Be Sleepy, Obtunded
- ACE Inhibitor–Related Symptomatic Hypotension
- Declining Serum Sodium Level
- Worsening Renal Function

Low Perfusion at Rest?	Congestion at Rest? No	Congestion at Rest? Yes
No	Warm and Dry A	Warm and Wet B
Yes	Cold and Dry L	Cold and Wet C

NYHA Classiffication

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

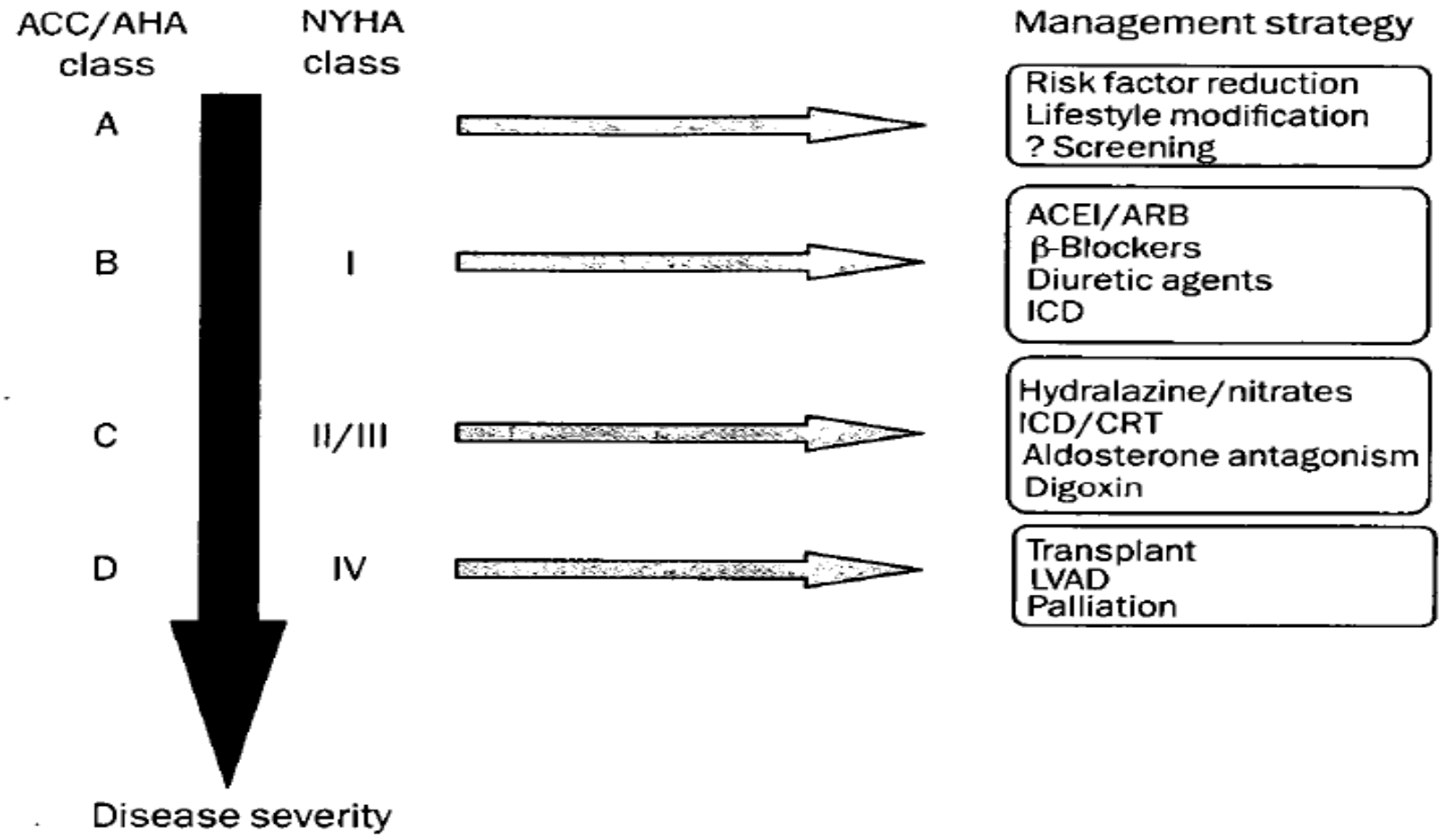
ACC/AHA


At Risk for Heart Failure
Heart Failure
STAGE A
At high risk for HF but without structural heart disease or symptoms of HF.
STAGE B
Structural heart disease but without signs or symptoms of HF.
STAGE C
Structural heart disease with prior or current symptoms of HF.
STAGE D
Refractory HF requiring specialized interventions.
e.g., Patients with:
-hypertension
-atherosclerotic disease
-diabetes
-obesity
-metabolic syndrome
or
Patients
-using cardiotoxins
-with FHx CM
Structural heart disease
e.g., Patients with:
-previous MI
-LV remodeling including LVH and low EF
-asymptomatic valvular disease
Development of symptoms of HF
e.g., Patients with:
-known structural heart disease
and
-shortness of breath and fatigue, reduced exercise tolerance
Refractory symptoms of HF at rest
e.g., Patients who have marked symptoms at rest despite maximal medical therapy (e.g., those who are recurrently hospitalized or cannot be safely discharged from the hospital without specialized interventions)
THERAPY
GOALS
-Treat hypertension
