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KULIAH SEMESTER 4
FK UNIVERSITAS MUHAMMADIYAH MALANG

WHATS PATIENTS NEED TO KNOW ?

- HEART FAILURE

  ACUTE vs CHRONIC HF

- ALO (ACUTE LUNG OEDEMA)

- COR PULMONALE

  ACUTE vs CHRONIC COR PULMONALE

WHATS DOCTOR SHOULD TO KNOW ?

ESC
European Society of Cardiology

ESC Clinical Practice Guidelines on

The Management of Chronic and Acute Heart Failure: What Patients Need to Know

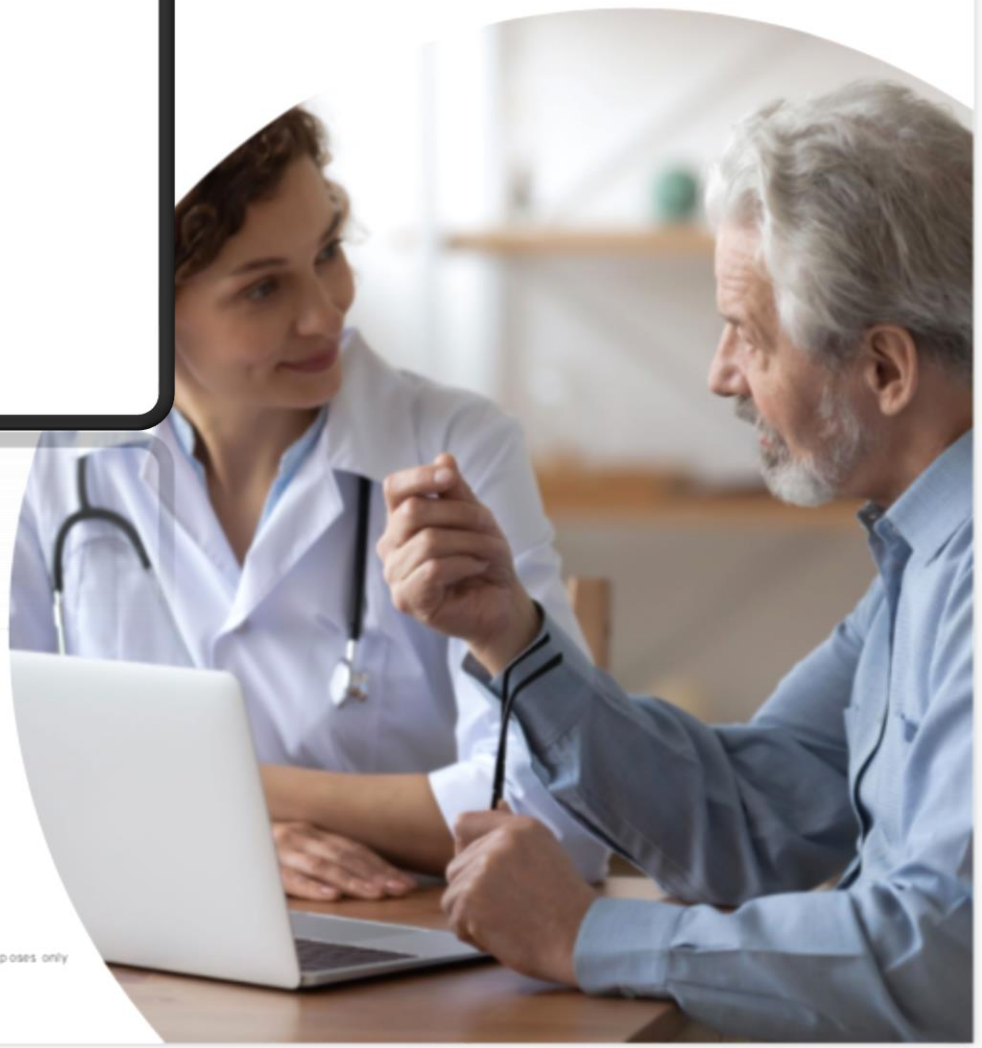


Image is of model used for illustrative purposes only

What is Heart Failure?

Heart failure is not a single disease but a '**syndrome**' made up of **symptoms**, such as breathlessness or fatigue, that may appear alongside **signs** such as swollen ankles, caused by something wrong in the heart.

Heart failure can be **acute** (comes on quickly and severely, requiring urgent attention) or **chronic** (long-lasting, with the coming-and-going of symptoms). This document mainly refers to **chronic heart failure**.

Types of Heart Failure

Heart failure occurs when the **pumping action** of the heart is impaired. This impairment may be mild or severe.

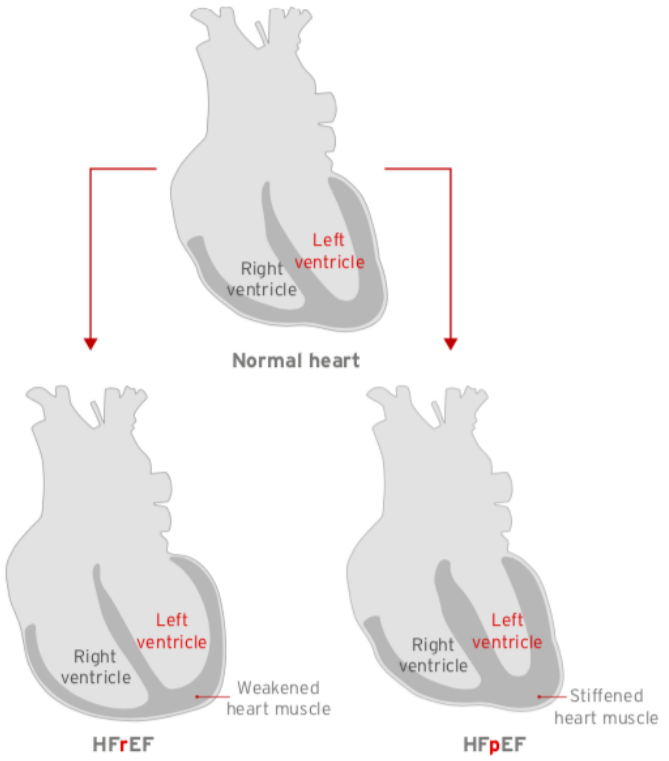
Generally, there are three types of chronic heart failure based on the amount of blood that is pumped out of the heart's main pumping chamber, the **left ventricle**, during each heartbeat. This is known as the '**left ventricular ejection fraction**'.

The three types of chronic heart failure are:

- Heart Failure with **reduced** Ejection Fraction (**HFrEF**)
- Heart Failure with **mildly reduced** Ejection Fraction (**HFmrEF**)
- Heart Failure with **preserved** Ejection Fraction (**HFpEF**)

	HFrEF	HFmrEF	HFpEF
Left ventricular ejection fraction	<40%	≥40 to <50%	≥50%
Changes in heart structure	In HFrEF, the heart is usually **enlarged** compared with a normal heart and **pumping weakly**	HFmrEF is **between** HFrEF and HFpEF	In HFpEF, the heart is **less enlarged** than in HFrEF; the left ventricle is **smaller** compared with the HFrEF heart and **stiffened**
Changes in heart function	The left ventricle fills with higher pressure than is normal. There is higher pressure in the lungs, veins and liver that can lead to breathlessness and/or oedema (swelling)		

The changes associated with each type of chronic heart failure are shown below:



Advanced Heart Failure

Advanced heart failure is a **development** of chronic heart failure when symptoms cannot be fully controlled despite maximum therapy. This is sometimes referred to as '**resistance to treatment**'.

Advanced heart failure is **different** from when acute heart failure arises in a patient with chronic heart failure, which describes the rapid onset of a change in heart function that requires urgent attention.

Diagnosis of Heart Failure

To be diagnosed with heart failure, you must have **symptoms and/or signs** of heart failure as well as **abnormalities and functional problems** in the heart as seen on tests.

