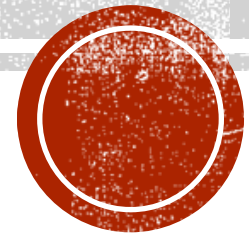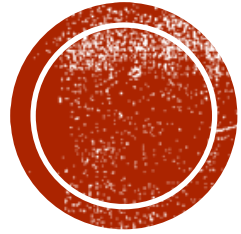# MANAGEMENT OF HEART FAILURE

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Tehran university of medical sciences

A 65-YEAR-OLD MALE WITH A HISTORY OF HTN AND IHD ,PRESENTS TO THE EMERGENCY DEPARTMENT WITH WORSENING SHORTNESS OF BREATH (NYHA III) AND BILATERAL LEG SWELLING FOR 2 WEEKS."*

Key Symptoms:

- - Progressive dyspnea (initially on exertion, now at rest)

- - Orthopnea, PND (paroxysmal nocturnal dyspnea)

- - Fatigue, weight gain (+5 kg in 2 weeks)

Past Medical History:

- - HTN x 10 years, T2DM x 5 years

- - No prior MI or known CAD

Vital Signs:

- - BP: 150/90 mmHg | HR: 110 bpm | RR: 24/min | SpO_2: 90% (room air)

-

Physical Examination :

- - Cardiovascular:

-     - Elevated JVP (10 cm), S3 gallop
  - - Bilateral pitting edema (up to knees)
  - - Crackles in lung bases (bibasilar)

- - Abdominal:
  - Hepatomegaly, no ascites
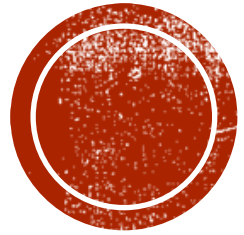
DIFFERENTIAL DIAGNOSIS?

- 1.Acute decompensated heart failure (ADHF)

- 2.COPD exacerbation

- 3.Pulmonary embolism

- 4.Renal failure
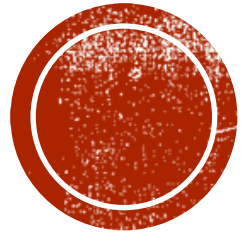
INITIAL WORK UP?

ECG
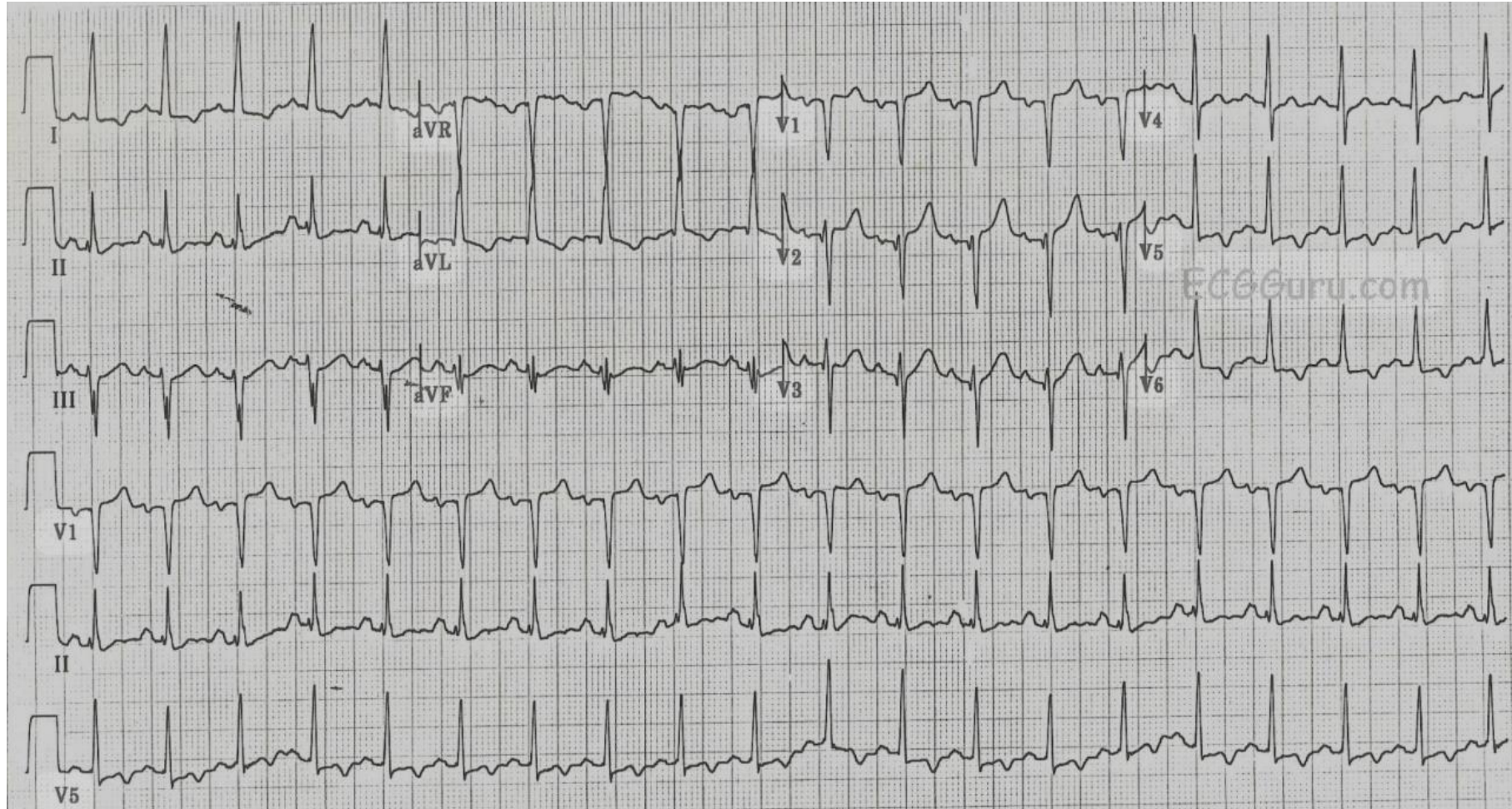
CXR
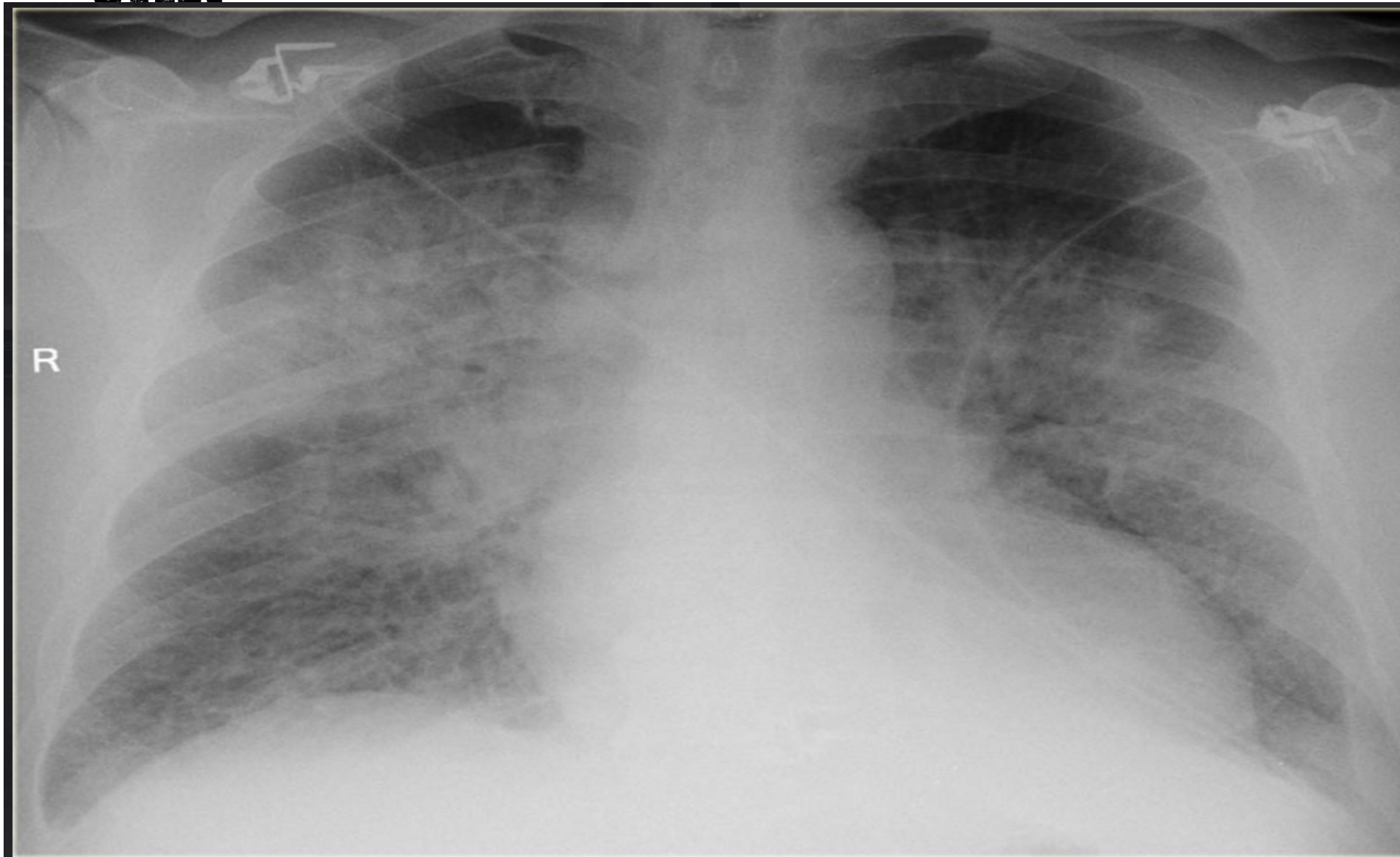
LABS