-Encourage smoking cessation
-Treat lipid disorders
-Encourage regular exercise
-Discourage alcohol intake, illicit drug use
-Control metabolic syndrome
DRUGS
-ACEI or ARB in appropriate patients (see text) for vascular disease or diabetes
THERAPY
GOALS
-All measures under Stage A
DRUGS
-ACEI or ARB in appropriate patients (see text)
-Beta-blockers in appropriate patients (see text)
DEVICES IN SELECTED PATIENTS
-Implantable defibrillators
THERAPY
GOALS
-All measures under Stages A and B
-Dietary salt restriction
DRUGS FOR ROUTINE USE
-Diuretics for fluid retention
-ACEI
-Beta-blockers
DRUGS IN SELECTED PATIENTS
-Aldosterone antagonist
-ARBs
-Digitalis
-Hydralazine/nitrates
DEVICES IN SELECTED PATIENTS
-Biventricular pacing
-Implantable defibrillators
THERAPY
GOALS
-Appropriate measures under Stages A, B, C
-Decision re: appropriate level of care
OPTIONS
-Compassionate end-of-life care/hospice
-Extraordinary measures
• heart transplant
• chronic inotropes
• permanent mechanical support
• experimental surgery or drugs

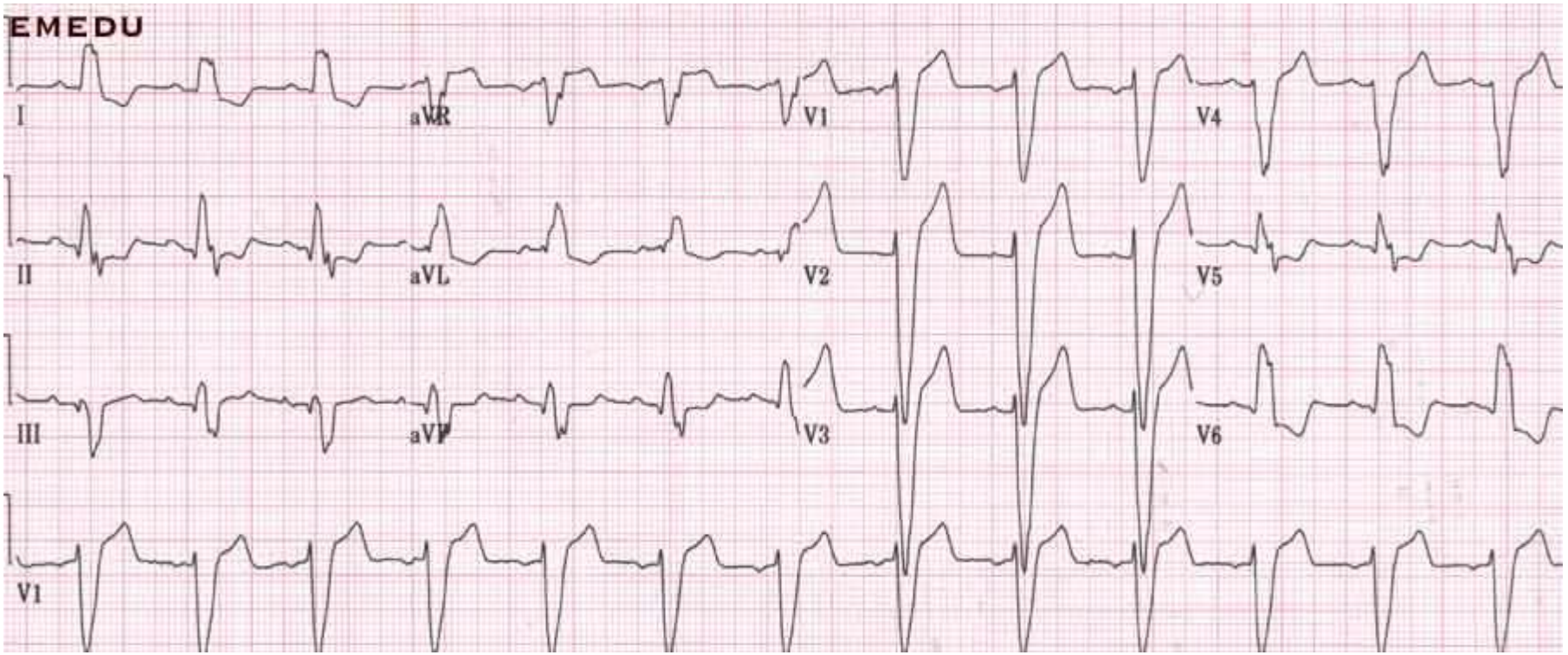
Investigations to consider in all patients
Transthoracic echocardiography is recommended to evaluate cardiac structure and function, including diastolic function (Section 4.1.2), and to measure LVEF to make the diagnosis of HF, assist in planning and monitoring of treatment, and to obtain prognostic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