The types of tests and investigations you may have to diagnose your condition are shown below:

Blood tests, such as BNP/ NT-proBNP

Electrocardiogram (ECG), checks electrical activity of the heart

X-ray

Echocardiogram (echo), ultrasound of the heart

Severity Classification of Heart Failure

Following diagnosis, doctors will often classify your condition using the **New York Heart Association (NYHA) Functional Classification** system, according to the severity of your symptoms and how they affect your physical activity:

NYHA class	Description
Class I	No limitation of physical activity. Ordinary physical activity does not cause excessive symptoms, e.g., breathlessness, fatigue or palpitations (more noticeable or 'skipping' heartbeats)
Class II	Slight limitation of physical activity. Comfortable at rest, but ordinary physical activity causes excessive symptoms
Class III	Significant limitation of physical activity. Comfortable at rest, but less than ordinary physical activity causes excessive symptoms
Class IV	Unable to do any physical activity without discomfort. Symptoms can be present even at rest. If any physical activity is done, discomfort is increased

Hereditary Forms of Heart Failure

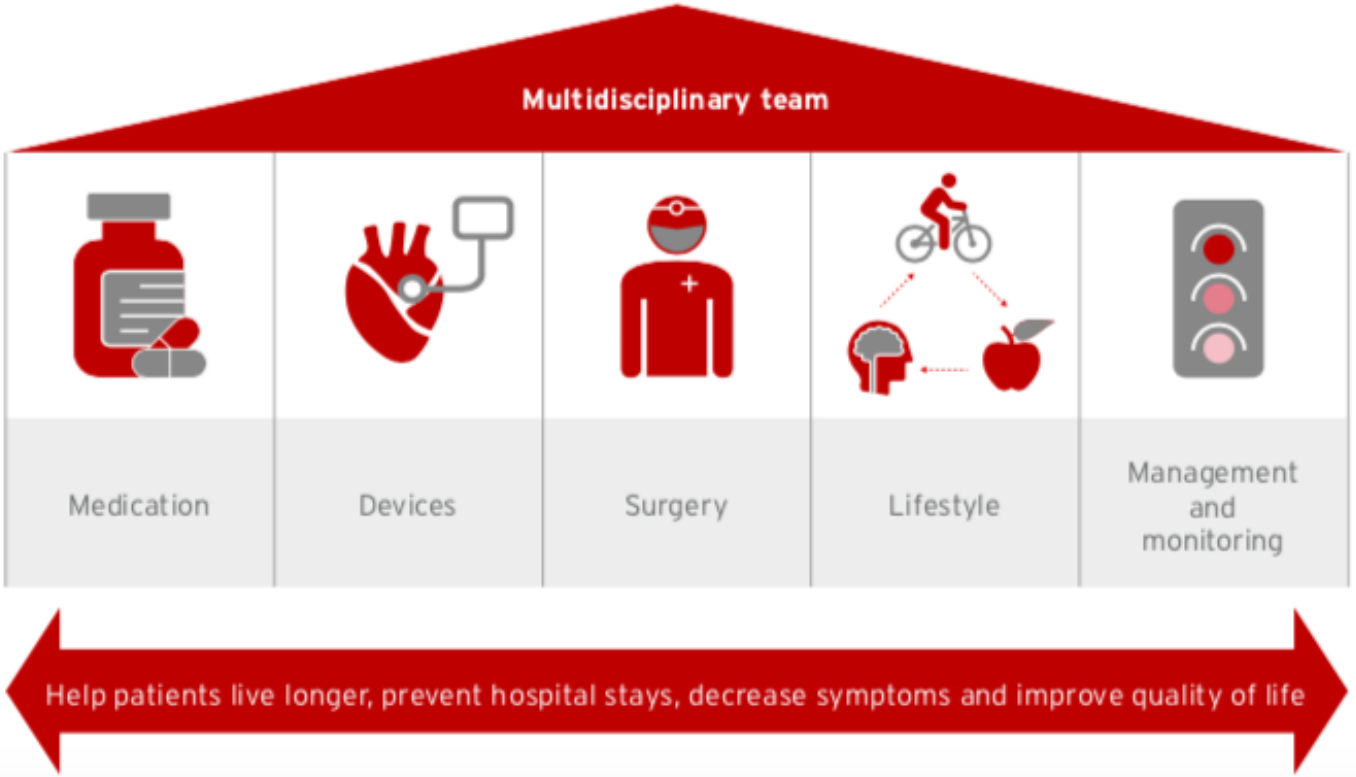
Some causes of heart failure, such as a disease of the heart muscle called cardiomyopathy, may be '**hereditary**', meaning they can be passed down in your family. Genetic testing should be considered in people who may have cardiomyopathy depending on age, family history and heart structure.

Treatment for Heart Failure

Care from a **multidisciplinary team** (healthcare professionals across different specialities) is key to meeting the three major goals of treatment for people with heart failure:

1. longer life
2. prevent hospital stays due to worsening heart failure
3. decrease symptoms and improve quality of life

Some of the ways that you and your multidisciplinary team can help to achieve these goals are shown below:



Medications for People with HFrEF

Medicines are the **first** treatment for HFrEF and should be started as early as possible, before devices or other non-medicinal treatments are used.

The ESC Clinical Practice Guidelines currently recommend four different types of medicines for people with HFrEF: Angiotensin converting enzyme inhibitors (ACE-I) or angiotensin receptor neprilysin inhibitors (ARNI), beta-blockers (BB), mineralocorticoid receptor antagonists (MRA) and sodium-glucose cotransporter-2 (SGLT2) inhibitors. The table below explains how the different medicines work:

Type of medicine	What it does
Angiotensin converting enzyme inhibitors (ACE-I)	Relax blood vessels and reduce how hard the heart has to work
Angiotensin receptor neprilysin inhibitors (ARNI)	Work in a similar way to ACE-I (above) and have additional heart-protective effects
Beta-blockers (BB)	Slow down the heart so that it doesn't have to work as hard, and protect the heart from future heart attacks
Mineralocorticoid receptor antagonists (MRA)	Reduce build-up of fluid and sodium, reducing scarring of heart muscle, and thus protect the heart
Sodium-glucose cotransporter-2 (SGLT2) inhibitors	Help remove fluid and sodium, protecting the heart and kidneys[2]

You may also receive other types of medications to control your symptoms or improve your condition, e.g., **diuretics** ('water pills', which help your body get rid of salt [sodium] and water) are recommended to reduce excess fluid and lower pressures within the heart.

Medications for People with HFmrEF

Most research into medications for people living with heart failure has been focused on treatment of people with HFrEF. However, many medications used for HFrEF may also help people with HFmrEF, including diuretics.

Medications for People with HFpEF

Recently, SGLT2 inhibitors have also been shown to help people with HFpEF live longer, prevent hospital stays, decrease symptoms and improve quality of life[2].

Other medications can be used to help relieve symptoms for people with HFpEF, such as diuretics to reduce breathlessness. As most people with HFpEF have underlying high blood pressure and/or coronary artery disease, many are treated with ACE-I/ angiotensin II receptor blockers (ARB), BB or MRA.

Managing Heart Failure Alongside Other Health Conditions

Many people with heart failure also have other health conditions such as diabetes, kidney disease or chronic obstructive pulmonary disease.

Your heart failure treatment might be **changed** if you have one of these conditions, are pregnant or have another condition such as congenital heart disease.

For people with heart failure and **atrial fibrillation**, anticoagulants ('blood thinners') are often needed to prevent stroke, and digoxin is sometimes given to slow a high heart rate.

For people who don't have enough **iron**, an iron infusion can be given to improve symptoms and prevent hospitalisation.

People with HFrEF are at increased risk of **cardiac arrest**, where the heart suddenly stops pumping.

Pacemakers may be recommended for people with a heartbeat that is too slow or too fast.

People who have recovered from cardiac arrest and those with a history of heart attack are most likely to receive an **ICD**. In people with other heart disease not related to the blood vessels of the heart, ICDs are most helpful in those **under 70 years old**.

A **cardiac resynchronisation therapy** (CRT) device may be used in certain people to improve heart function and quality of life, depending on the results of an **ECG** as well as how well and for how long medications are working.

Some of the important steps in the process of receiving or replacing an implanted device are shown below:

If you have a **left ventricular ejection fraction ≤35%**, you should be considered for an **implanted device (ICD or CRT)**

You should receive **education around the purpose** of the device and **potential complications**

A **review of medications** (particularly diuretic therapy) is advised **after receiving a CRT**

You should be **evaluated by an experienced cardiologist before your device is replaced**, in case management goals or needs have changed

Time

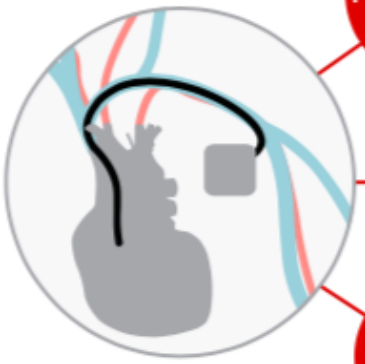
Devices and Surgery for Heart Failure

Devices

Medical devices can help support the heart by using **electrical signals** to keep it beating regularly and/or improve how it works.

These devices, placed under the skin near the collarbone, may not only **improve symptoms** but have been shown to help people with heart failure **live longer**.

Three types of devices that may be recommended to you are shown below:



Pacemaker

A pacemaker monitors heart rate and sends **small and painless electrical impulses** to the heart to start each heartbeat if needed

ICD

An Implantable Cardioverter Defibrillator (ICD) is a pacemaker-like device that can deliver either a **painless electrical impulse** or a **more noticeable shock** to the heart to correct the heart rhythm if it senses a serious problem that could lead to sudden cardiac arrest

CRT-P /CRT-D

A cardiac resynchronisation therapy pacemaker (CRT-P) is a **special type of pacemaker** that makes the different parts of the heart pump together. It can be combined with an ICD (CRT-D)

Surgery

Some people with underlying cardiac diseases that are causing heart failure will benefit from **surgery** or other procedures.