- BNP: 800 pg/mL** (highly suggestive of HF)

- Troponin: Negative**

- Renal function:** Mildly elevated creatinine (1.4 mg/dL)

ECHOCARDIOGRAPHY FINDINGS

Key Findings:

- LVEF: 30%** (Severely reduced → **HFrEF**)

- Significant RWMA in ant and post circulation

- LVH - Mod MR

FINAL DIAGNOSIS?
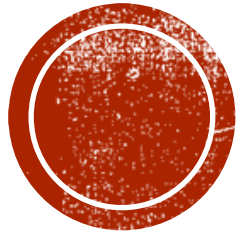
ACUTE DECOMPENSATED HEART FAILURE

Initial Classification

Serial Assessment and Reclassification

HFrEF
- LVEF ≤40%

→ **HFrEF**
- LVEF ≤40%

→ **HFimpEF**
- LVEF >40%

HFmrEF
- LVEF 41%–49%

→ **HFrEF**
- LVEF ≤40%

→ **HFmrEF**
- LVEF 41%–49%

→ *****
- LVEF ≥50%

HFpEF
- LVEF ≥50%

→ **HFrEF**
- LVEF ≤40%

→ **HFmrEF**
- LVEF 41%–49%

→ **HFpEF**
- LVEF ≥50%
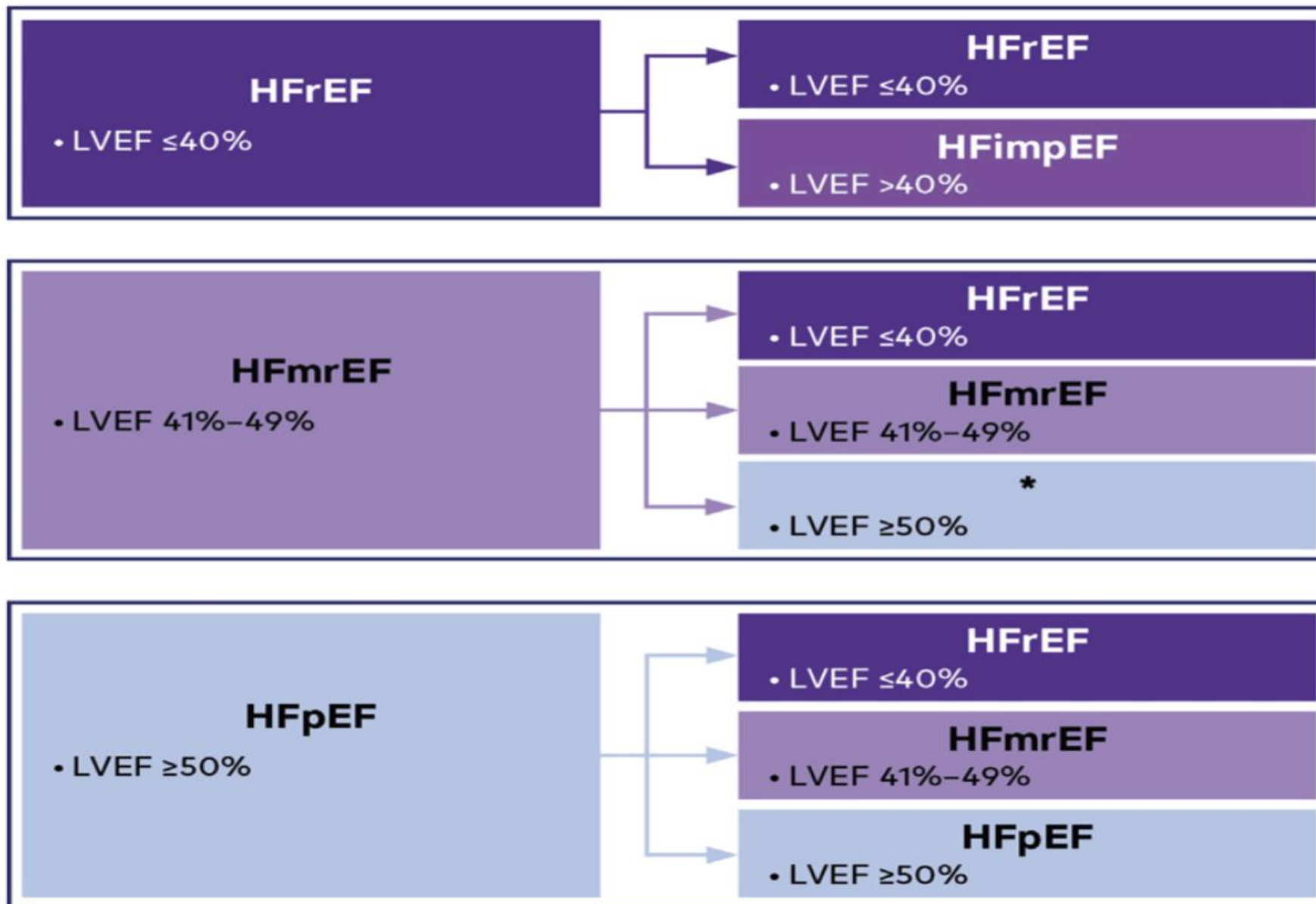
TABLE 48.1 American College of Cardiology/American Heart Association (ACC/AHA) Stages of Heart Failure (HF) Compared to the New York Heart Association (NYHA) Functional Classification

