

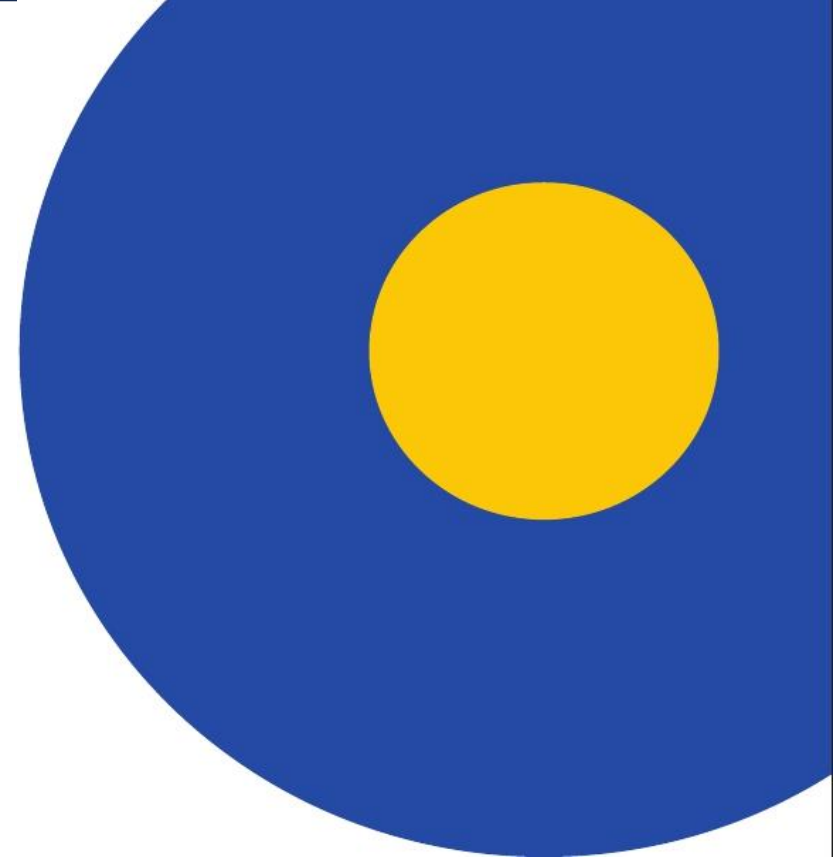
# Heart Failure – Part 3

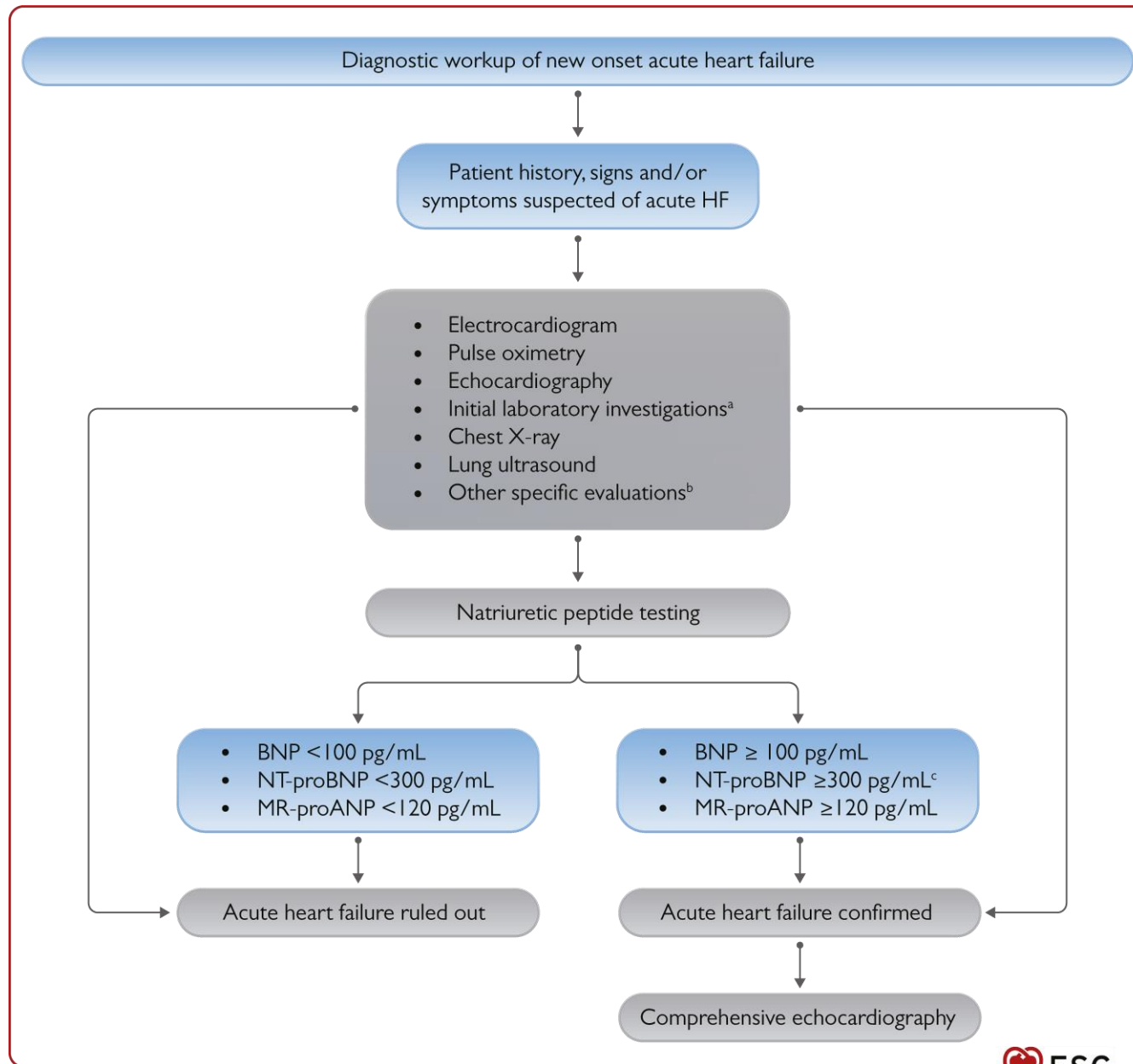
According to 2021 ESC guidelines

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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.

<sup>a</sup>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. <sup>b</sup>Specific evaluation includes coronary angiography, in case of suspected ACS, and CT in case of suspected pulmonary embolism.

<sup>c</sup>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

# Diagnostic tests in patients with acute heart failure (1)

Exam	Time of measurement	Possible findings	Diagnostic value for AHF	Indication
ECG	Admission, during hospitalization, <sup>a,b</sup> pre-discharge	Arrhythmias, myocardial ischaemia	None	Recommended
Chest-X ray	Admission, during hospitalization <sup>a</sup>	Congestion, lung infection	Confirmatory	May be considered