Some of the common surgical or catheter procedures for heart failure, who they are for, and what they do and how, are listed below:

Procedure/ surgery	Who's it for?	What it does and how
Catheter ablation	People with worsening heart failure symptoms due to atrial fibrillation	Restores normal heart rhythm by blocking extra electrical impulses coming into the heart
Coronary artery bypass grafting	People with narrowing of the coronary arteries, symptoms of angina and left ventricular ejection fraction ≤35%	Diverts blood around narrowed parts of the arteries to improve blood flow and oxygen supply to the heart

Valve repair or replacement	People who develop problems with their heart valves, including aortic stenosis (narrowing of the opening of the left ventricle)	Surgery may be done to repair or replace the valve. In patients with severe aortic stenosis, surgical or catheter replacement of the aortic valve is recommended
Mitral valve procedures	People who have symptoms despite medications and in whom the procedure is likely to reduce heart failure hospitalisation	Prevents abnormal blood flow between heart chambers
Mechanical circulatory support	People with advanced heart failure	Implanted device that takes over the pumping function of the heart. It can be used until a heart transplant is available or as a long-term treatment
Heart transplantation	People with advanced heart failure	Optimal treatment for limited group of patients

Lifestyle Modifications for People with Heart Failure

People with heart failure can make **lifestyle modifications** to improve their symptoms and the condition itself.

Your healthcare team should refer you to **rehabilitation** where you can learn more about your condition and how to look after yourself.

Looking after yourself is **essential** in the effective management of heart failure and you should discuss any lifestyle recommendations with your healthcare team.

Some examples of lifestyle modifications are shown below:

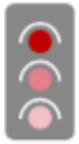
Exercise according to physical ability

Reduce **sedentary habits**, cigarettes and alcohol

Maintain a **healthy diet** and **body weight**

Plan travel and leisure activities according to physical ability

Seek help if experiencing **depression, anxiety or low mood**



Monitor, recognise and react to changes in signs/symptoms

Management and Monitoring of Heart Failure

Regular monitoring is important to maintain symptom control.

You may meet with your healthcare providers in the following ways:

A **multidisciplinary team** (which combines healthcare professionals from different specialities) is recommended to ensure correct tests, accurate diagnosis and appropriate therapy, education and follow-up

Regular follow-up is important, even if your condition is stable. The ESC Clinical Practice Guidelines recommend **at least every 6 months** to check things like heart rhythm, blood pressure and kidney function

If you've recently been discharged from hospital, follow-up should be more frequent, including a visit **1–2 weeks after leaving hospital** to check your symptoms and how well the medications are working

Telemonitoring, where you may send information such as your symptoms, weight or blood pressure to your healthcare provider, may be used **to adjust treatment or get further advice**

Each person's experience with heart failure is **different**; despite the best medications, devices and surgical treatments, symptoms can get worse.

A supportive approach from all members of your **multidisciplinary team** can improve quality of life by balancing medical treatment and symptom control with particular reference to mental and spiritual wellbeing.

WHATS DOCTOR SHOULD TO KNOW ?

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

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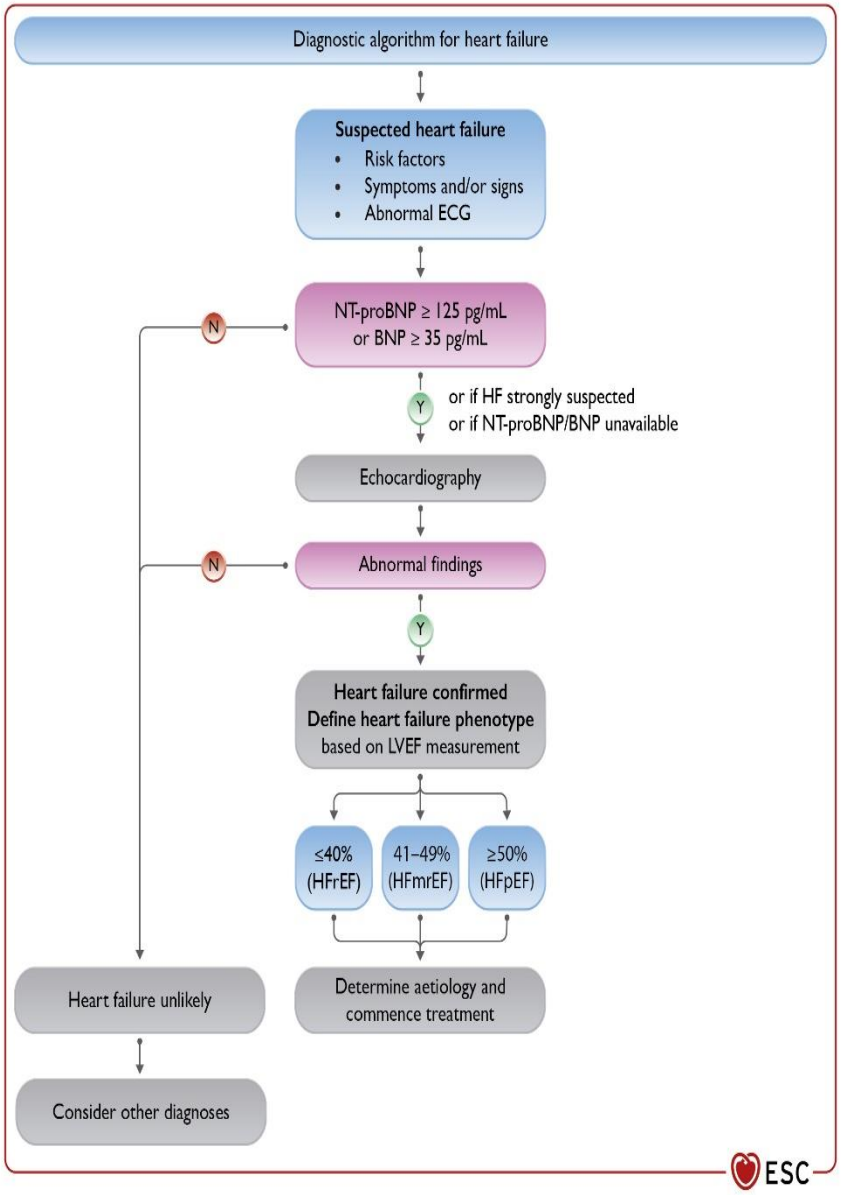
The diagnostic algorithm for heart failure



ECG = electrocardiogram; HFmrEF = heart failure with mildly reduced ejection fraction;
HFpEF = heart failure with preserved ejection fraction; HFrEF = heart failure with reduced ejection fraction; LVEF = left ventricular ejection fraction; NT-proBNP = N-terminal pro-B type natriuretic peptide.
The abnormal echocardiographic findings are described in more detail in the respective sections onHFrEF (section 5), HFmrEF (section 7), and HFpEF (section 8).

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure
(European Heart Journal 2021 – doi:10.1093/eurheartj/ehab368)

Causes of heart failure, common modes of presentation and specific investigations (1)

Cause	Examples of presentations	Specific investigations
CAD	Myocardial infarction Angina or "angina-equivalent" Arrhythmias	Invasive coronary angiography CT-coronary angiogram Imaging stress tests (echo, nuclear, CMR)
Hypertension	Heart failure with preserved systolic function Malignant hypertension/acute pulmonary oedema	24 h ambulatory BP Plasma metanephrines, renal artery imaging Renin and aldosterone
Valve disease	Primary valve disease e.g. aortic stenosis Secondary valve disease e.g. functional regurgitation Congenital valve disease	Echo – transoesophageal/stress
Arrhythmias	Atrial tachyarrhythmias Ventricular arrhythmias	Ambulatory ECG recording Electrophysiology study, if indicated
CMPs	All Dilated Hypertrophic Restrictive ARVC Peripartum Takotsubo syndrome Toxins: alcohol, cocaine, iron, copper	CMR, genetic testing Right and left heart catheterization CMR, angiography Trace elements, toxicology, LFTs, GGT

ARVC = arrhythmogenic right ventricular cardiomyopathy; BP = blood pressure; CAD= coronary artery disease; CMP = cardiomyopathy; CMR= cardiac magnetic resonance; ECG = electrocardiogram; GGT= gamma-glutamyl transferase; LFT = liver function test.

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure
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Causes of heart failure, common modes of presentation and specific investigations (2)

Cause	Examples of presentations	Specific investigations
Congenital heart disease	Congenitally corrected/repaired transposition of great arteries Shunt lesions Repaired tetralogy of Fallot Ebstein's anomaly	CMR
Infective	Viral myocarditis Chagas disease HIV Lyme disease	CMR, EMB Serology
Drug-induced	Anthracyclines Trastuzumab VEGF inhibitors Immune Check Point Inhibitors Proteasome inhibitors RAF+MEK inhibitors	
Infiltrative	Amyloid Sarcoidosis Neoplastic	Serum electrophoresis and serum free light chains, Bence Jones protein, Bone scintigraphy, CMR, CT-PET, EMB Serum ACE, CMR, FDG-PET, chest CT, EMB CMR, EMB

ACE = angiotensin-converting enzyme; CMR= cardiac magnetic resonance; CK = creatinine kinase; CT = computed tomography; ECG = electrocardiogram; Echo = echocardiography; EMB = endomyocardial biopsy; FDG = fluorodeoxyglucose; HIV = human immunodeficiency virus; h = hour; MEK =mitogen-activated protein kinase; PET = positron emission tomography; VEGF = vascular endothelial growth factor

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure
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Causes of heart failure, common modes of presentation and specific investigations (3)

Cause	Examples of presentations	Specific investigations
Storage disorders	Haemochromatosis Fabry disease Glycogen storage diseases	Iron studies, genetics, CMR (T2* imaging), EMB α-galactosidase A, genetics, CMR (T1 mapping)
Endomyocardial disease	Radiotherapy Endomyocardial fibrosis/eosinophilia Carcinoid	CMR EMB 24 h urine 5-HIAA
Pericardial disease	Calcification Infiltrative	Chest CT, CMR, Right and Left heart catheterization
Metabolic	Endocrine disease Nutritional disease (thiamine, Vitamin B1 and selenium deficiencies) Autoimmune disease	TFTs, plasma metanephrines, renin & aldosterone, cortisol Specific plasma nutrients ANA, ANCA, rheumatology review
Neuromuscular disease	Friedreich's ataxia Muscular dystrophy	Nerve conduction studies, electromyogram, genetics CK, electromyogram, genetics

5-HIAA = 5-hydroxyindoleacetic acid; ANA = anti-nuclear antibody; ANCA = anti-nuclear cytoplasmic antibody; CK = creatinine kinase; CMR = cardiac magnetic resonance; CT = computed tomography; EMB = endomyocardial biopsy TFT = thyroid function test.