	ACC/AHA STAGES OF HEART FAILURE		NYHA FUNCTIONAL CLASSIFICATION
A	At high risk for HF but without structural heart disease or symptoms of heart failure.	None	
B	Structural heart disease but without signs or symptoms of heart failure.	I	No limitation of physical activity. Ordinary physical activity does not cause symptoms of heart failure.
C	Structural heart disease with prior or current symptoms of heart failure.	I	No limitation of physical activity. Ordinary physical activity does not cause symptoms of heart failure.
		II	Slight limitation of physical activity. Comfortable at rest, but ordinary physical activity results in symptoms of heart failure.
		III	Marked limitation of physical activity. Comfortable at rest, but less than ordinary activity causes symptoms of heart failure.
D	Refractory heart failure requiring specialized interventions.	IV	Unable to carry on any physical activity without symptoms of heart failure, or symptoms of heart failure at rest.

HF, Heart failure.

TABLE 48.2 Using the Medical History to Assess the Heart Failure Patient

Symptoms associated with heart failure include:

1. Fatigue
2. Shortness of breath at rest or during exercise
3. Dyspnea
4. Tachypnea
5. Cough
6. Diminished exercise capacity
7. Orthopnea
8. Paroxysmal nocturnal dyspnea
9. Nocturia
10. Weight gain/Weight loss
11. Edema (of the extremities, scrotum, or elsewhere)
12. Increasing abdominal girth or bloating
13. Abdominal pain (particularly if confined to the right upper quadrant)
14. Loss of appetite or early satiety
15. Cheyne-Stokes respirations (often reported by the family rather than the patient)
16. Somnolence or diminished mental acuity

Historical information that is helpful in determining if symptoms are due to heart failure include:

1. A past history of heart failure
2. Cardiac disease (e.g., coronary artery, valvular or congenital disease, previous myocardial infarction)
3. Risk factors for heart failure (e.g., diabetes, hypertension, obesity)
4. Systemic illnesses that can involve the heart (e.g., amyloidosis, sarcoidosis, inherited neuromuscular diseases)
5. Recent viral illness or history of HIV or Chagas disease
6. Family history of heart failure or sudden cardiac death
7. Environmental and/or medical exposure to cardiotoxic substances
8. Substance abuse
9. Noncardiac illnesses that could affect the heart indirectly (including high output states such as anemia, hyperthyroidism, arteriovenous fistulae)

TABLE 48.3 Physical Findings of Heart Failure

1. Tachycardia
2. Extra beats or irregular rhythm
3. Narrow pulse pressure or thready pulse *
4. Pulses alternans *
5. Tachypnea
6. Cool and/or mottled extremities *
7. Elevated jugular venous pressure
8. Dullness and diminished breath sounds at one or both lung bases
9. Rales, rhonchi, and/or wheezes
10. Apical impulse displaced leftward and/or inferiorly
11. Sustained apical impulse
12. Parasternal lift
13. S3 and/or S4 (either palpable and/or audible)
14. Tricuspid or mitral regurgitant murmur
15. Hepatomegaly (often accompanied by right upper quadrant discomfort)
16. Ascites
17. Pre-sacral edema
18. Anasarca *
19. Pedal edema
20. Chronic venous stasis changes

*Indicative of more severe disease.

Diagnostic Algorithm for Patients With Suspected HF

Assessment
- Clinical history
- Physical examination
- ECG, labs

Natriuretic Peptide
- NT-proBNP >125 pg/mL
- BNP ≥35 pg/mL

Transthoracic Echocardiography
- Additional testing, if necessary

HF Diagnosis Confirmed
- Determine cause and classify

HFrEF
LVEF ≤40%

HFmrEF
LVEF 41%–49%

HFpEF
LVEF ≥50%

- Evaluate for precipitating factors
- Initiate treatment
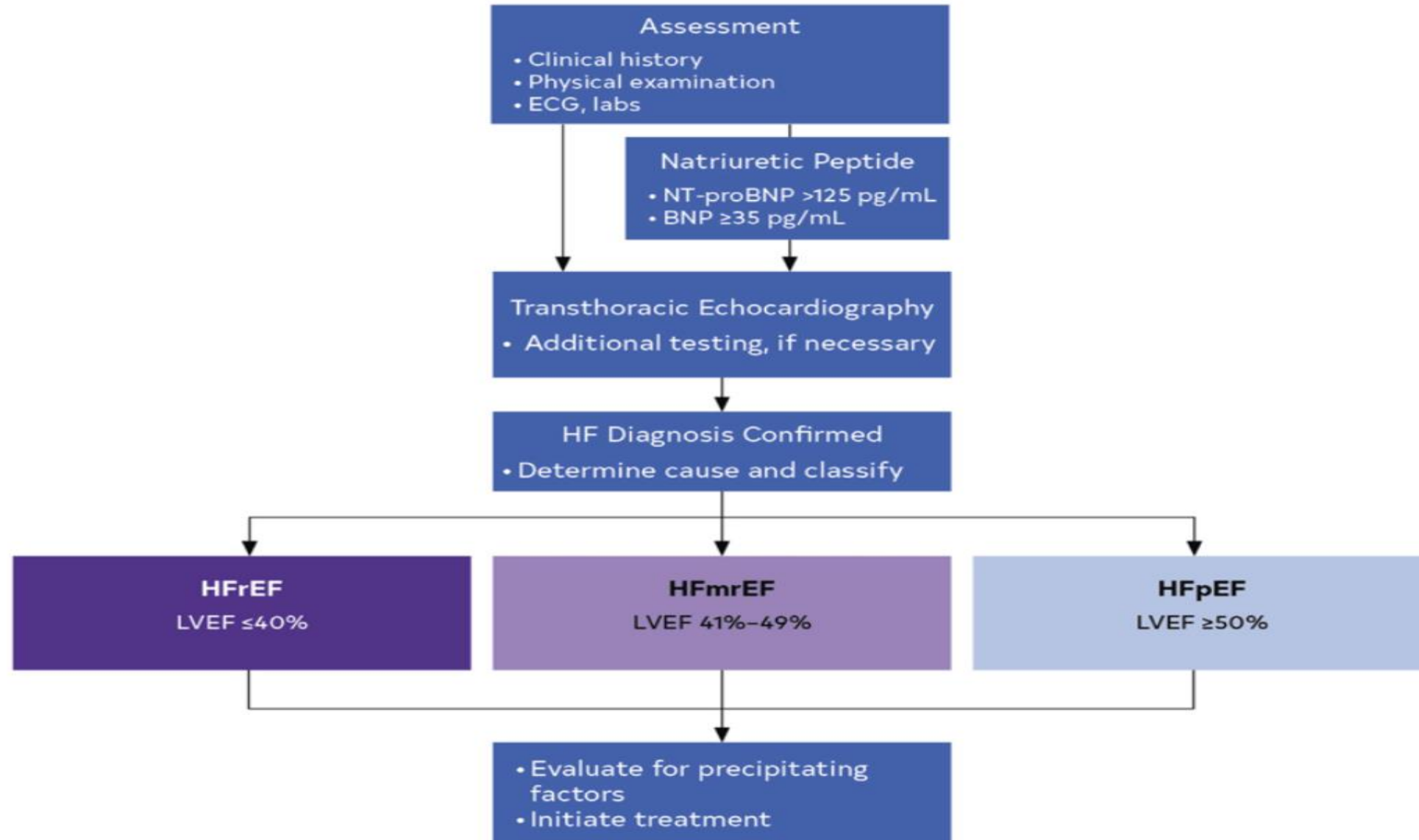
Recommended diagnostic tests in all patients with suspected chronic heart failure