LUS	Admission, during hospitalization <sup>a</sup> pre-discharge	Congestion	Confirmatory	May be considered
Echocardiography	Admission, during hospitalization, <sup>a</sup> 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, <sup>a</sup> 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.

<sup>a</sup>Based on clinical conditions.

<sup>b</sup>Continuous ECG monitoring can be considered based on clinical conditions.

## Diagnostic tests in patients with acute heart failure (2)

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

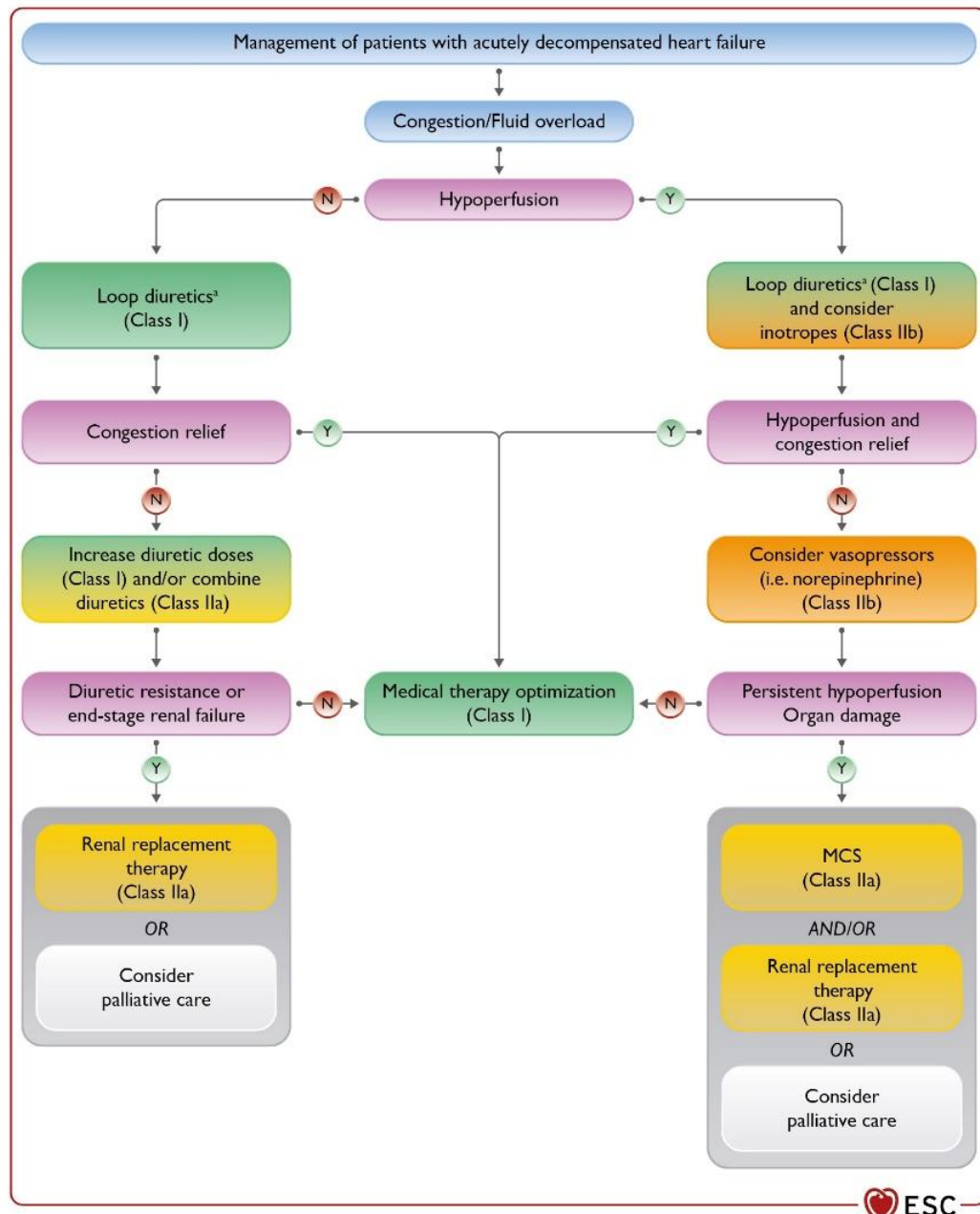
ACS = acute coronary syndrome; AHF = acute heart failure; BNP = B-type natriuretic peptide; ECG = electrocardiogram; LUS = lung ultrasound; MR-proANP = mid-regional pro-atrial natriuretic peptide; NT-proBNP = N-terminal pro-B-type natriuretic peptide; TSH = thyroid-stimulating hormone. <sup>a</sup>Based on clinical conditions.