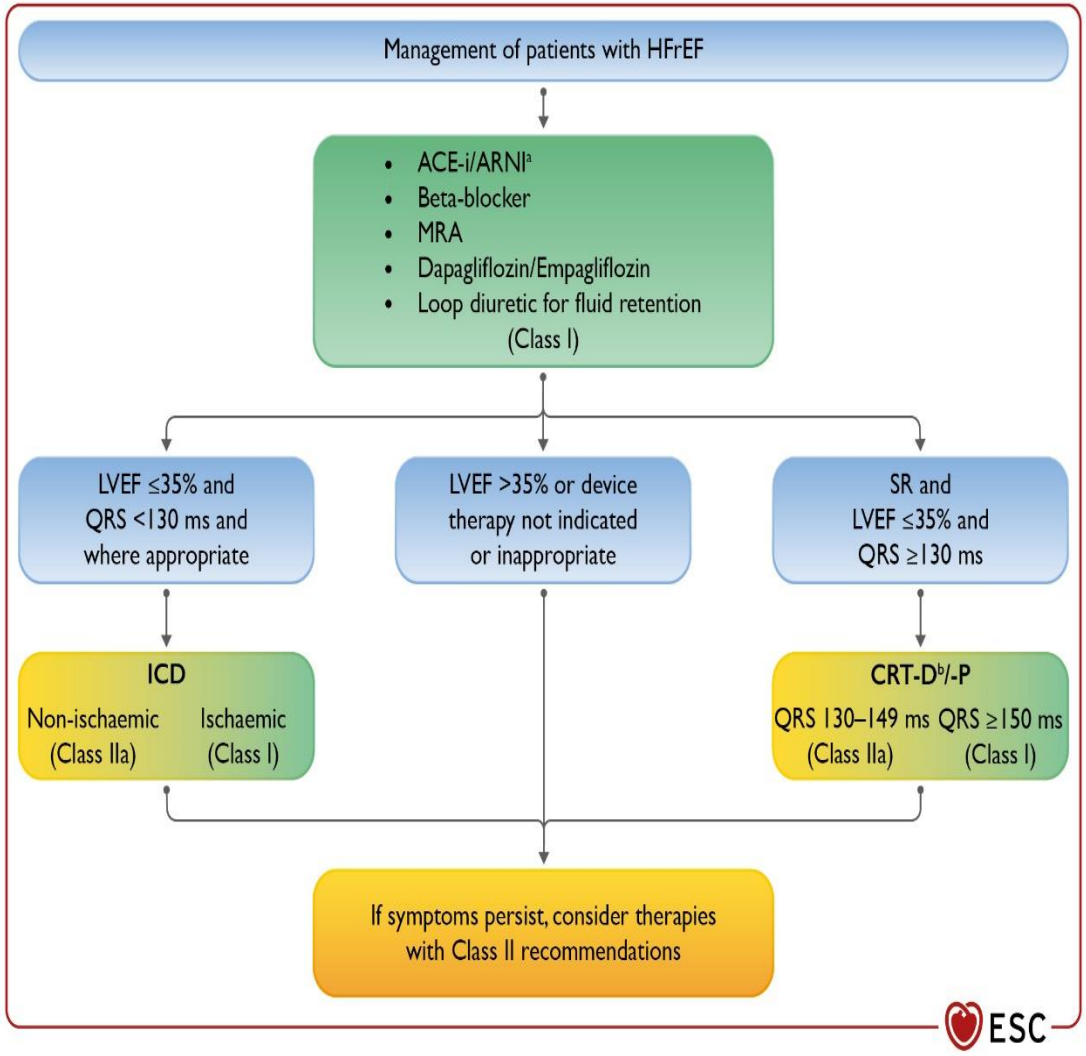
2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure
(European Heart Journal 2021 – doi:10.1093/eurheartj/ehab368)

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

BNP = B-type natriuretic peptide; ECG = electrocardiogram; HbA1c = glycated haemoglobin; NT-proBNP = N-terminal pro-B-type natriuretic peptide; TSAT = transferrin saturation.
[a]References are listed in section 4.2 for this item.

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 pacemaker; ICD = implantable cardioverter-defibrillator; HFrEF = heart failure with reduced ejection fraction; MRA = mineralocorticoid receptor antagonist; QRS = Q, R, and S waves of an ECG; SR = sinus rhythm.

[a]As a replacement for ACE-I.

[b]Where appropriate. Class I=green. Class IIa=Yellow.

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure (European Heart Journal 2021 – doi:10.1093/eurheartj/ehab368)

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.

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure
(European Heart Journal 2021 – doi:10.1093/eurheartj/ehab368)

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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(European Heart Journal 2021 – doi:10.1093/eurheartj/ehab368)

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.

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure
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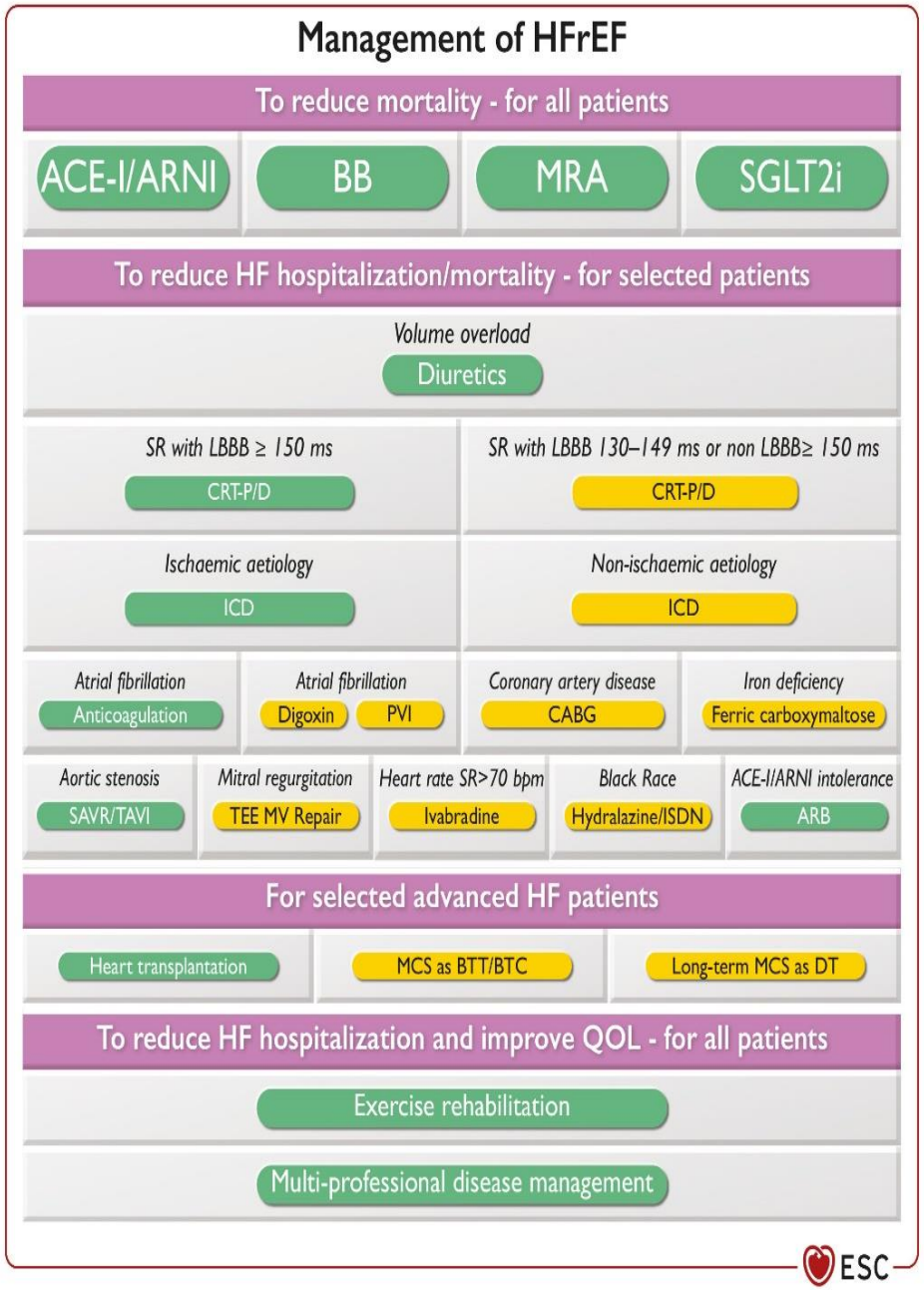
Evidence-based doses of disease-modifying drugs in key randomized trials in patients with heart failure with reduced ejection fraction (3)

	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.