Recommendations	Class	Level
BNP/NT-proBNP[a]	I	B
12-lead ECG	I	C
Transthoracic echocardiography	I	C
Chest radiography (X-ray)	I	C
Routine blood tests for comorbidities, including full blood count, urea an electrolytes, thyroid function, fasting glucose and HbA1c, lipids, iron status (TSAT and ferritin)	I	C
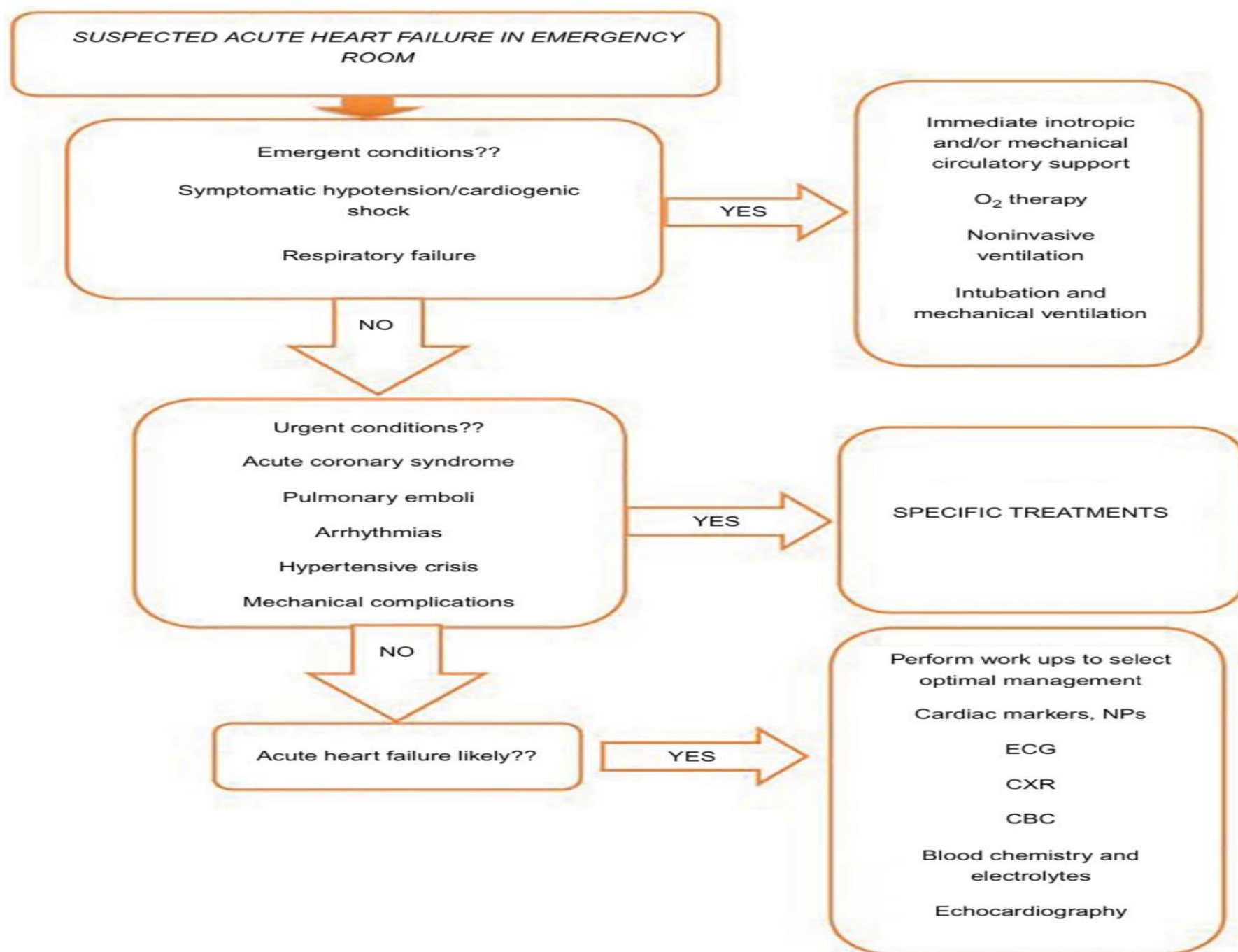
FIG. 12.3 Initial management algorithm for acute heart failure (AHF). *CBC*, complete blood count; *ECG*, electrocardiogram; *ED*, emergency department; *NP*, natriuretic peptide.
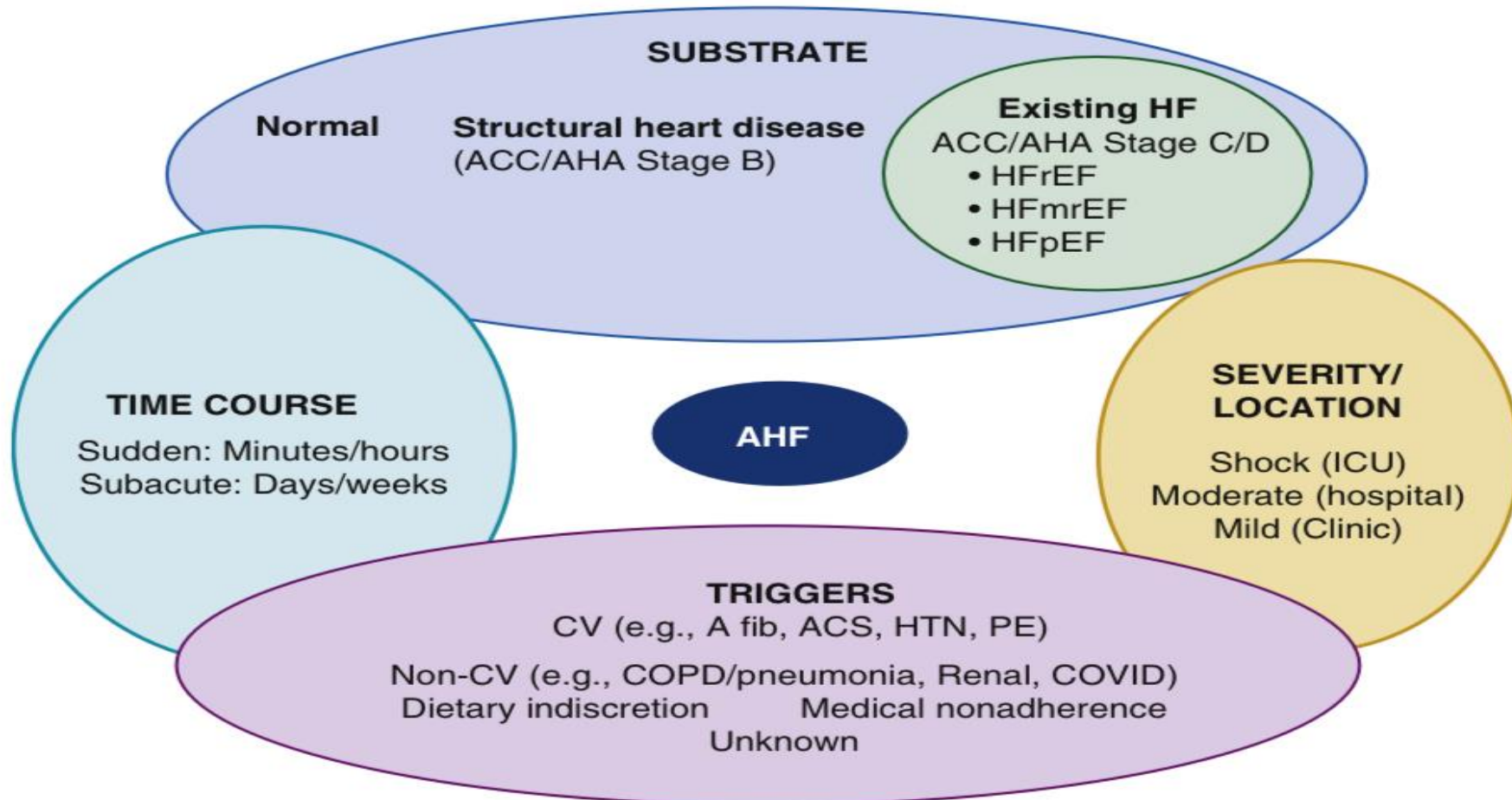
FIGURE 49.7 Systematic approach to classification of patients with acute heart failure.