<sup>b</sup>Continuous ECG monitoring can be considered based on clinical conditions.

# Clinical presentations of acute heart failure

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

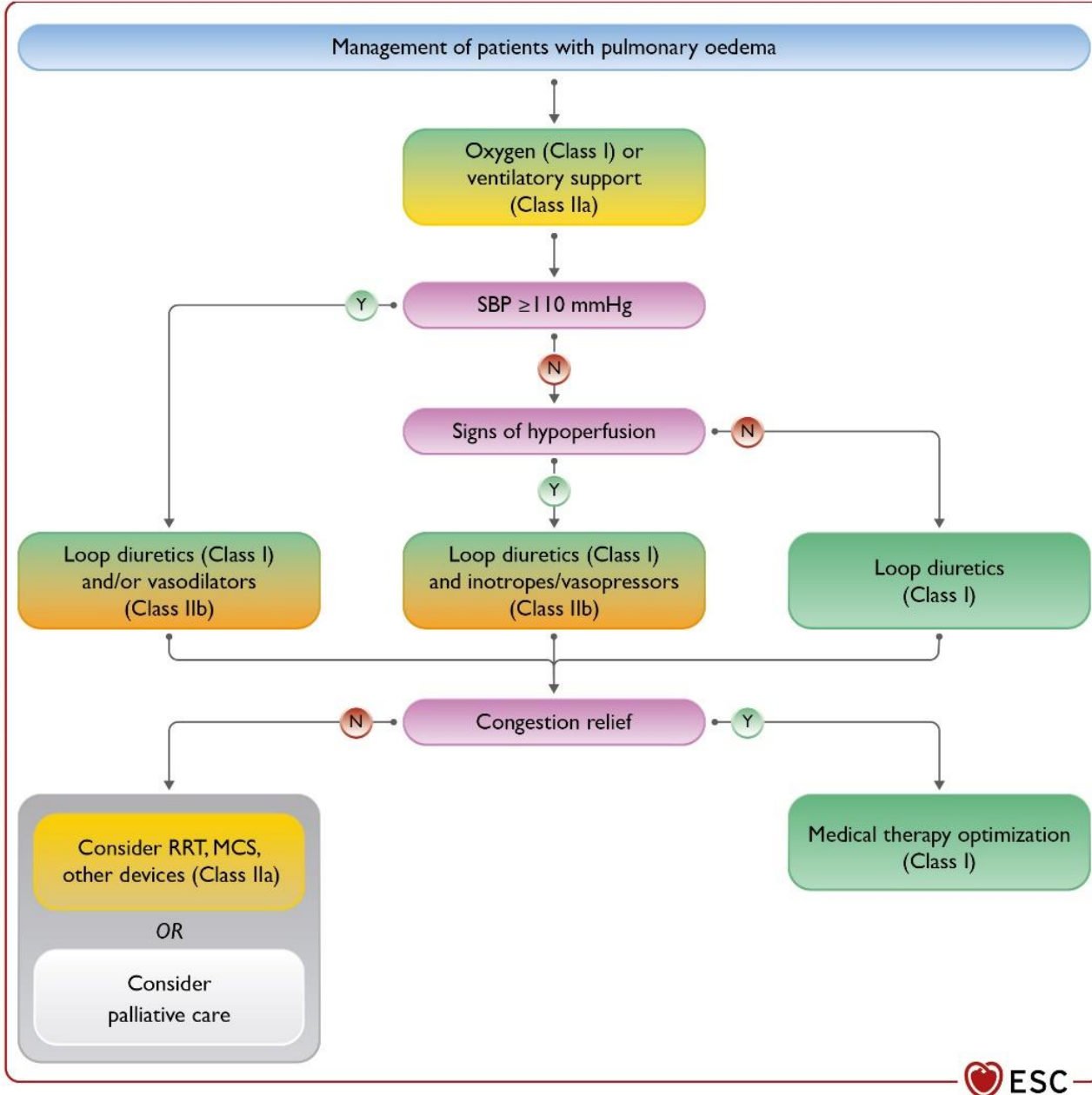
LV = left ventricular; LVEDP = left ventricular end-diastolic pressure; MCS = mechanical circulatory support; PCWP = pulmonary capillary wedge pressure; RV = right ventricular; RVEDP = right ventricular end-diastolic pressure; RRT = renal replacement therapy; SBP = systolic blood pressure. <sup>a</sup>May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