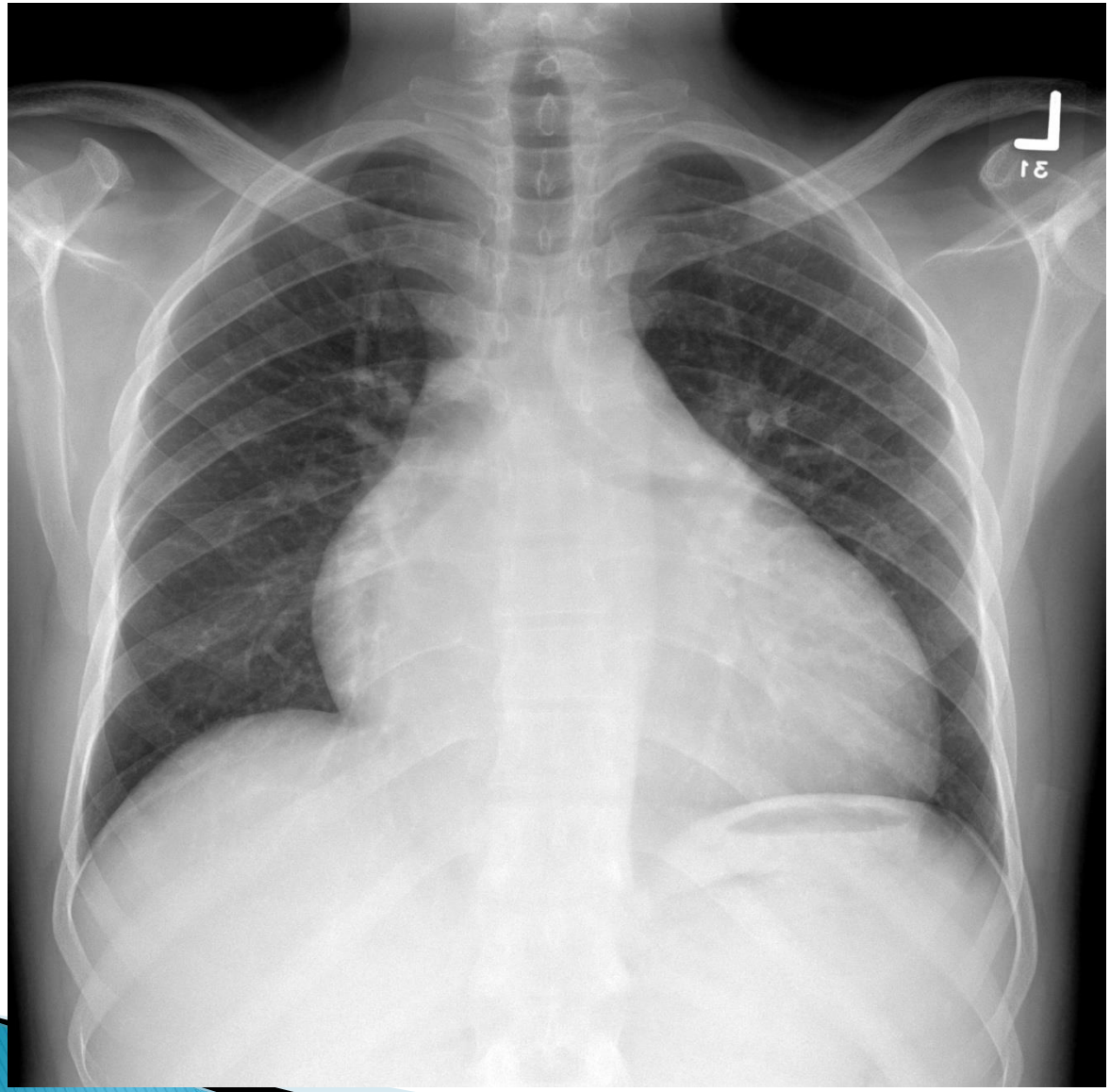
Investigations to consider in selected patients
CMR imaging is recommended to evaluate cardiac structure and function, to measure LVEF, and to characterize cardiac tissue, especially in subjects with inadequate echocardiographic images or where the echocardiographic findings are inconclusive or incomplete (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.