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 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 showsmanagement options with Class I and IIa recommendations. See the specific Tables for those with Class IIb recommendations.

www.escardio.org/guidelines

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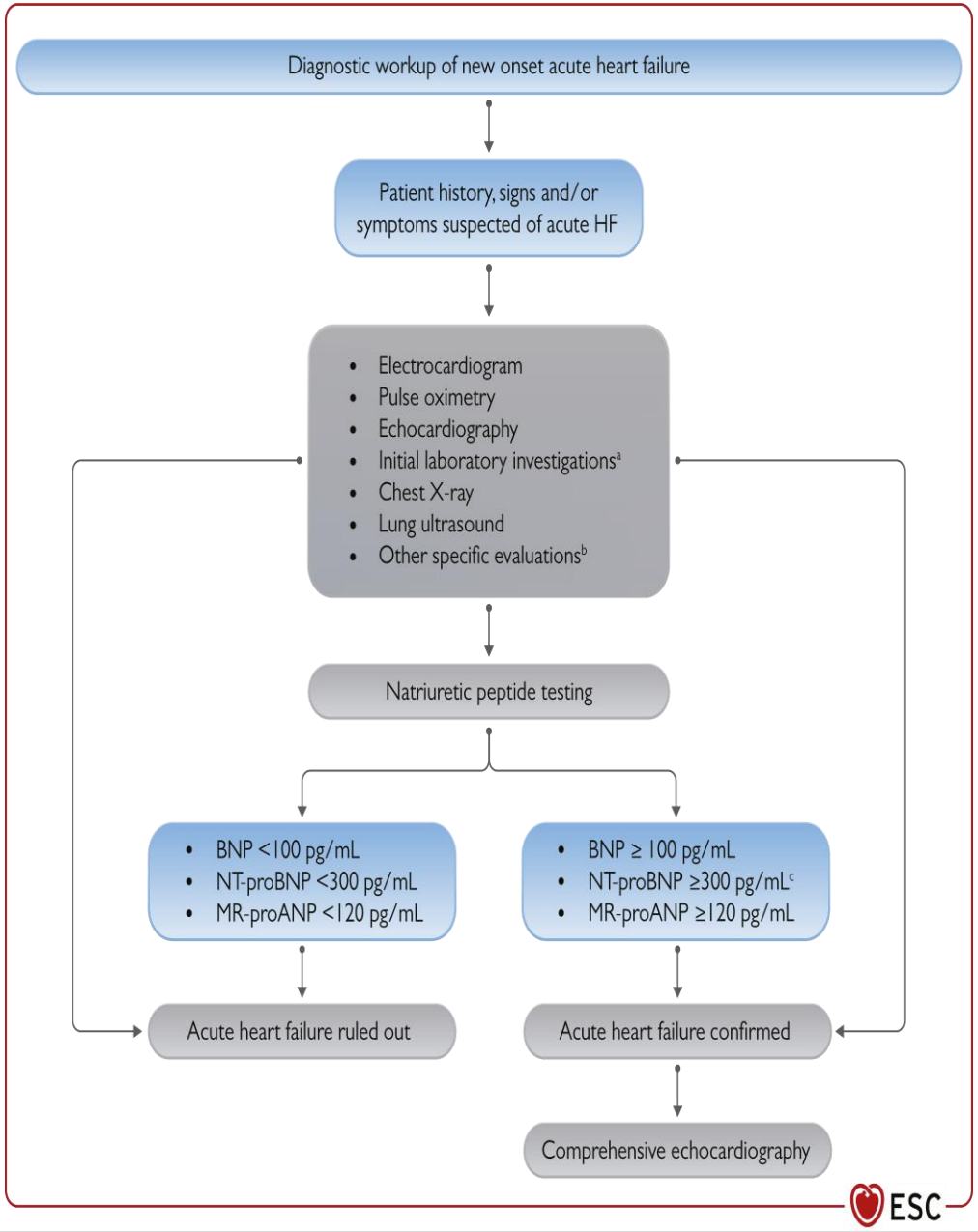
Diagnostic work up of new onset acute heart failure



ACS = acute coronary syndrome; BNP = B-type natriuretic peptide; CT = computed tomography; HF = heart failure; MR-proANP=mid-regional pro-atrial natriuretic peptide; NT-proBNP = N-terminal pro-B-type natriuretic peptide; TSH = thyroid-stimulating hormone.

[a]Initial laboratory exams include troponin, serum creatinine, electrolytes, blood urea nitrogen or urea, TSH, liver function tests as well as D-dimer and procalcitonin when pulmonary embolism or infection are suspected, arterial blood gas analysis in case of respiratory distress, and lactate in case of hypoperfusion.

[b]Specific evaluation includes coronary angiography, in case of suspected ACS, and CT in case of suspected pulmonary embolism.

[c]Rule-in values for the diagnosis of acute HF: >450 pg/mL if aged <55 years, >900 pg/mL if aged between 55 and 75 years and >1800 pg/mL if aged >75 years

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure (European Heart Journal 2021 – doi:10.1093/eurheartj/ehab368)

Diagnostic tests in patients with acute heart failure (1)

Exam	Time of measurement	Possible findings	Diagnostic value for AHF	Indication
ECG	Admission, during hospitalization,[a,b] pre-discharge	Arrhythmias, myocardial ischaemia	None	Recommended
Chest-X ray	Admission, during hospitalization[a]	Congestion, lung infection	Confirmatory	May be considered
LUS	Admission, during hospitalization[a] pre-discharge	Congestion	Confirmatory	May be considered
Echocardiography	Admission, during hospitalization,[a] pre-discharge	Congestion, cardiac function, mechanical causes	Major	Recommended
Natriuretic peptides (BNP, NT-proBNP, MR-proANP)	Admission, pre-discharge	Congestion	High negative predictive value	Recommended
Serum troponin	Admission	Myocardial injury	Exclusion of ACS	Recommended
Serum creatinine	Admission, during hospitalization,[a] pre-discharge	Renal function	None	Recommended for prognostic assessment

ACS = acute coronary syndrome; AHF = acute heart failure; BNP = B-type natriuretic peptide; ECG = electrocardiogram; LUS = lung ultrasound; MR-proANP = mid-regional pro-atrial natriuretic peptide; NT-proBNP = N-terminal pro-B-type natriuretic peptide; TSH = thyroid-stimulating hormone.

[a]Based on clinical conditions.

[b]Continuous ECG monitoring can be considered based on clinical conditions.

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Diagnostic tests in patients with acute heart failure (2)

Exam	Time of measurement	Possible findings	Diagnostic value for AHF	Indication
Serum electrolytes (sodium, potassium, chloride)	Admission, during hospitalization,[a] pre-discharge	Electrolyte abnormalities	None	Recommended for prognostic assessment and treatment
Iron status (transferrin, ferritin)	Pre-discharge	Iron status	None	Recommended for prognostic assessment and treatment
TSH	Admission	Hypo- hyperthyroidism	None	Recommended for treatment
D-dimer	Admission	Pulmonary embolism	Excludes pulmonary embolism	Recommended when pulmonary embolism is suspected
Pro-calcitonin	Admission	Pneumonia	Useful for diagnosis of pneumonia	May be done when pneumonia is suspected
Lactate	Admission, during hospitalization[a]	Lactic acidosis	Useful to assess perfusion status	Recommended when peripheral hypoperfusion is suspected
Pulse oximetry and arterial blood gas analysis	Admission, during hospitalization[a]	Respiratory failure	Useful to assess respiratory function	Recommended when respiratory failure is suspected

ACS = acute coronary syndrome; AHF = acute heart failure; BNP = B-type natriuretic peptide; ECG = electrocardiogram; LUS = lung ultrasound; MR-proANP = mid-regional pro-atrial natriuretic peptide; NT-proBNP = N-terminal pro-B-type natriuretic peptide; TSH = thyroid-stimulating hormone. [a]Based on clinical conditions. [b]Continuous ECG monitoring can be considered based on clinical conditions.