## Management of acute decompensated heart failure

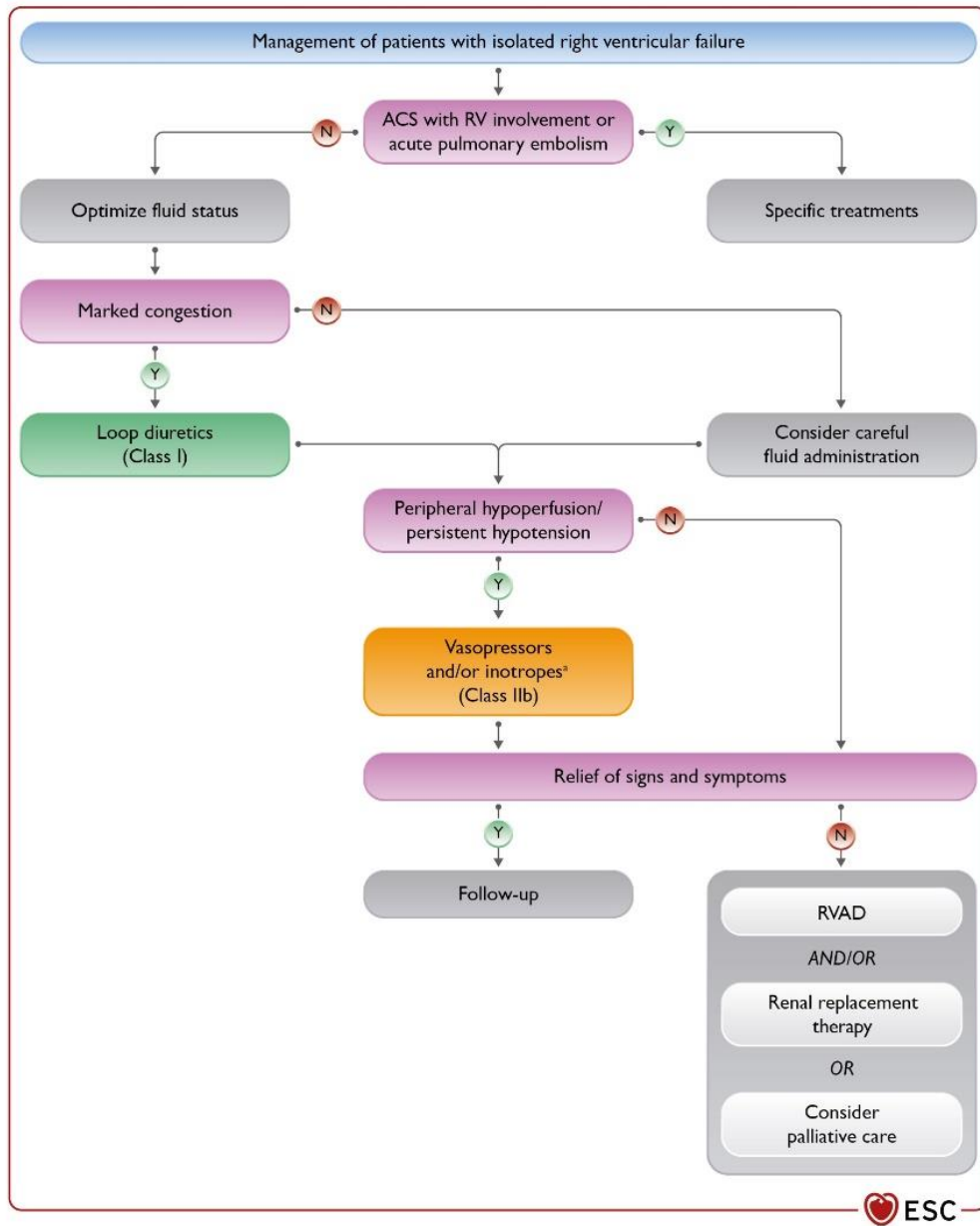
MCS=mechanical circulatory support.

<sup>a</sup>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.