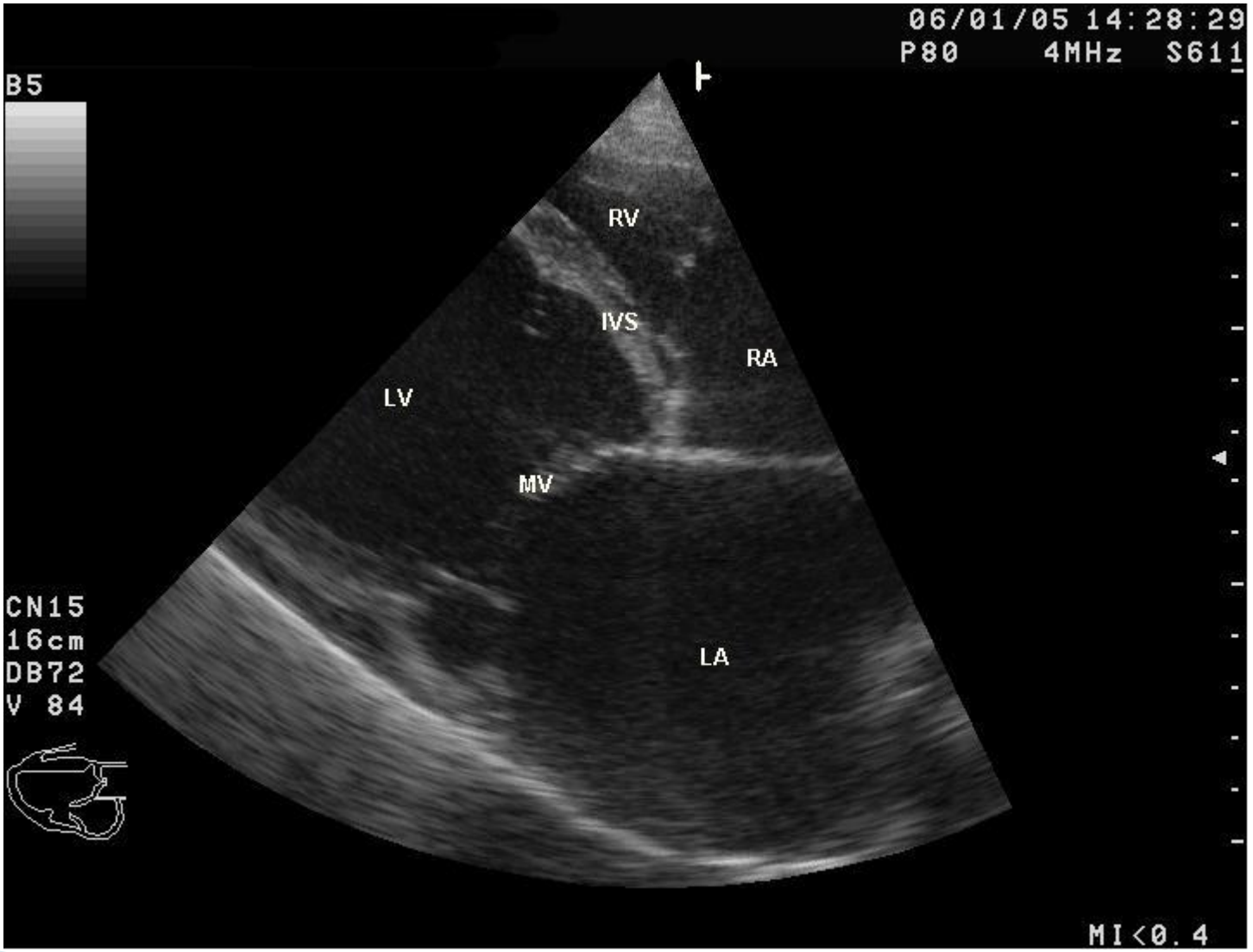
Therapy

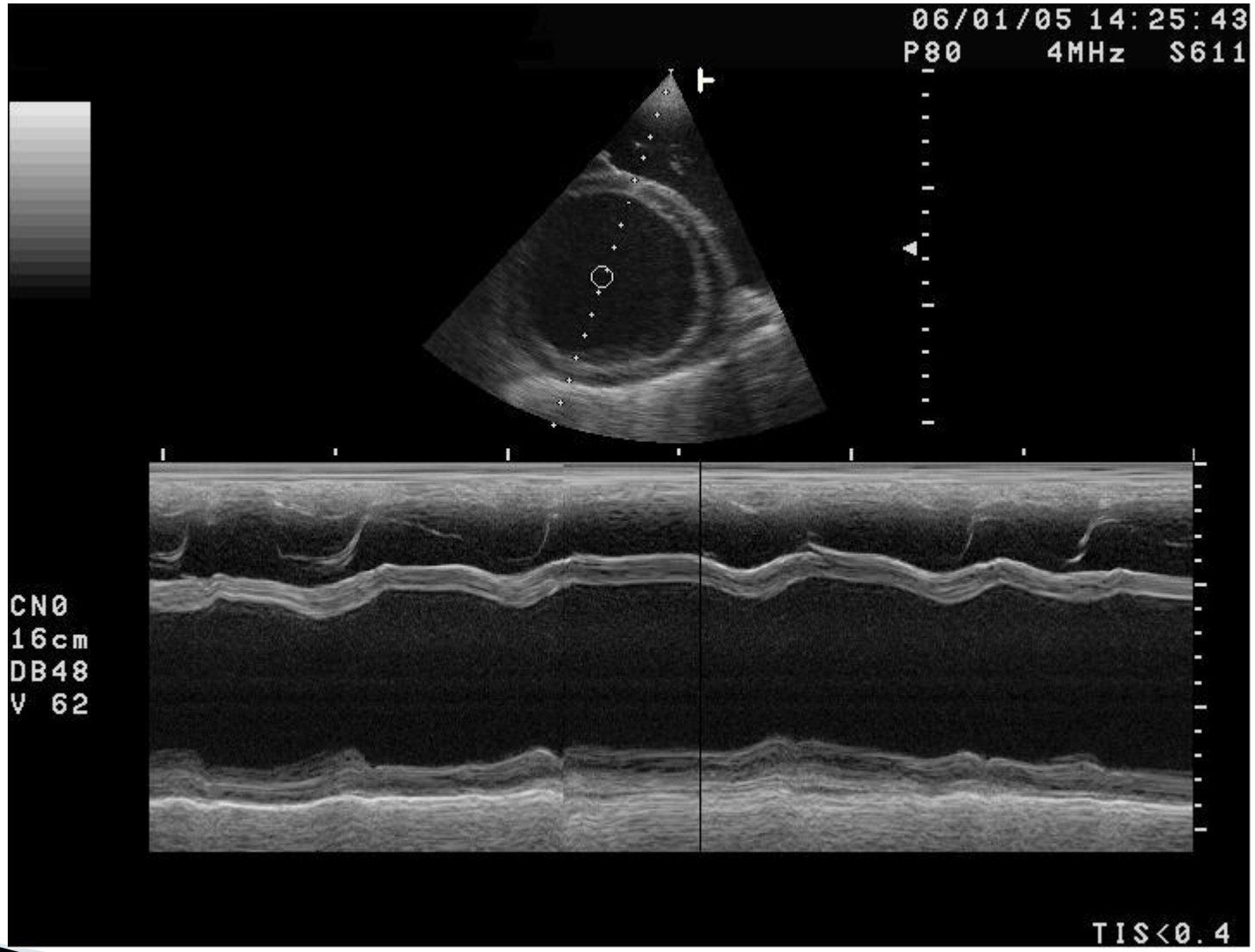

ACC/AHA class
NYHA class
Management strategy
A
B
C
D
I
II/III
IV
Risk factor reduction
Lifestyle modification
? Screening
ACEI/ARB
β-Blockers
Diuretic agents
ICD
Hydralazine/nitrates
ICD/CRT
Aldosterone antagonism
Digoxin
Transplant
LVAD
Palliation
Disease severity

- 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
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1