ACUTE MANAGEMENT OF AHF

TABLE 12.2
Management of Acute Heart Failure Based on Hemodynamic Profile

Hemodynamic Profile	Description	Treatment
Dry and warm	Compensated	Adjust oral medications
Dry and cold	Hypoperfused and hypovolemic	IV fluid challenge If failed, start inotrope
Wet and warm	Hypertensive (elevated BP) Vascular-type fluid redistribution	Vasodilators Diuretics
	Congestive (normal BP) Cardiac-type fluid retention	Diuretic Vasodilators If failed, approach to diuretic resistance
Wet and cold	Cardiogenic shock (systolic BP <85 mmHg)	Pharmacologic and/or mechanical circulatory support Address causes
	Peripheral hypoperfusion syndrome Systolic BP: 85–110 mmHg and imminent end-organ failure anticipated	Inotrope therapy

BP, blood pressure; IV, intravenous.

Patient with acute heart failure

↓

Bedside assessment to identify *hemodynamic profiles*

↓

Presence of congestion?

Yes (95% of all AHF patients) → 'Wet' patient

No (5% of all AHF patients) → 'Dry' patient

↓

ADEQUATE PERIPHERAL PERFUSION?

Yes → 'Wet and warm' patient (typically elevated or normal systolic blood pressure)

No → 'Wet and cold' patient

Yes → 'Dry and warm' Adequately perfused = Compensated → Adjust oral therapy

No → 'Dry and cold' Hypoperfused, Hypovolemic → Consider fluid challenge consider inotropic agent if still hypoperfused

'Wet and warm' patient:

Vascular type-fluid redistribution **Hypertension** predominates
- Vasodilator
- Diuretic

Cardiac type-fluid accumulation **Congestion** predominates
- Diuretic
- Vasodilator
- Ultrafiltration (consider if diuretic resistance)

'Wet and cold' patient
Systolic blood pressure <90 mm Hg

Yes
- Inotropic agent
- Consider vasopressor in refractory cases
- Diuretic (when perfusion corrected)
- Consider mechanical circulatory support if no response to drugs

No
- Vasodilators
- Diuretics
- Consider inotropic agent in refractory cases

FIGURE 49.8 Algorithm for management of patients admitted with acute heart failure (AHF) based on degree of congestion and perfusion. (From Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) developed with the special contribution of the Heart Failure Association (HFA) of the ESC. *Eur Heart J.* 2016;37:2129–2200.)

CHRONIC MANAGEMENT OF HEART FAILURE

Stage A

e.g., Patients with:
- HTN
- Atherosclerotic disease
- DM
- Obesity
- Metabolic syndrome
  or
Patients
- Using cardiotoxins
- With family history of cardiomyopathy

→ Structural heart disease →

THERAPY

Goals
- Heart healthy lifestyle
- Prevent vascular, coronary disease
- Prevent LV structural abnormalities

Drugs
- ACEI or ARB in appropriate patients for vascular disease or DM
- Statins as appropriate

Stage B

e.g., Patients with:
- Previous MI
- LV remodeling including LVH and low EF
- Asymptomatic valvular disease

→ Development of symptoms of HF →

THERAPY

Goals
- Prevent HF symptoms
- Prevent further cardiac remodeling

Drugs
- ACEI or ARB as appropriate
- β-blockers as appropriate

In selected patients
- ICD
- Revascularization or valvular surgery as appropriate

Stage C

e.g., Patients with:
- Known structural heart disease and
- HF signs and symptoms

→ Refractory symptoms of HF at rest, despite GDMT →

HFpEF

THERAPY

Goals
- Control symptoms
- Improve HRQOL
- Prevent hospitalization
- Prevent mortality

