

## CHAPTER 4

# ACUTE HEART FAILURE

### 4.1 WET-AND-WARM HEART FAILURE PATIENT \_\_\_\_\_ p.52

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### 4.2 CARDIOGENIC SHOCK (WET-AND-COLD) \_\_\_\_\_ p.61

P. Vranckx, U. Zeymer

## Clinical profiles of patients with acute heart failure

Clinical profiles of patients with acute heart failure  
based on the presence/absence of congestion and/or hypoperfusion

|  | CONGESTION (-) | CONGESTION (+)<br>Pulmonary congestion, orthopnoea/paroxysmal, nocturnal dyspnoea, peripheral (bilateral) oedema, jugular venous dilatation, congested hepatomegaly, gut congestion, ascites, hepatojugular reflux |
|--|----------------|--|
| HYPOPERFUSION (-)  | WARM-DRY       | WARM-WET   |
| HYPOPERFUSION (+)<br>Cold sweaty extremities, Oliguria, Mental confusion, Dizziness, Narrow pulse pressure | COLD-DRY       | COLD-WET   |

Hypoperfusion is **not synonymous** with hypotension, but often hypoperfusion is accompanied by hypotension.

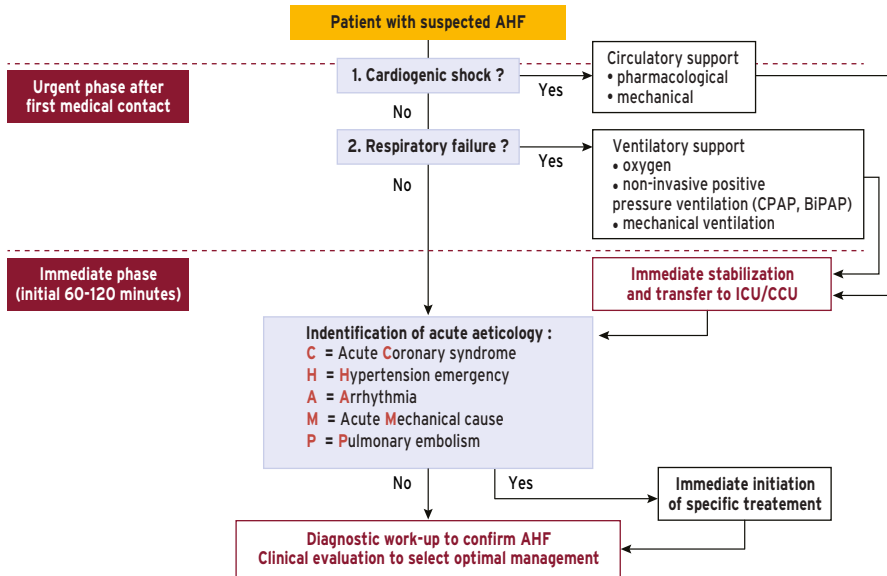
## ACUTE HEART FAILURE: Diagnosis and causes (2)

- 1 **Symptoms:** Dyspnea (on effort or at rest)/ breathlessness, fatigue, orthopnea, cough, weight gain/ankle swelling.
- 2 **Signs:** Tachypnea, tachycardia, low or normal blood pressure, raised jugular venous pressure, 3<sup>rd</sup>/4<sup>th</sup> heart sound, rales, oedema, intolerance of the supine position.
- 3 **Cardiovascular risk profile:** Older age, HTN, diabetes, smoking, dyslipidemia, family history, history of CVD.
- 4 **Precipitants/causes that need urgent management (CHAMP):** Acute coronary syndrome. Hypertensive emergency. Rapid arrhythmias or severe bradyarrhythmia/conduction disturbance. Mechanical causes. Pulmonary embolism.
- 5 **Differential diagnosis:** Exacerbated pulmonary disease, pneumonia, pulmonary embolism, pneumothorax, acute respiratory distress syndrome, (severe) anaemia, hyperventilation (metabolic acidosis), sepsis/septic shock, redistributive/hypovolemic shock.