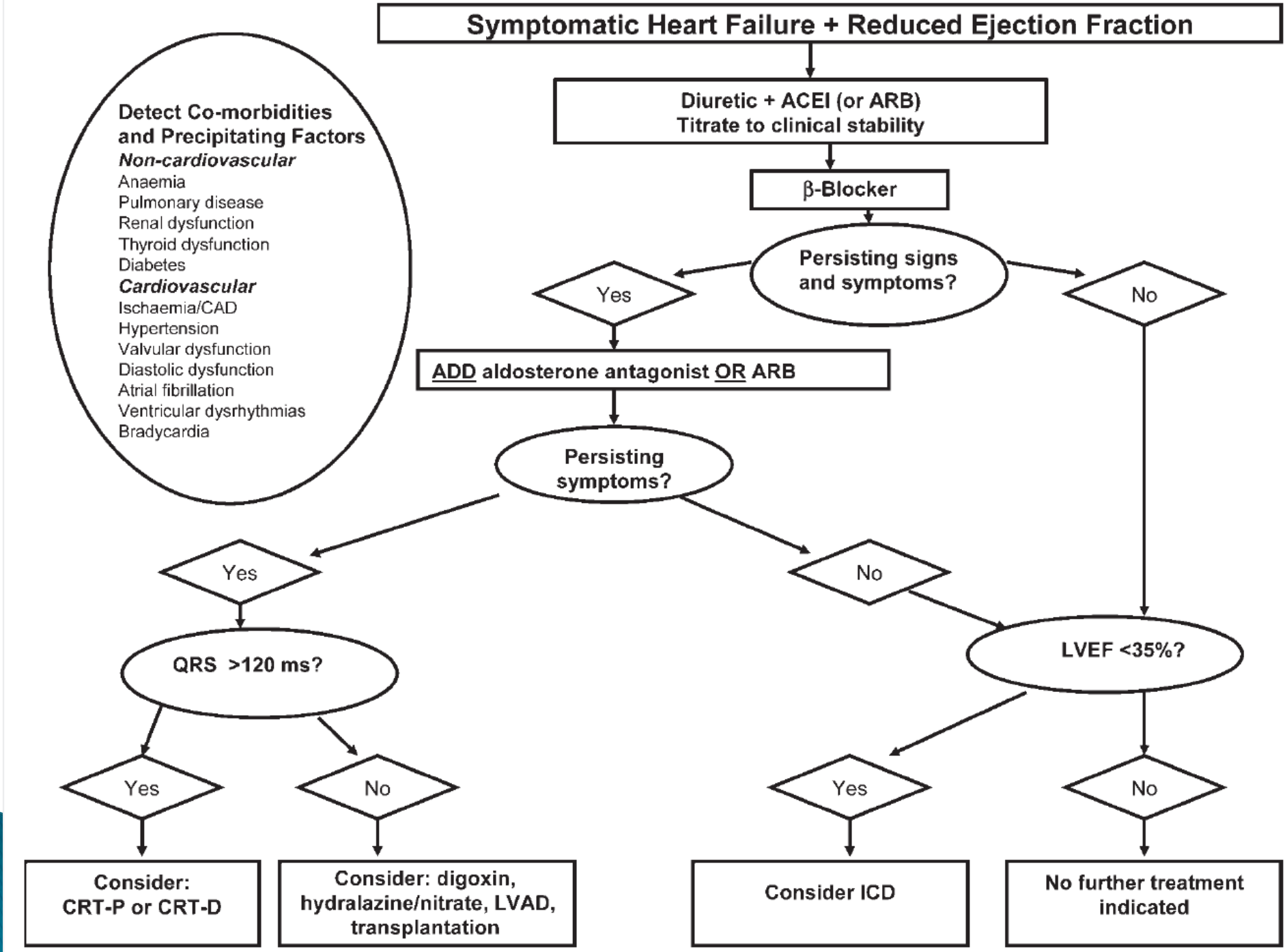

06/01/05 14:28:29
P80 4MHz S611
B5
RV
IVS
RA
LV
MV
LA
CN15
16cm
DB72
V 84
MI<0.4


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[a]	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.
Spironolactone	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

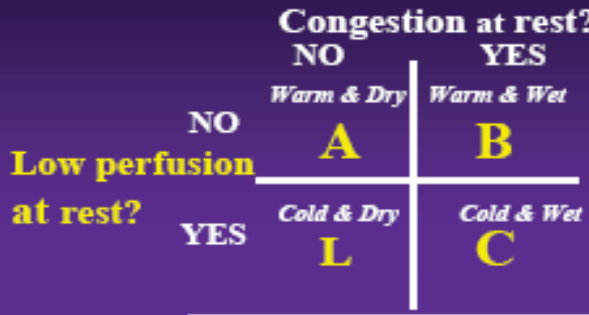
Recommendations
Thiazolidinediones (glitazones) should not be used as they cause worsening HF and increase the risk of HF hospitalization.
Most CCBs (with the exception of amlodipine and felodipine) should not be used as they have a negative inotropic effect and can cause worsening HF.
NSAIDs and COX-2 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
Diuretic + ACEI (or ARB)