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Clinical presentations of acute heart failure

	Acutely decompensated heart failure (ADHF)	Acute pulmonary oedema	Isolated right ventricular failure	Cardiogenic Shock
Main mechanisms	LV dysfunction Sodium and water renal retention	Increased afterload and/or predominant LV diastolic dysfunction Valvular heart disease	RV dysfunction and/or pulmonary hypertension	Severe cardiac dysfunction
Main cause of symptoms	Fluid accumulation, increased intraventricular pressure	Fluid redistribution to the lungs and acute respiratory failure	Increased central venous pressure and often systemic hypoperfusion	Systemic hypoperfusion
Onset	Gradual (days)	Rapid (hours)	Gradual or rapid	Gradual or rapid
Main haemodynamic abnormalities	Increased LVEDP and PCWP[a] Low or normal cardiac output Normal to low SBP	Increased LVEDP and PCWP[a] Normal cardiac output Normal to high SBP	Increased RVEDP Low cardiac output Low SBP	Increased LVEDP and PCWP[a] Low cardiac output Low SBP
Main clinical presentations	Wet and warm OR Dry and cold	Wet and warm[b]	Dry and cold OR Wet and cold	Wet and cold
Main treatment	Diuretics Inotropic agents/vasopressors (if peripheral hypoperfusion/ hypotension) Short-term MCS if needed	Diuretics Vasodilators[b]	Diuretics for peripheral congestion Inotropic agents/vasopressors (if peripheral hypoperfusion/ hypotension) Short-term MCS if needed	Inotropic agents/ vasopressors Short-term MCS

LV = left ventricular; LVEDP = left ventricular end-diastolic pressure; MCS = mechanical circulatory support; PCWP = pulmonary capillary wedge pressure; RV = right ventricular; RVEDP = right ventricular end-diastolic pressure; RRT = renal replacement therapy; SBP = systolic blood pressure. [a]May be normal with low cardiac output. [b]Wet and cold profile with need of inotropes and/or vasopressors may rarely occur.

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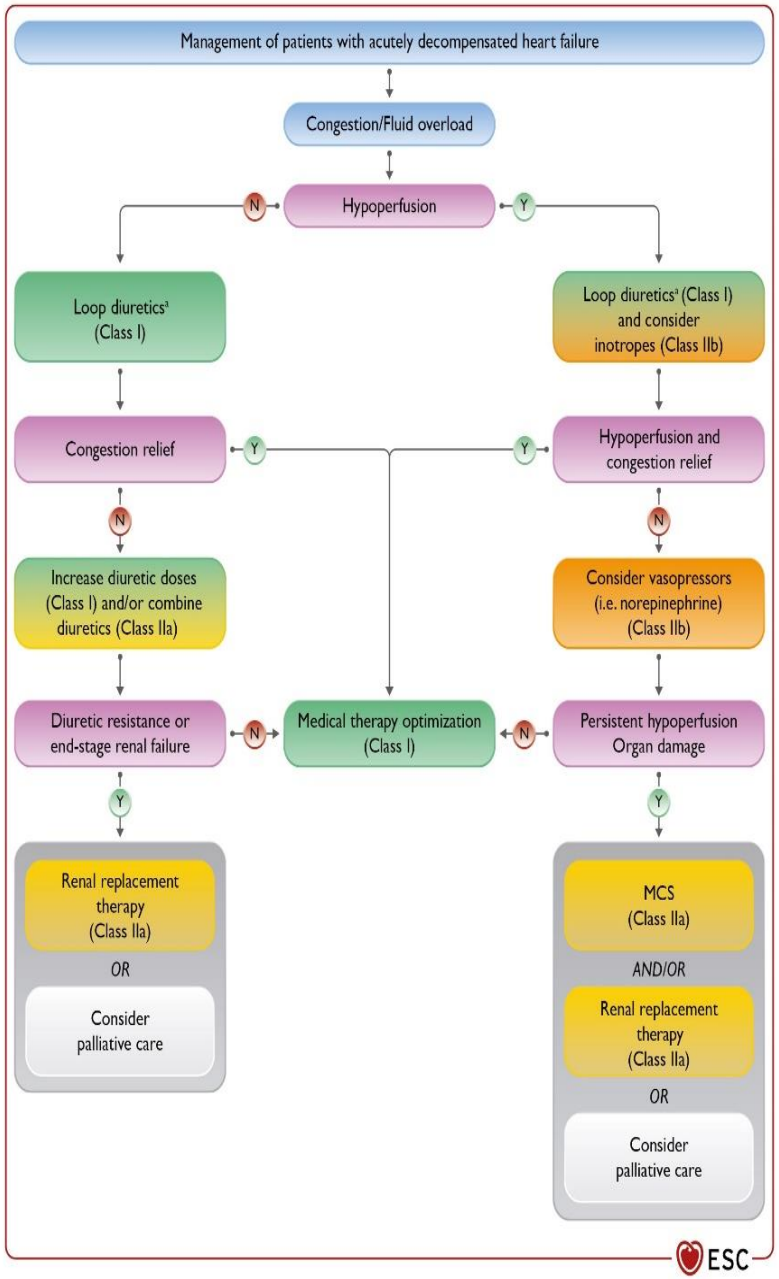
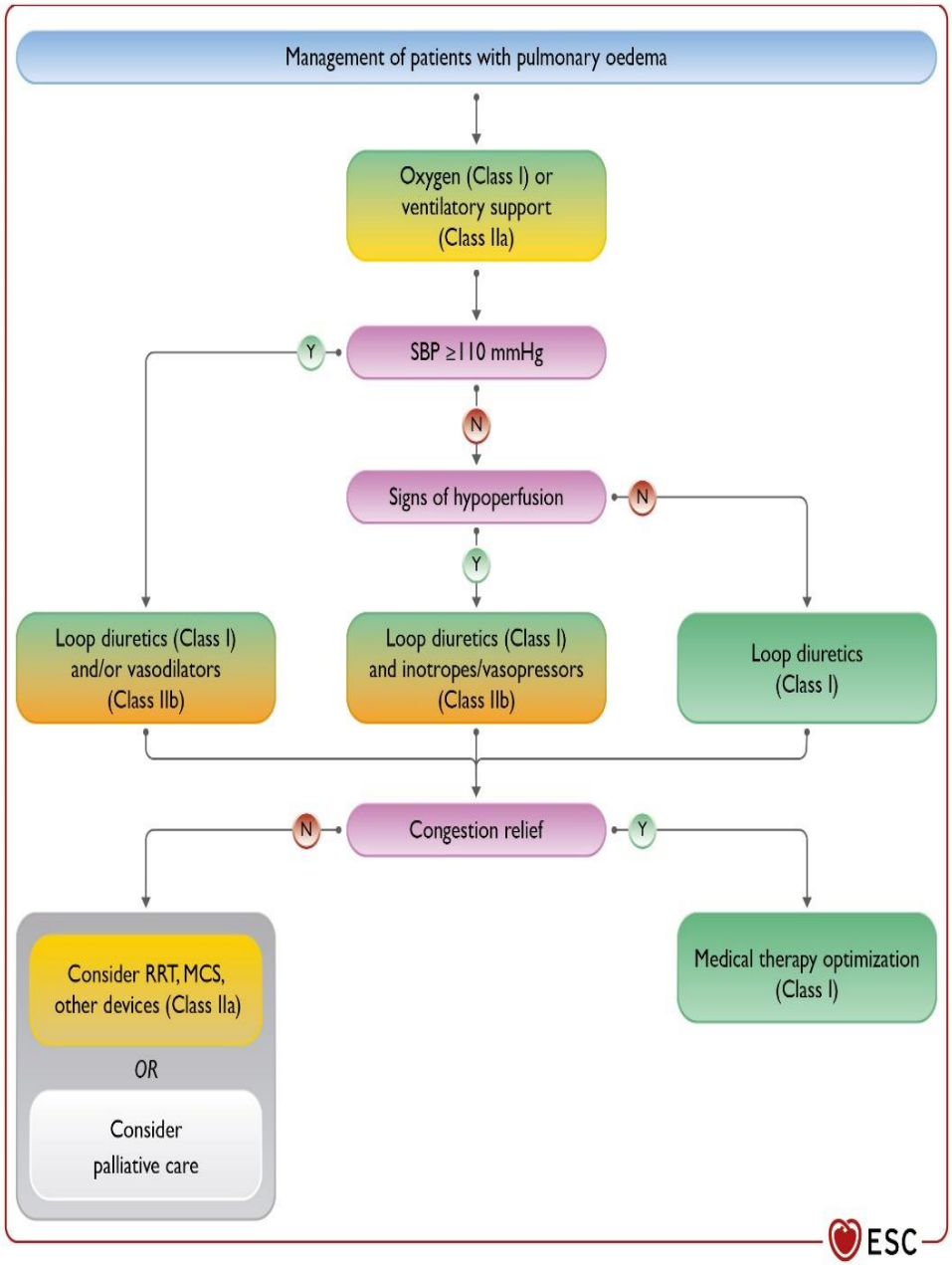
Management of acute decompensated heart failure



MCS=mechanical circulatory support.
[a]Adequate diuretic doses to relieve congestion and close monitoring of diuresis is recommended (see Figure13) regardless of perfusion status.

Management of pulmonary oedema



MCS=mechanical circulatory support; RRT= renal replacement therapy; SBP=systolic blood pressure.