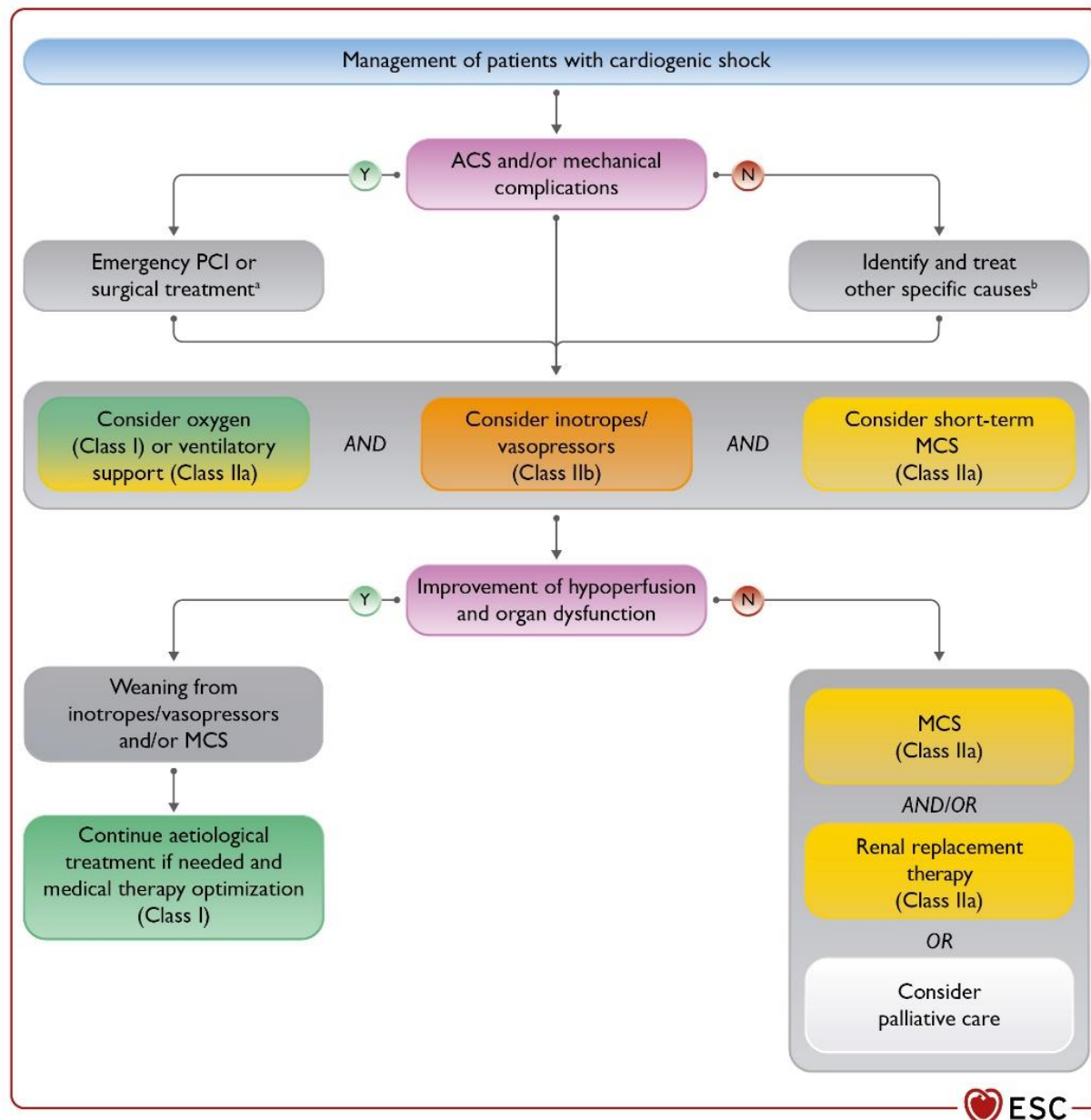


## Management of right ventricular failure

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



## Management of cardiogenic shock

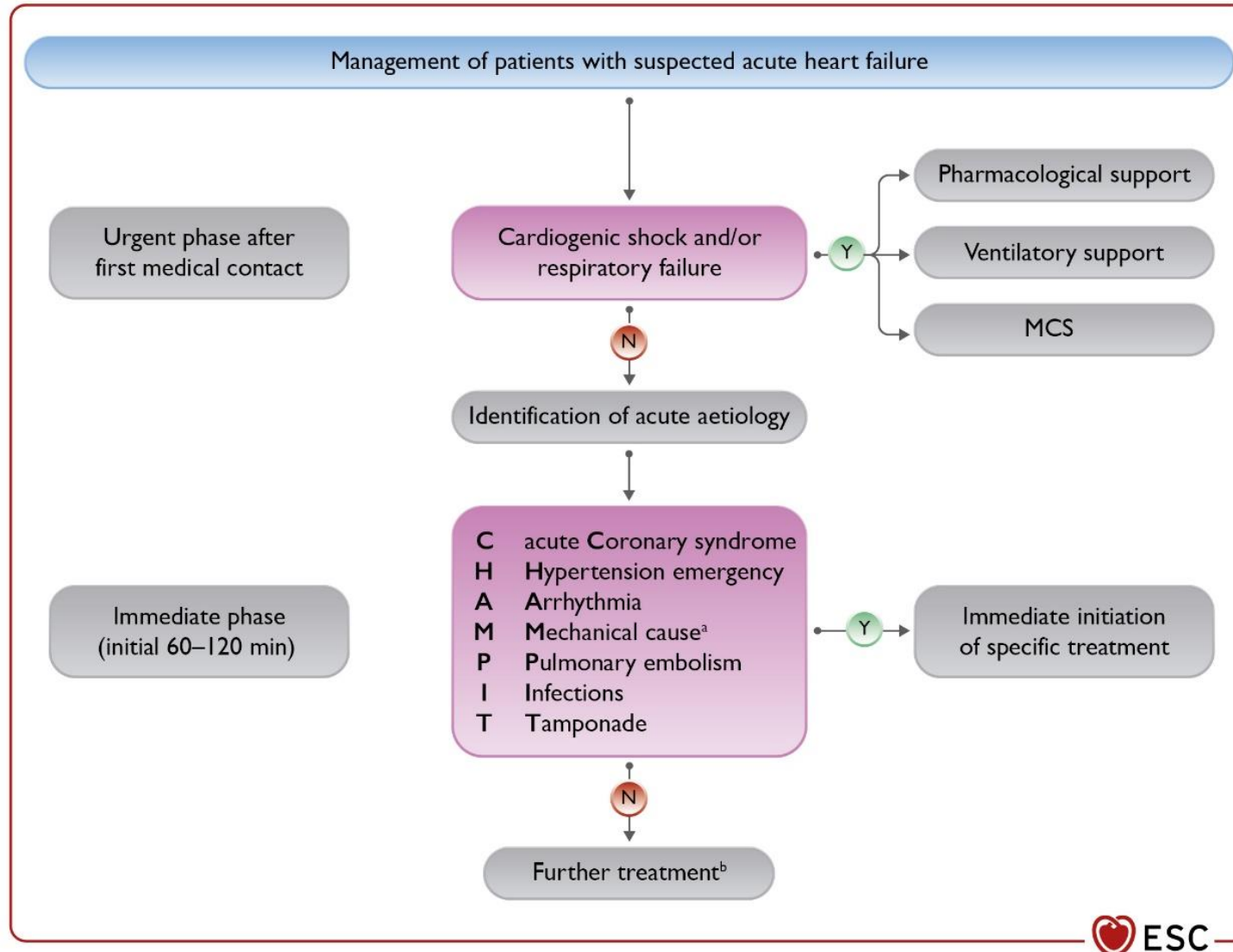


ACS = acute coronary syndrome; BTT = bridge to transplantation; MCS = mechanical circulatory support; PCI = percutaneous coronary intervention.

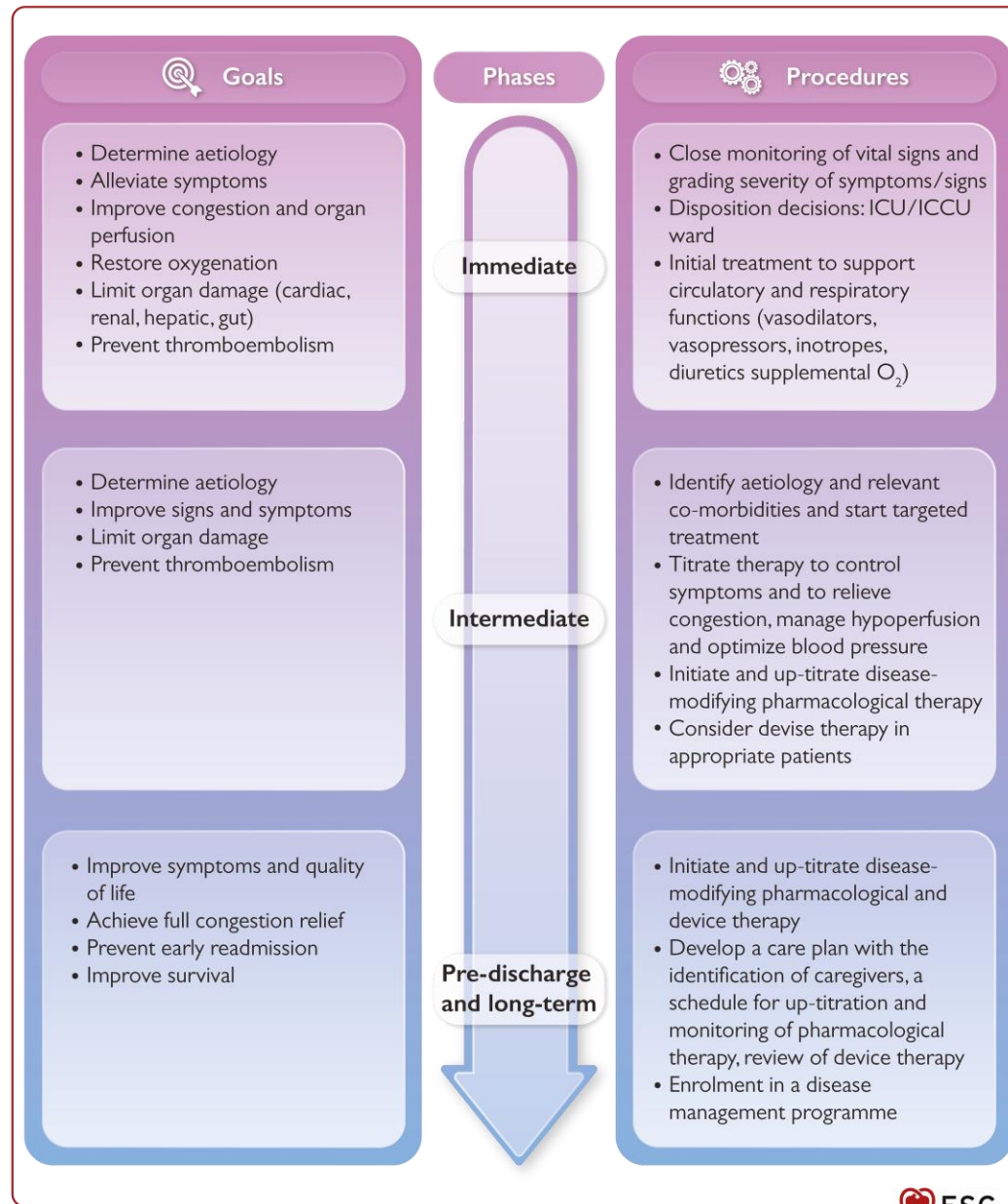
<sup>a</sup>PCI in ACS, pericardiocentesis in tamponade, mitral valve surgery in papillary muscle rupture. In case of interventricular septum rupture, MCS as BTT should be considered.