Strategies
- Identification of comorbidities

Treatment
- Diuresis to relieve symptoms of congestion
- Follow guideline-driven indications for comorbidities (e.g., HTN, AF, CAD, DM)
- Revascularization or valvular surgery as appropriate

HFrEF

THERAPY

Goals
- Control symptoms
- Patient education
- Prevent hospitalization
- Prevent mortality

Drugs for routine use
- Diuretics for fluid retention
- ACEI or ARB
- β-blockers
- Aldosterone antagonists

Drugs for use in selected patients
- Hydralazine/isosorbide dinitrate
- ACEI and ARB
- Digoxin

In selected patients
- CRT
- ICD
- Revascularization or valvular surgery as appropriate

Stage D

e.g., Patients with:
- Marked HF symptoms at rest
- Recurrent hospitalizations despite GDMT

THERAPY

Goals
- Control symptoms
- Improve HRQOL
- Reduce hospital readmissions
- Establish patient's end-of-life goals

Options
- Advanced care measures
- Heart transplant
- Chronic inotropes
- Temporary or permanent MCS
- Experimental surgery or drugs
- Palliative care and hospice
- ICD deactivation

CORRECTION OF SYSTEMIC FACTORS

- Thyroid dysfuncyion

- Infections

- Uncontrolled diabetes

- Hypertension

- revascularisasion

NONPHARMACOLOGIC THERAPY

- Exercise training:
  - For stable HF pateints increased exercise capacity decreased hospitalization rate, increased quality of life, decreased symptoms

- Weight loss in obese patient

- Dietary NA restriction

NONPHARMACOLOGIC THERAPY

- Fluid and free water restriction especially if hyponatremic

- Minimize medications known to have deleterious effecton heart failure (NSAIDs, OCTs)

- Oxygen

- Fluid removal(dyalisi, thoracentesis, paracentesis)

TABLE 50.5 Factors That May Precipitate Acute Decompensation in Patients with Chronic Heart Failure

Dietary indiscretion

Inappropriate reduction in HF medications

Myocardial ischemia/infarction

Arrhythmias (tachycardia or bradycardia)

Infection

Anemia

Initiation of medications that worsen the symptoms of HF
   Calcium antagonists (verapamil, diltiazem)
   Beta-blockers
   Nonsteroidal antiinflammatory drugs
   Thiazolidinediones
   Antiarrhythmic agents (all class I agents, sotalol [class III])
   Anti-TNF antibodies

Alcohol consumption

Pregnancy

Worsening hypertension

Acute valvular insufficiency

HF, Heart failure; *TNF*, tumor necrosis factor.
From Mann DL. Heart Failure and Cor Pulmonale. In: Kasper DL, et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill; 2007:1448.
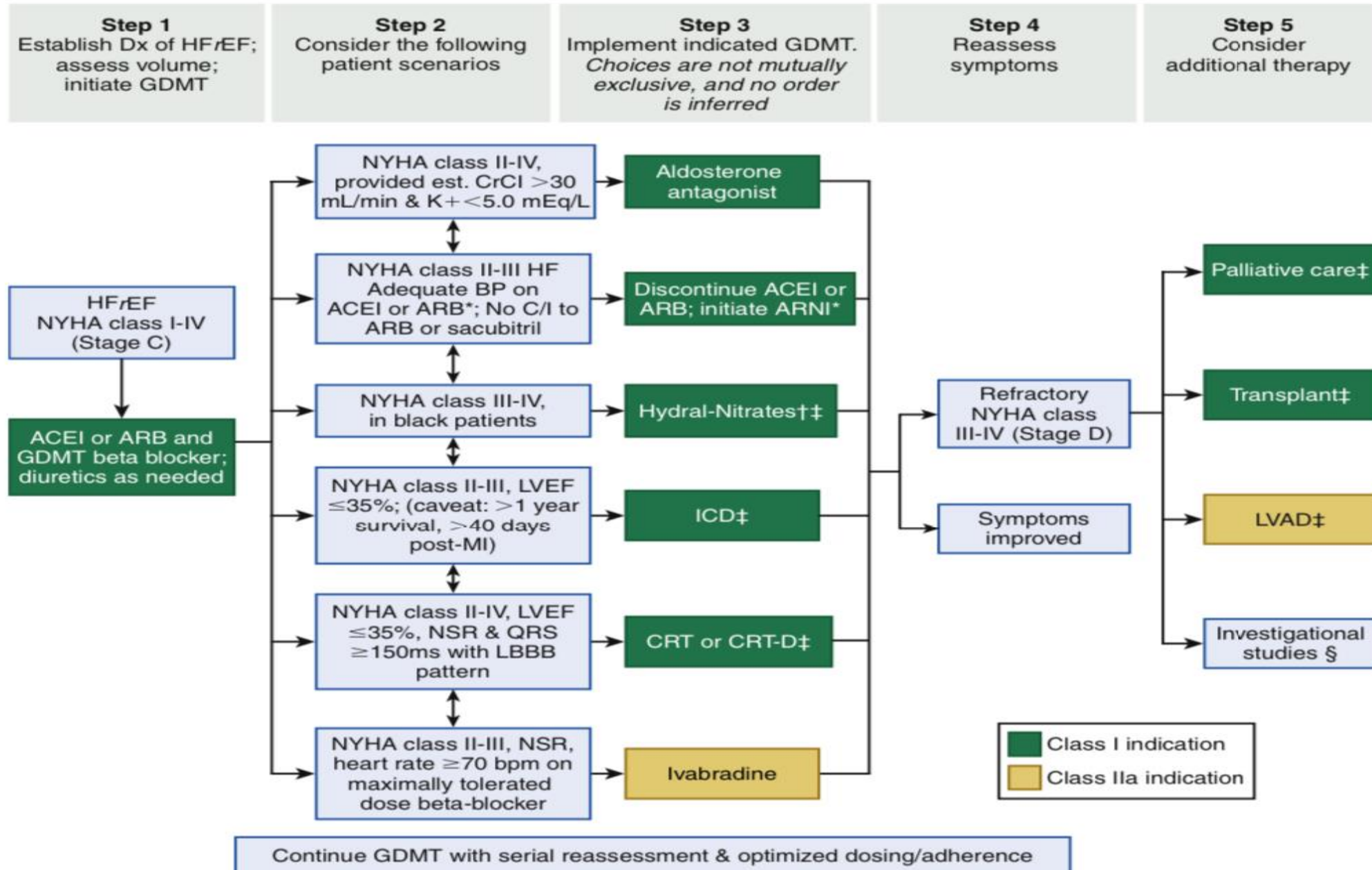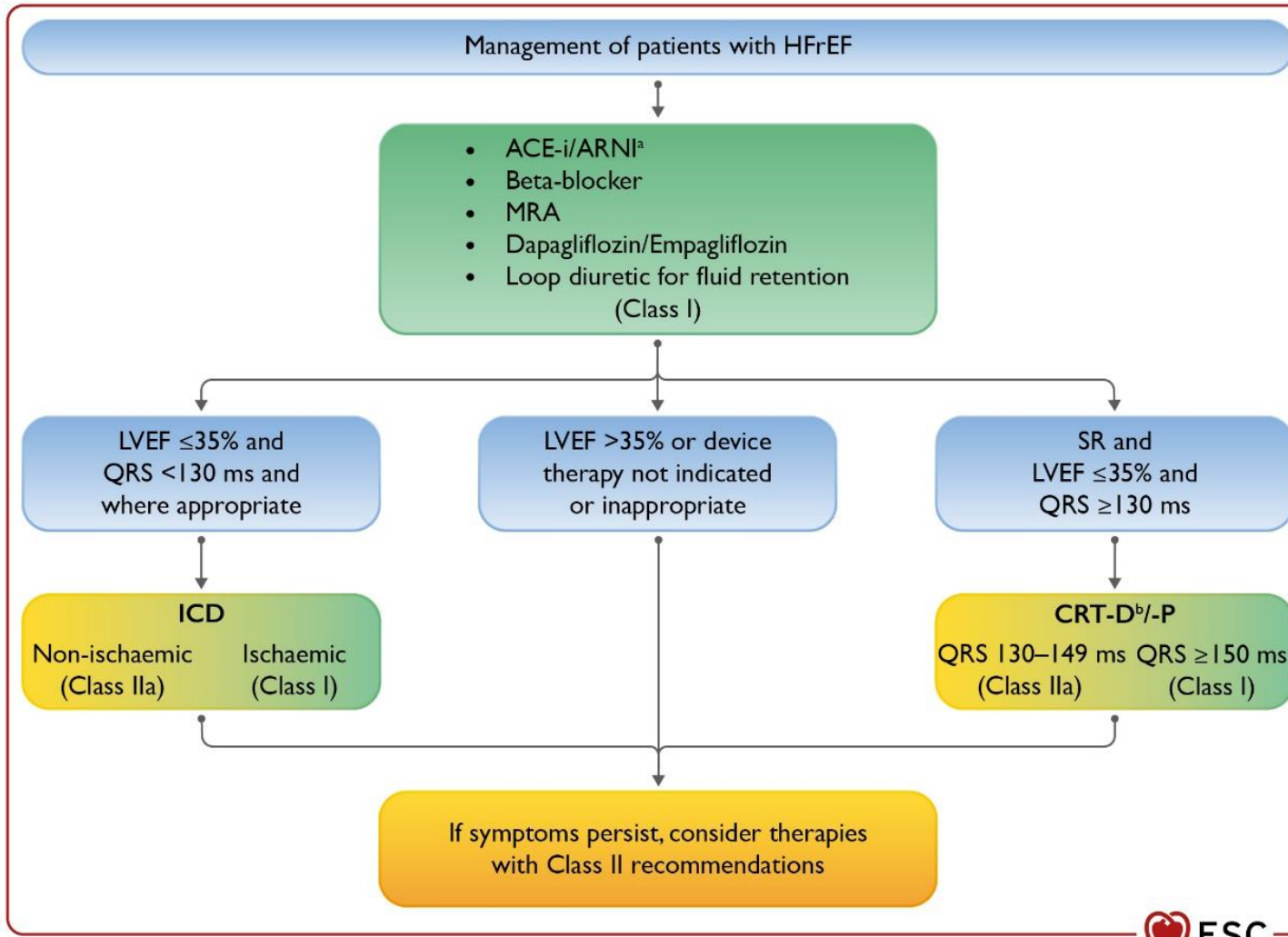
MEDICAL TREATMENT:

- loop diuretics (for fluid retention)

- ACE inh, ARNI

- Beta Blockers

- MRA

- SGLT2 inh (Empagliflozin, dapagliflozin)

Step 1
Establish Dx of HF*r*EF; assess volume; initiate GDMT

Step 2
Consider the following patient scenarios

Step 3
Implement indicated GDMT. *Choices are not mutually exclusive, and no order is inferred*

Step 4
Reassess symptoms

Step 5
Consider additional therapy

HF*r*EF
NYHA class I-IV
(Stage C)

ACEI or ARB and GDMT beta blocker; diuretics as needed

NYHA class II-IV, provided est. CrCl >30 mL/min & K+ <5.0 mEq/L → Aldosterone antagonist

NYHA class II-III HF Adequate BP on ACEI or ARB*; No C/I to ARB or sacubitril → Discontinue ACEI or ARB; initiate ARNI*

NYHA class III-IV, in black patients → Hydral-Nitrates†‡

NYHA class II-III, LVEF ≤35%; (caveat: >1 year survival, >40 days post-MI) → ICD‡

NYHA class II-IV, LVEF ≤35%, NSR & QRS ≥150ms with LBBB pattern → CRT or CRT-D‡

NYHA class II-III, NSR, heart rate ≥70 bpm on maximally tolerated dose beta-blocker → Ivabradine

Refractory NYHA class III-IV (Stage D)

Symptoms improved

Palliative care‡

Transplant‡

LVAD‡

Investigational studies §

Class I indication
Class IIa indication

Continue GDMT with serial reassessment & optimized dosing/adherence

Therapeutic algorithm of Class I Therapy Indications for a patient with heart failure with reduced ejection fraction

ACE-I = angiotensin-converting enzyme inhibitor; ARNI = angiotensin receptor-neprilysin inhibitor; CRT-D = cardiac resynchronization therapy with defibrillator; CRT-P = cardiac resynchronization therapy with pacemaker; ICD = implantable cardioverter-defibrillator; HFrEF = heart failure with reduced ejection fraction; MRA = mineralocorticoid receptor antagonist; QRS = Q, R, and S waves (on a 12-lead electrocardiogram); SR = sinus rhythm.
[a]As a replacement for ACE-I.
[b]Where appropriate. Class I=green. Class IIa=Yellow.

Management of HFrEF

To reduce mortality - for all patients

ACE-I/ARNI | BB | MRA | SGLT2i

To reduce HF hospitalization/mortality - for selected patients

Volume overload
Diuretics

SR with LBBB ≥ 150 ms
CRT-P/D

SR with LBBB 130–149 ms or non LBBB ≥ 150 ms
CRT-P/D

Ischaemic aetiology
ICD

Non-ischaemic aetiology
ICD

Atrial fibrillation
Anticoagulation

Atrial fibrillation
Digoxin | PVI

Coronary artery disease
CABG

Iron deficiency
Ferric carboxymaltose

Aortic stenosis
SAVR/TAVI

Mitral regurgitation
TEE MV Repair

Heart rate SR>70 bpm
Ivabradine

Black Race
Hydralazine/ISDN

ACE-I/ARNI intolerance
ARB

For selected advanced HF patients

Heart transplantation | MCS as BTT/BTC | Long-term MCS as DT

To reduce HF hospitalization and improve QOL - for all patients

Exercise rehabilitation

Multi-professional disease management

ESC

Strategic phenotypic overview of the management of heart failure with reduced ejection fraction