Titrate to clinical stability
β-Blocker
Persisting signs and symptoms?
Yes
No
ADD aldosterone antagonist OR ARB
Persisting symptoms?
Yes
No
QRS >120 ms?
Yes
No
LVEF <35%?
Yes
No
Consider: CRT-P or CRT-D
Consider: digoxin, hydralazine/nitrate, LVAD, transplantation
Consider ICD
No further treatment indicated
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

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

Acute Heart Failure

Two Minute Assessment of Hemodynamic Profile



Evidence for low perfusion

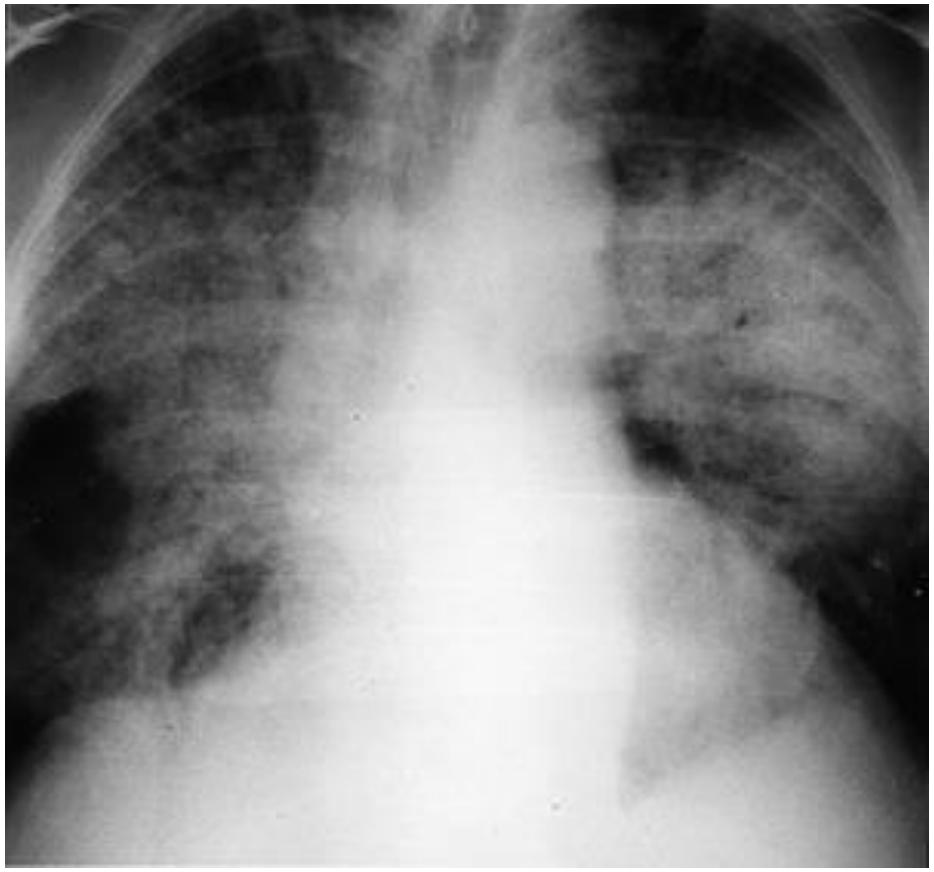
- Narrow pulse pressure*
- Cool extremities*
- May be sleepy, obtunded
- Suspect from ACEI hypotension and low Serum Sodium
- One cause of worsening renal fn