<sup>b</sup>Other causes include acute valve regurgitation, pulmonary embolism, infection, acute myocarditis, arrhythmia.

## Initial management of acute heart failure

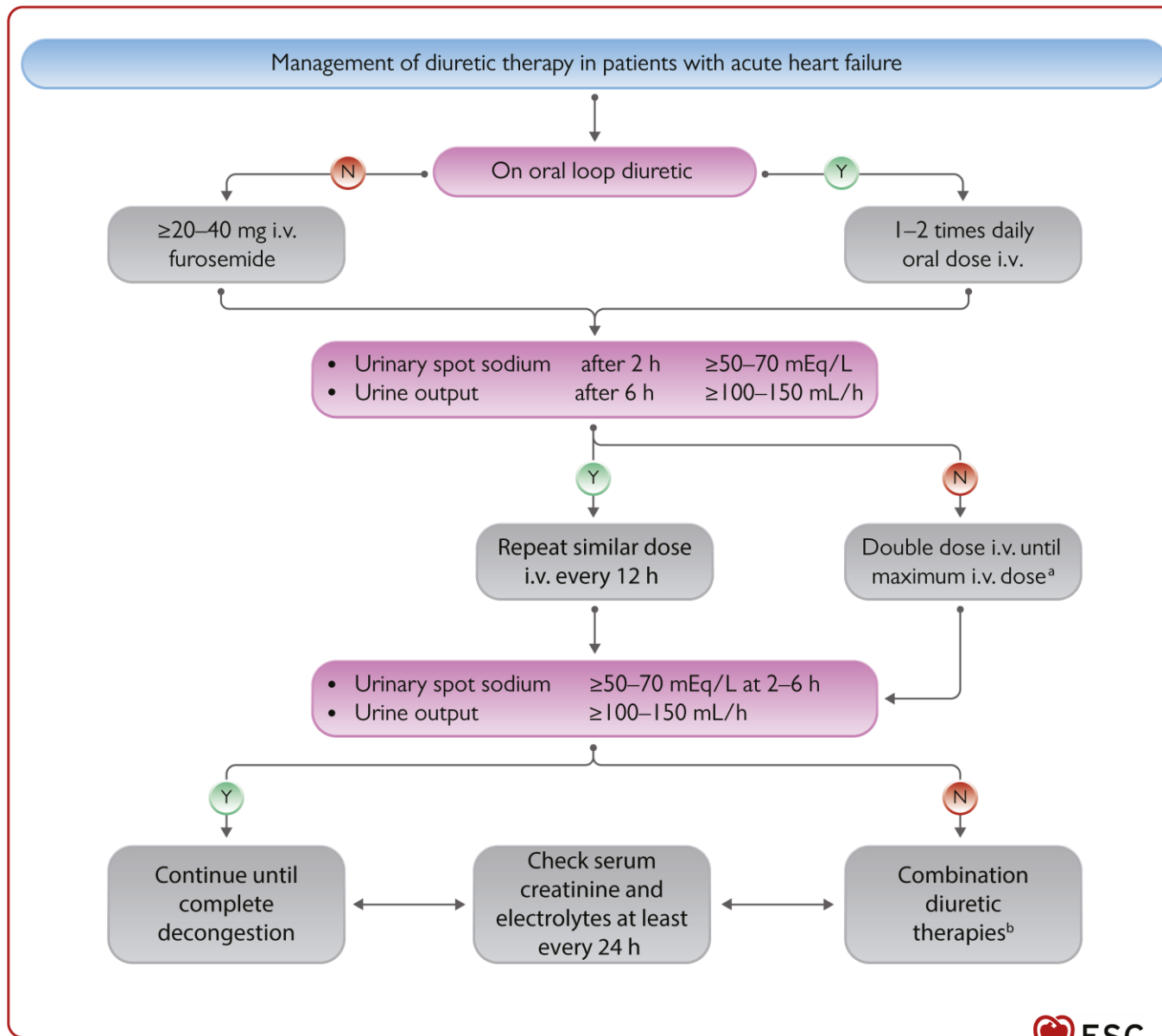


MCS = mechanical circulatory support.  
<sup>a</sup>Acute mechanical cause: myocardial rupture complicating acute coronary syndrome (free wall rupture, ventricular septal defect, acute mitral regurgitation), chest trauma or cardiac intervention, acute native or prosthetic valve incompetence secondary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



## 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.

<sup>a</sup>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.

<sup>b</sup>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.

# Recommendations for the initial treatment of acute heart failure (1)

Recommendations	Class	Level
<b>Oxygen and ventilatory support</b>		
Oxygen is recommended in patients with SpO <sub>2</sub> <90% or PaO <sub>2</sub> <60 mmHg to correct hypoxaemia.	I	C
Intubation is recommended for progressive respiratory failure persisting in spite of oxygen administration or non-invasive ventilation.	I	C
Non-invasive positive pressure ventilation should be considered in patients with respiratory distress (respiratory rate >25 breaths/min, SpO <sub>2</sub> <90%) and started as soon as possible in order to decrease respiratory distress and reduce the rate of mechanical endotracheal intubation.	IIa	B

PaO<sub>2</sub> = partial pressure of oxygen; SpO<sub>2</sub> =transcutaneous oxygen saturation.