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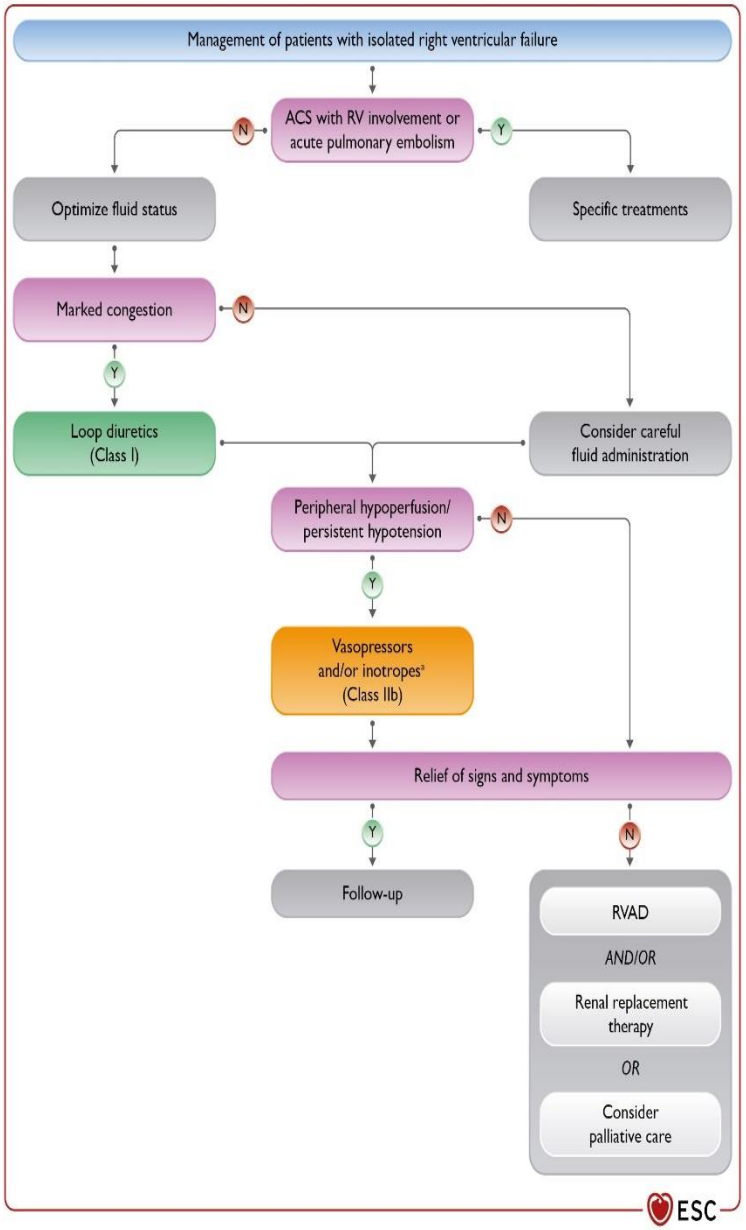
Management of right ventricular failure



ACS=acute coronary syndrome; RV=right ventricular; RVAD=right ventricular assist device.
[a]Inotropes alone in case of hypoperfusion without hypotension.

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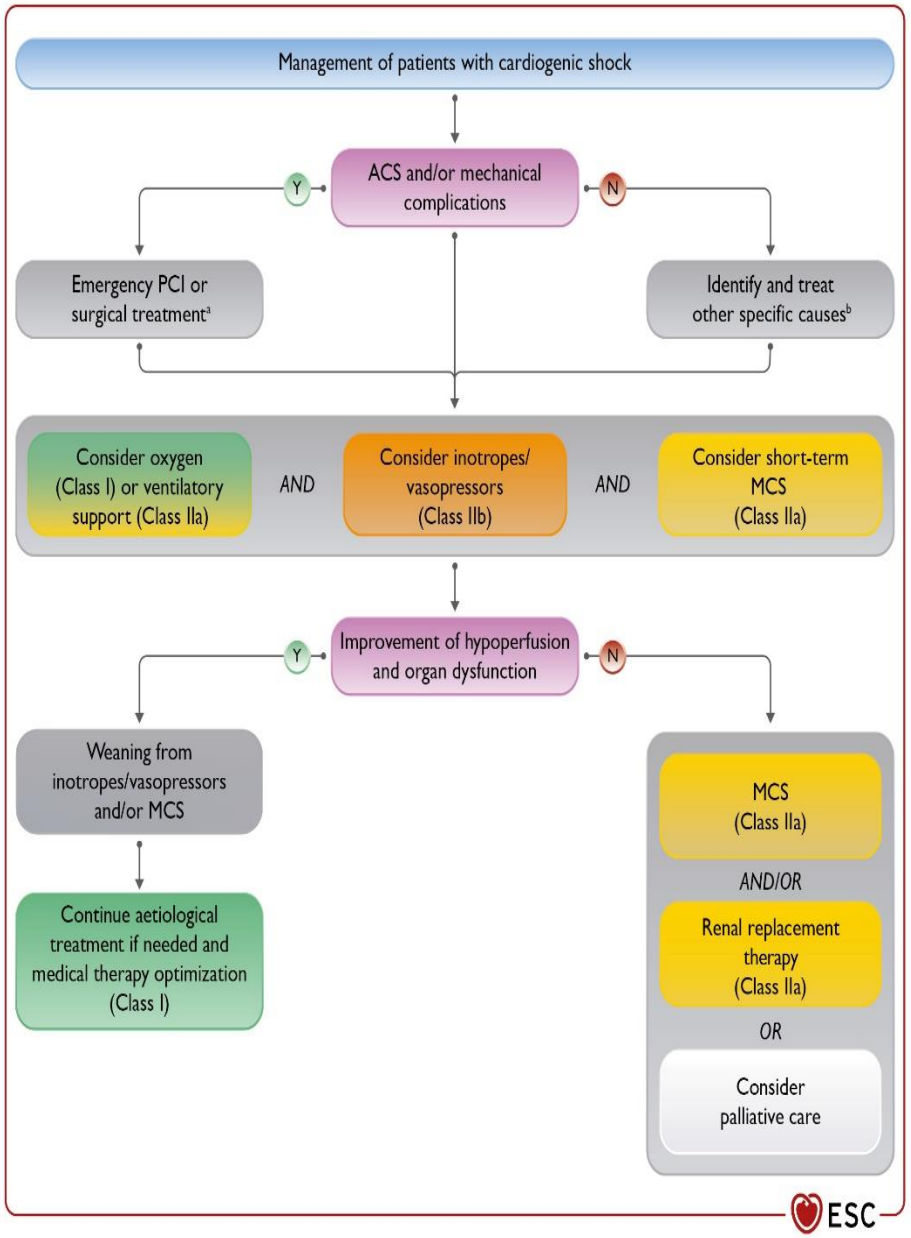
Management of cardiogenic shock

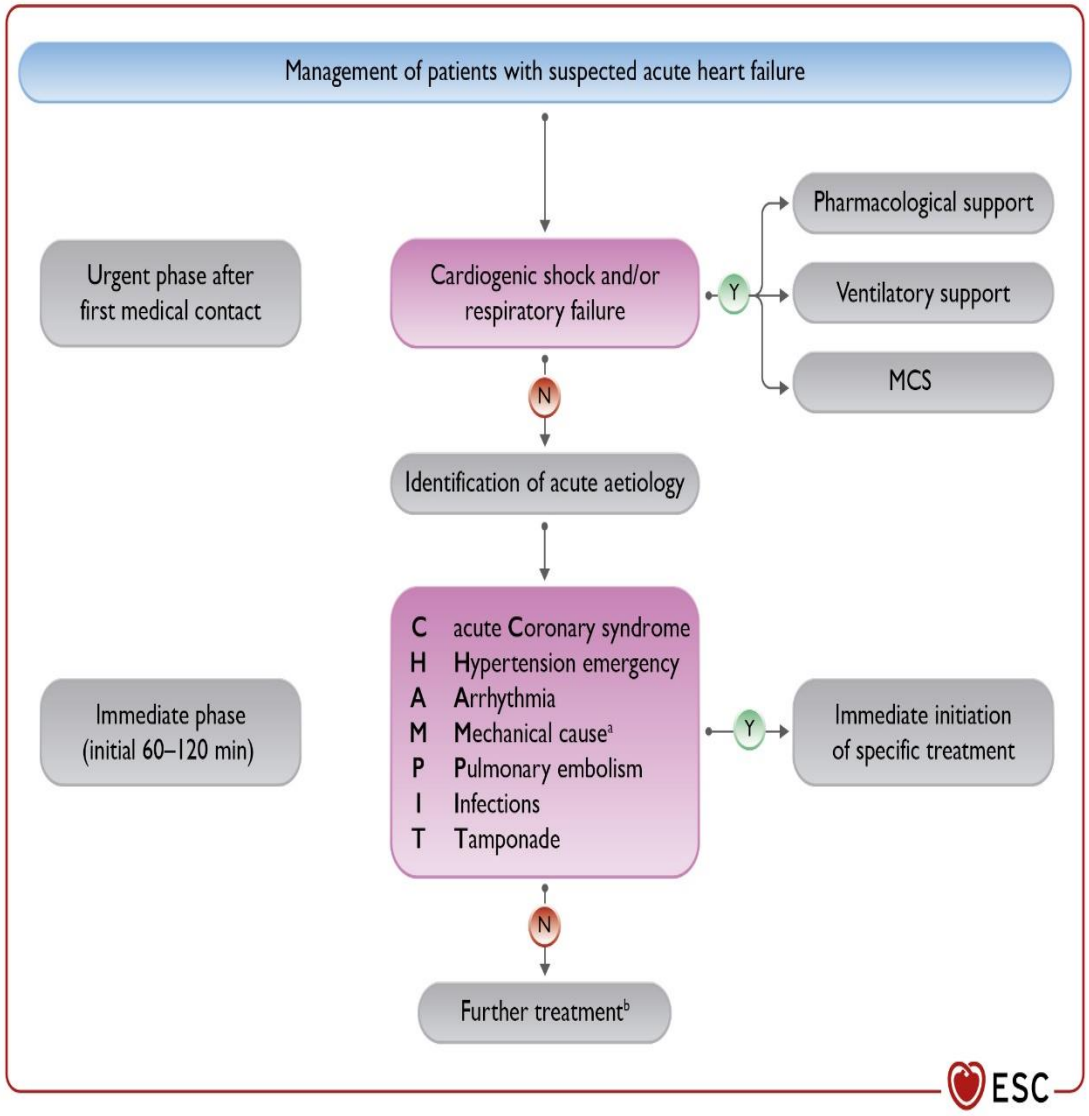


ACS = acute coronary syndrome; BTT = bridge to transplantation; MCS = mechanical circulatory support; PCI = percutaneous coronary intervention.