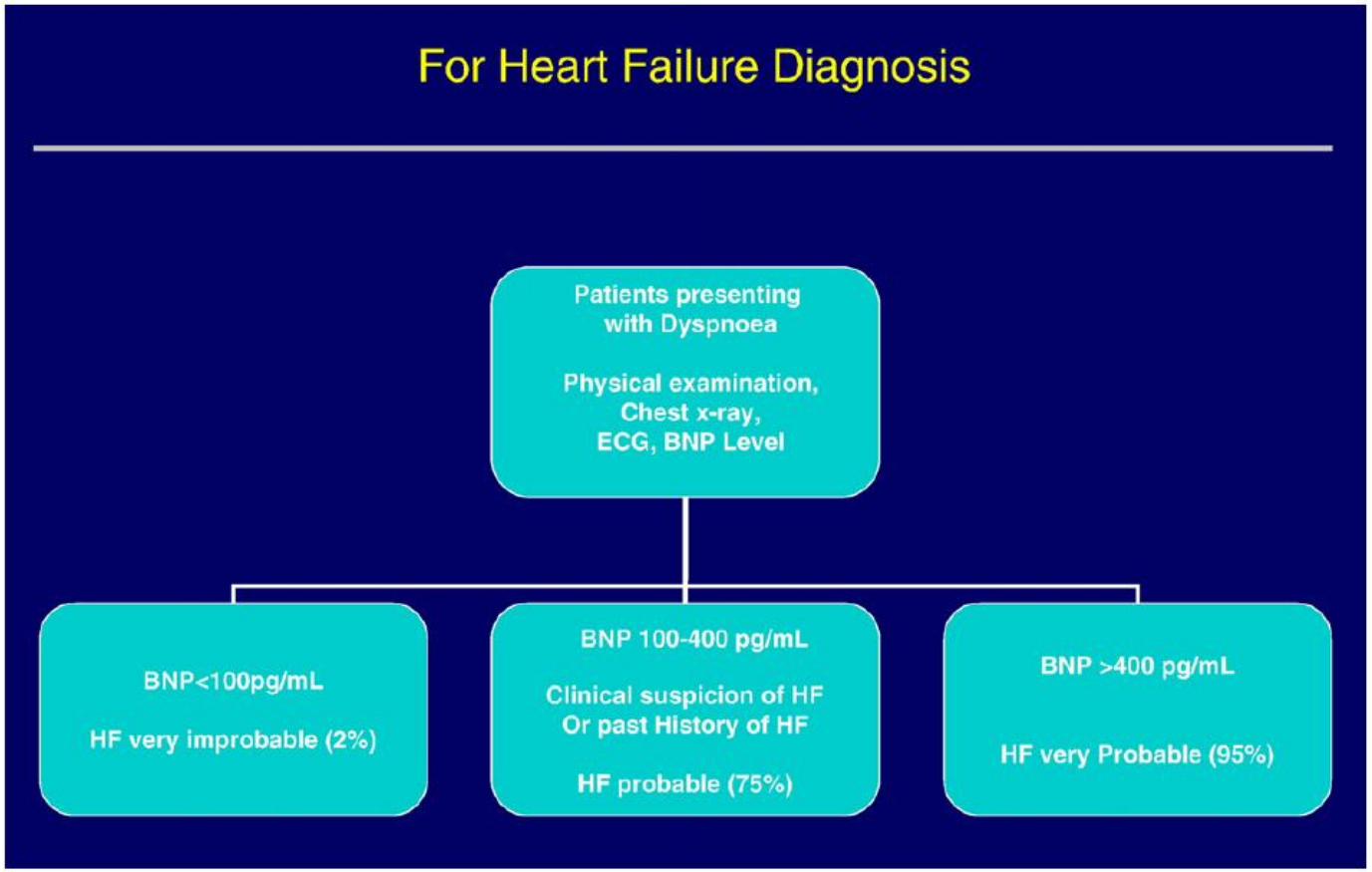
Evidence for Congestion

- Orthopnea*
- Elevated JVP*
- Edema (25%)
- Pulsatile hepatomegaly
- Ascites
- Rales (rare in chronic HF)
- Louder S3