ACE-I = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; ARNI = angiotensin receptor-neprilysin inhibitor; BB = beta-blocker; b.p.m. = beats per minute; BTC = bridge to candidacy; BTT = bridge to transplantation; CABG = coronary artery bypass graft; CRT-D = cardiac resynchronization therapy with defibrillator; CRT-P = cardiac resynchronization therapy with pacemaker; DT = destination therapy; HF = heart failure; HFrEF = heart failure with reduced ejection fraction; ICD = implantable cardioverter-defibrillator; ISDN = isosorbide dinitrate; LBBB = left bundle branch block; MCS = mechanical circulatory support; MRA = mineralocorticoid receptor antagonist; MV = mitral valve; PVI = pulmonary vein isolation; QOL = quality of life; SAVR = surgical aortic valve replacement; SGLT2i = sodium-glucose co-transporter 2 inhibitor; SR = sinus rhythm; TAVI = transcatheter aortic valve replacement; TEE = transcatheter edge to edge. Colour code for classes of recommendation: Green for Class of recommendation I; Yellow for Class of recommendation IIa (see Table 1 for further details on classes of recommendation).
The Figure shows management options with Class I and IIa recommendations. See the specific Tables for those with Class IIb recommendations.

Pharmacological treatments indicated in patients with (NYHA class II-IV) heart failure with reduced ejection fraction (LVEF ≤40%)

Recommendations	Class	Level
An ACE-I is recommended for patients with HFrEF to reduce the risk of HF hospitalization and death.	I	A
A beta-blocker is recommended for patients with stable HFrEF to reduce the risk of HF hospitalization and death.	I	A
An MRA is recommended for patients with HFrEF to reduce the risk of HF hospitalization and death.	I	A
Dapagliflozin or empagliflozin are recommended for patients with HFrEF to reduce the risk of HF hospitalization and death.	I	A
Sacubitril/valsartan is recommended as a replacement for an ACE-I in patients with HFrEF to reduce the risk of HF hospitalization and death.	I	B

ACE-I = angiotensin-converting enzyme inhibitor; HF = heart failure; HFrEF = heart failure with reduced ejection fraction; LVEF = left ventricular ejection fraction; MRA = mineralocorticoid receptor antagonist; NYHA= New York Heart Association.

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Evidence-based doses of disease-modifying drugs in key randomized trials in patients with heart failure with reduced ejection fraction (1)

	Starting dose	Target dose
ACE-I		
Captopril[a]	6.25 mg *t.i.d.*	50 mg *t.i.d.*
Enalapril	2.5 mg *b.i.d.*	10–20 mg *b.i.d.*
Lisinopril[b]	2.5–5 mg *o.d.*	20–35 mg *o.d.*
Ramipril	2.5 mg *b.i.d.*	5 mg *b.i.d.*
Trandolapril[a]	0.5 mg *o.d.*	4 mg *o.d.*
ARNI		
Sacubitril/valsartan	49/51 mg *b.i.d.*[c]	97/103 mg *b.i.d.*

ACE-I = angiotensin-converting enzyme inhibitor; ARNI = angiotensin receptorneprilysin inhibitor; b.i.d. = bis in die; o.d. = omne in die (once daily); t.i.d. = ter in die (three times a day).
[a]Indicates an ACE-I where the dosing target is derived from post-myocardial infarction trials.
[b]Indicates drugs where a higher dose has been shown to reduce morbidity/mortality compared with a lower dose of the same drug, but there is no substantive randomized, placebo-controlled trial and the optimum dose is uncertain. [c]Sacubitril/valsartan may have an optional lower starting dose of 24/26 mg b.i.d. for those with a history of symptomatic hypotension.

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Evidence-based doses of disease-modifying drugs in key randomized trials in patients with heart failure with reduced ejection fraction (2)

	Starting dose	Target dose
Beta-blockers		
Bisoprolol	1.25 mg *o.d.*	10 mg *o.d.*
Carvedilol	3.125 mg *b.i.d.*	25 mg *b.i.d.*[e]
Metoprolol succinate (CR/XL)	12.5–25 mg *o.d.*	200 mg *o.d.*
Nebivolol[d]	1.25 mg *o.d.*	10 mg *o.d.*
MRA		
Eplerenone	25 mg *o.d.*	50 mg *o.d.*
Spironolactone	25 mg *o.d.*[f]	50 mg *o.d.*

b.i.d. = bis in die (twice daily); CR = controlled release; MRA = mineralocorticoid receptor antagonist; o.d. = omne in die (once daily); XL = extended release.
[d]Indicates a treatment not shown to reduce CV or all-cause mortality in patients with heart failure (or shown to be non-inferior to a treatment that does).
[e]A maximum dose of 50 mg twice daily can be administered to patients weighing over 85 kg.
[f]Spironolactone has an optional starting dose of 12.5 mg in patients where renal status or hyperkalaemia warrant caution.

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Evidence-based doses of disease-modifying drugs in key randomized trials in patients with heart failure with reduced ejection fraction (3)

	Starting dose	Target dose
SGLT2 inhibitor		
Dapagliflozin	10 mg *o.d.*	10 mg *o.d.*
Empagliflozin	10 mg *o.d.*	10 mg *o.d.*
Other agents		
Candesartan	4 mg *o.d.*	32 mg *o.d.*
Losartan	50 mg *o.d.*	150 mg *o.d.*
Valsartan	40 mg *b.i.d.*	160 mg *b.i.d.*
Ivabradine	5 mg *b.i.d.*	7.5 mg *b.i.d.*
Vericiguat	2.5 mg *o.d.*	10 mg *o.d.*

b.i.d. = bis in die (twice daily); o.d. = omne in die (once daily); SGLT2 = sodium-glucose co-transporter 2; t.i.d. = ter in die (three times a day.

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Evidence-based doses of disease-modifying drugs in key randomized trials in patients with heart failure with reduced ejection fraction (3)

	Starting dose	Target dose
Other agents (continued)		
Digoxin	62.5 µg *o.d.*	250 µg *o.d.*
Hydralazine/ Isosorbide dinitrate	37.5 mg *t.i.d.*/ 20 mg *t.i.d.*	75 mg *t.i.d.*/ 40 mg *t.i.d.*

b.i.d. = bis in die (twice daily); o.d. = omne in die (once daily); SGLT2 = sodium-glucose co-transporter 2; t.i.d. = ter in die (three times a day.

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KEY LEARNING POINTS

- 1. **HFrEF requires 4 key drugs (ARNI, BB, MRA, SGLT2i).**

-

- 2. **Diuretics relieve symptoms but do not improve survival.**

- 3. **Early diagnosis & guideline adherence improve outcomes.**

DISCHARGE PLAN

-

- **- Medications:**
-   - ARNI, Beta-blocker, MRA, SGLT2i, Loop diuretic PRN

-

- **- Lifestyle Modifications:**
-   - Low-salt diet (<2g/day), daily weight monitoring

- **- Follow-Up:**
-   - Cardiology clinic in 1 week
-   - Repeat echo in 3 months