## Recommendations for the initial treatment of acute heart failure (2)

Recommendations	Class	Level
<b>Diuretics</b>		
Intravenous loop diuretics are recommended for all patients with AHF admitted with signs/symptoms of fluid overload to improve symptoms.	I	C
Combination of a loop diuretic with thiazidetype diuretic should be considered in patients with resistant oedema who do not respond to an increase in loop diuretic doses.	IIa	B
<b>Vasodilators</b>		
In patients with AHF and SBP >110 mmHg, i.v. vasodilators may be considered as initial therapy to improve symptoms and reduce congestion.	IIb	B

AHF = acute heart failure; i.v. = intravenous; SBP = systolic blood pressure.

# Recommendations for the initial treatment of acute heart failure (3)

Recommendations	Class	Level
<b>Inotropic agents</b>		
Inotropic agents may be considered in patients with SBP <90 mmHg and evidence of hypoperfusion who do not respond to standard treatment, including fluid challenge, to improve peripheral perfusion and maintain end-organ function.	<b>IIb</b>	<b>C</b>
Inotropic agents are not routinely recommended, due to safety concerns, unless the patient has symptomatic hypotension and evidence of hypoperfusion.	<b>IIa</b>	<b>B</b>
<b>Vasopressors</b>		
A vasopressor, preferably norepinephrine, may be considered in patients with cardiogenic shock to increase blood pressure and vital organ perfusion.	<b>IIb</b>	<b>B</b>

SBP = systolic blood pressure.

# Recommendations for the initial treatment of acute heart failure (3)

Recommendations	Class	Level
<b>Other drugs</b>		
Thromboembolism prophylaxis (e.g. with LMWH) is recommended in patients not already anticoagulated and with no contraindication to anticoagulation, to reduce the risk of deep venous thrombosis and pulmonary embolism.	I	A
Routine use of opiates is not recommended, unless in selected patients with severe/intractable pain or anxiety.	III	C

LMWH= low-molecular-weight heparin.



# Recommendations for the use of short-term mechanical circulatory support in patients with cardiogenic shock

Recommendations	Class	Level
Short-term MCS should be considered in patients with cardiogenic shock as a BTR, BTD, BTB. Further indications include treatment of the cause of cardiogenic shock or long-term MCS or transplantation.	<b>IIa</b>	<b>C</b>
IABP may be considered in patients with cardiogenic shock as a BTR, BTD, BTB, including treatment of the cause of cardiogenic shock (i.e. mechanical complication of acute MI) or longterm MCS or transplantation.	<b>IIb</b>	<b>C</b>
IABP is not routinely recommended in post-MI cardiogenic shock.	<b>III</b>	<b>B</b>

BTB = bridge to bridge; BTD = bridge to decision; BTR = bridge to recovery; IABP = intra-aortic balloon pump; MCS = mechanical circulatory support; MI = myocardial infarction.

# Recommendations for pre-discharge and early post-discharge follow-up of patients hospitalized for acute heart failure

Recommendations	Class	Level
It is recommended that patients hospitalized for HF be carefully evaluated to exclude persistent signs of congestion before discharge and to optimize oral treatment	I	C
It is recommended that evidence-based oral medical treatment be administered before discharge.	I	C
An early follow-up visit is recommended at 1-2 weeks after discharge to assess signs of congestion, drug tolerance and start and/or uptitrate evidence-based therapy.	I	C
Ferric carboxymaltose should be considered for iron deficiency, defined as serum ferritin <100 ng/mL or serum ferritin 100–299 ng/mL with TSAT <20%, to improve symptoms and reduce rehospitalizations.	IIa	B

HR = heart failure; TSAT = transferrin saturation.

# Initial diagnostic assessment in patients with suspected cardiomyopathy (1)

**History** including detailed questions on any systemic disease, toxic agents (chemotherapy, alcohol, drugs), and familial history of cardiac or neuro-muscular disease, or sudden cardiac death in family members at young age (<50 years).

**Laboratory exams** including cardiac and muscular enzymes, liver and renal function, haemoglobin, white blood cell count (including differential white blood cell count to detect eosinophilia), natriuretic peptides, thyroid function tests, iron status, and markers of systemic autoimmune disease (hsCRP, anti-nuclear antibodies, soluble IL2 receptor).

**Standard 12-lead ECG and Echocardiography** to detect arrhythmias and assess cardiac structure and function and concomitant abnormalities

CAD = coronary artery disease; CMR = cardiac magnetic resonance; CTCA = computed tomography coronary angiography; ECG = electrocardiogram; hsCRP = high-sensitivity C-reactive protein; IL-2 = interleukin-2; LGE = late gadolinium enhancement.

## Initial diagnostic assessment in patients with suspected cardiomyopathy (2)

**Invasive coronary angiography or CT-CA** to rule out significant CAD in patients with cardiac dysfunction.

**CMR imaging** with T1 and T2 sequencing and LGE to visualize structural changes, storage, infiltration, inflammation, fibrosis and scarring.

**Genetic counselling and genetic testing** should be performed depending on age, family history, cardiac phenotype.

**24 or 48-hour ambulatory ECG monitoring** to detect atrial and ventricular arrhythmias.

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