[a]PCI in ACS, pericardiocentesis in tamponade, mitral valve surgery in papillary muscle rupture. In case of interventricular septum rupture, MCS as BTT should be considered.

[b]Other causes include acute valve regurgitation, pulmonary embolism, infection, acute myocarditis, arrhythmia.

Initial management of acute heart failure



MCS = mechanical circulatory support.
[a]Acute mechanical cause: myocardial rupture complicating acute coronary syndrome (free wall rupture, ventricular septal defect, acute mitral regurgitation), chest trauma or cardiac intervention, acute native or prosthetic valve incompetence secondary to endocarditis, aortic dissection or thrombosis.
[b]See previous slides for specific treatments according to different clinical presentations.

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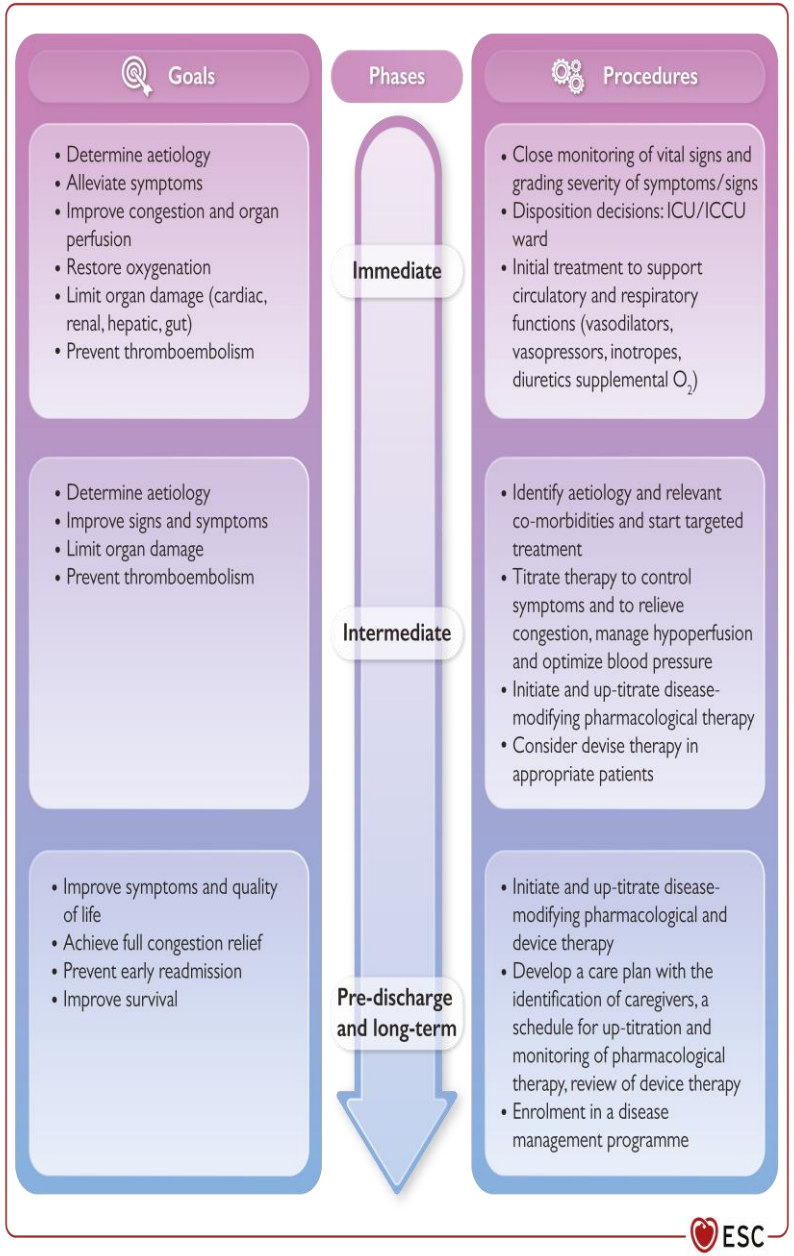
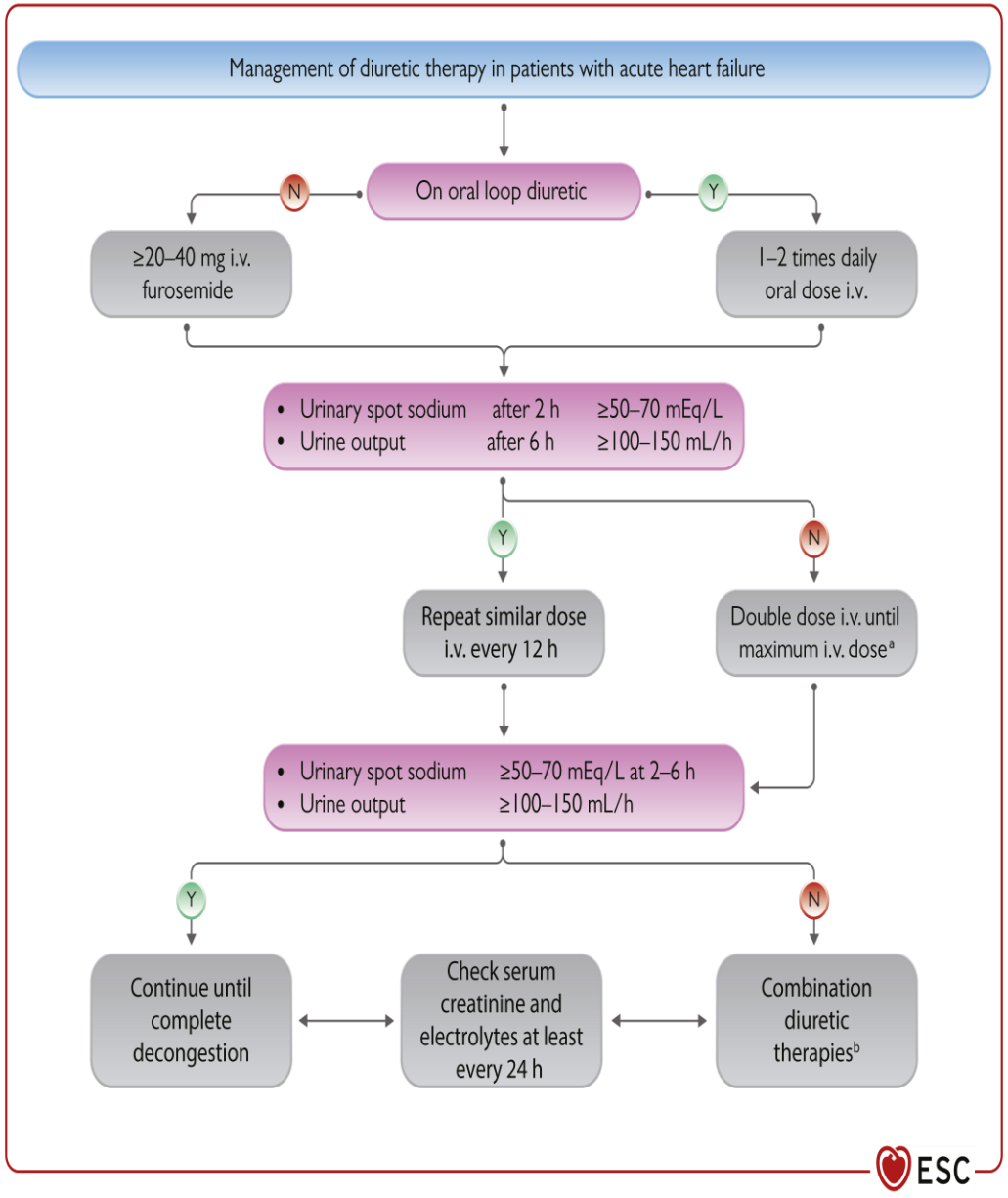


Stages of management of patients with acute heart failure

ICCU = intensive coronary care unit; ICU = intensive care unit.



Diuretic therapy (furosemide) in acute heart failure

i.v.=intravenous.

[a]The maximal daily dose for i.v. loop diuretics is generally considered furosemide 400–600 mg though up to 1000 mg may be considered in patients with severely impaired kidney function.

[b]Combination therapy is the addition to the loop diuretic of a diuretic with a different site of action, e.g. thiazides or metolazone or acetazolamide.

Thank You