- P2 radiation leftward
- Abdomino-jugular reflex
- Valsalva square wave

* *Most helpful*




For Heart Failure Diagnosis
Patients presenting with Dyspnoea
Physical examination, Chest x-ray, ECG, BNP Level
BNP<100pg/mL
HF very improbable (2%)
BNP 100-400 pg/mL
Clinical suspicion of HF Or past History of HF
HF probable (75%)
BNP >400 pg/mL
HF very Probable (95%)

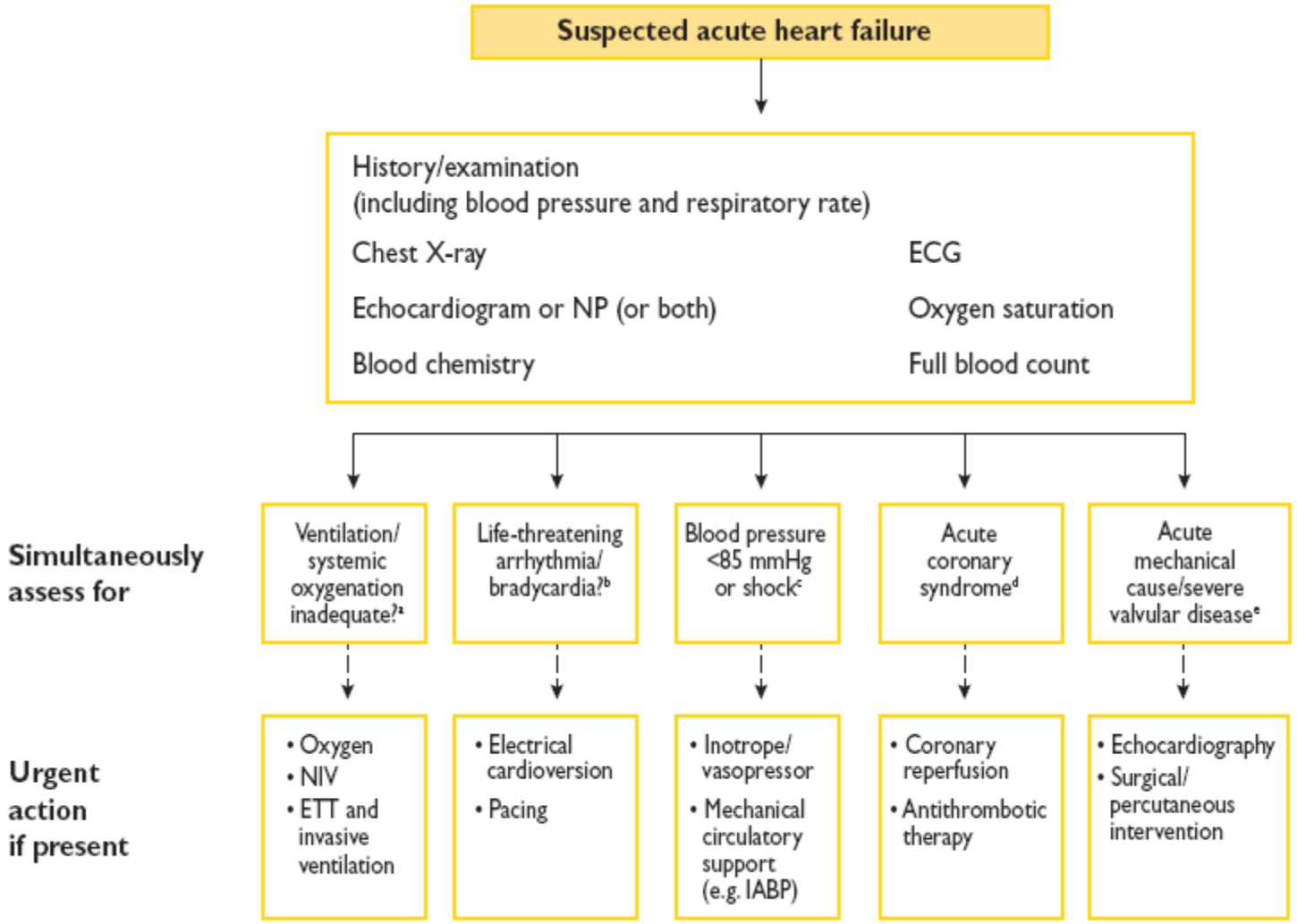
Optimal NT-proBNP Cut-points

"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%



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