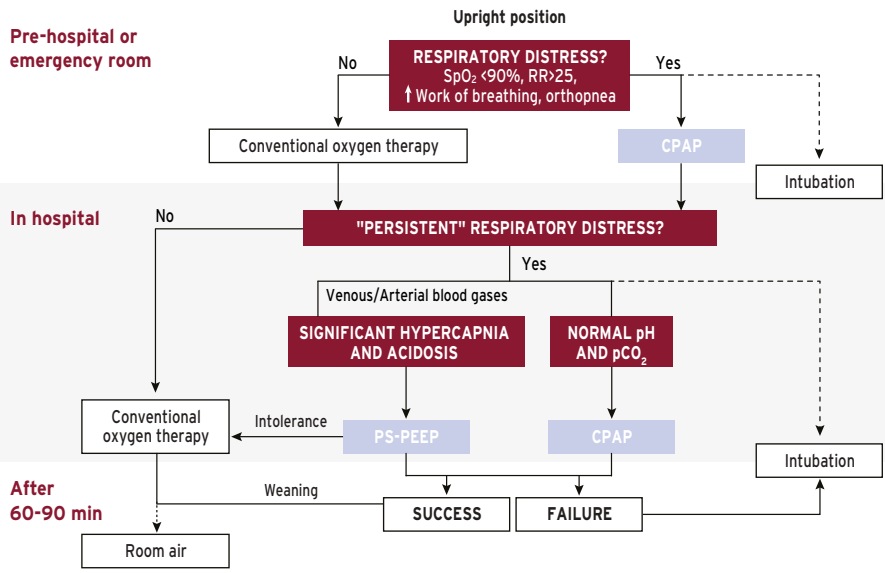
### FACTORS TRIGGERING ACUTE HEART FAILURE

- Acute coronary syndrome
- Tachyarrhythmia (e.g. atrial fibrillation, ventricular tachycardia)
- Excessive rise in blood pressure
- Infection (e.g. pneumonia, infective endocarditis, sepsis).
- Non-adherence with salt/fluid intake or medications
- Toxic substances (alcohol, recreational drugs)
- Drugs (e.g. NSAIDs, corticosteroids, negative inotropic substances, cardiotoxic chemotherapeutics)
- Exacerbation of chronic obstructive pulmonary disease
- Pulmonary embolism
- Surgery and perioperative complications
- Increased sympathetic drive, stress-related cardiomyopathy
- Metabolic/hormonal derangements (e.g. thyroid dysfunction, diabetic ketosis, adrenal dysfunction, pregnancy and peripartum related abnormalities)
- Cerebrovascular insult
- Acute mechanical cause : myocardial rupture complicating ACS (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

## Initial management of a patient with ACUTE HEART FAILURE



# ACUTE HEART FAILURE: Airway (A) and breathing (B) Oxygen therapy and ventilatory support in acute heart failure



Reference adapted from Mebazaa A et al. Eur J Heart Fail. (2015); 17:544-58.

### C - CIRCULATION\*

HR (bradycardia [ $<60/\text{min}$ ], normal [ $60-100/\text{min}$ ], tachycardia [ $>100/\text{min}$ ]), rhythm (regular, irregular), SBP (very low [ $<90 \text{ mmHg}$ ], low, normal [ $110-140 \text{ mmHg}$ ], high [ $>140 \text{ mmHg}$ ]), and elevated jugular pressure should be checked.

#### **INSTRUMENTATION & INVESTIGATIONS:**

Intravenous line (peripheral/central) and BP monitoring (arterial line in shock and severe ventilatory/gas-exchange disturbances)

#### **Laboratory measures**

- Cardiac markers (troponin, BNP/NT-proBNP/MR-proANP)
- Complete blood count, electrolytes, creatinine, urea, glucose, inflammation, TSH
- Consider arterial or venous blood gases, lactate, D-dimer (suspicion of acute pulmonary embolism)

#### **Standard 12-lead ECG**

- Rhythm, rate, conduction times?
- Signs of ischemia/myocardial infarction? Hypertrophy?

#### **Echocardiography**

- a) Immediately in haemodynamically unstable patients
- b) Within 48 hours when cardiac structure and function are either not known or may have changed since previous studies

Ventricular function (systolic and diastolic)? Estimated left-and right-side filling pressures? Lung ultrasound? Presence of valve dysfunction (severe stenosis/insufficiency)? Pericardial tamponade?

#### **ACTIONS:**

Rule in/out acute heart failure as cause of symptoms and signs

Determine clinical profile

Start as soon as possible treatment of both heart failure and the factors identified as triggers

Establish cause

#### **D - DISABILITY DUE TO NEUROLOGICAL DETERIORATION**

- Normal consciousness/altered mental status?  
Measurement of mental state with AVPU (alert, visual, pain or unresponsive) or Glasgow
- Coma Scale: EMV score <8 → Consider endotracheal intubation and mechanical ventilation
- Anxiety, severe dyspnea? → Consider cautious administration of morphine 2 mg i.v. bolus, preceded by antiemetic as needed

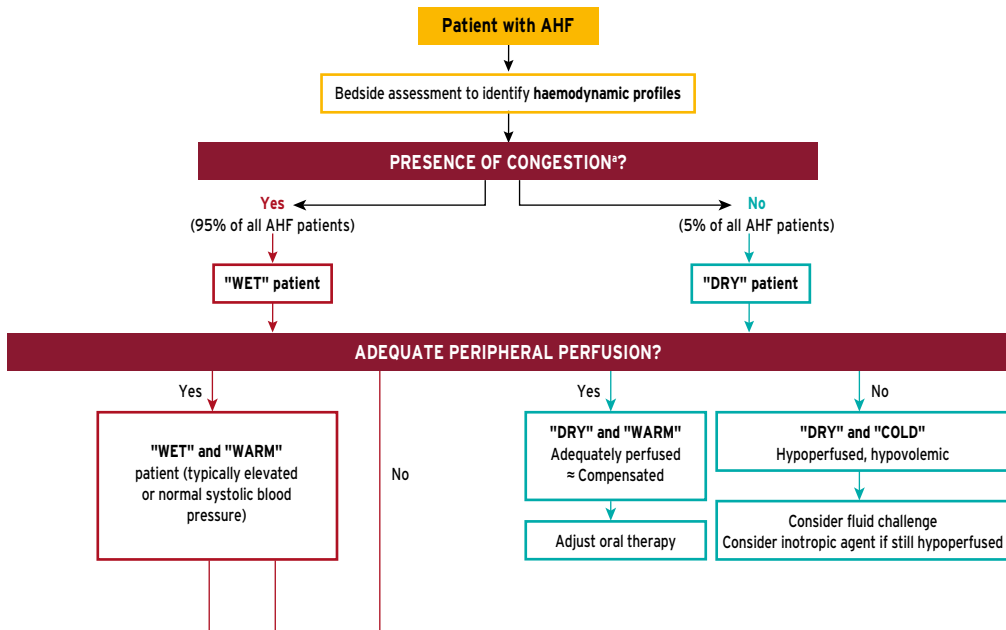
#### **E - EXPOSURE & EXAMINATION**

- Temperature/fever: central and peripheral
- Weight
- Skin/extremities: circulation (e.g. capillary refill), color
- Urinary output (<0.5 ml/kg/hr) → Consider inserting indwelling catheter; the benefits should outweigh the risks of infection and long-term complications

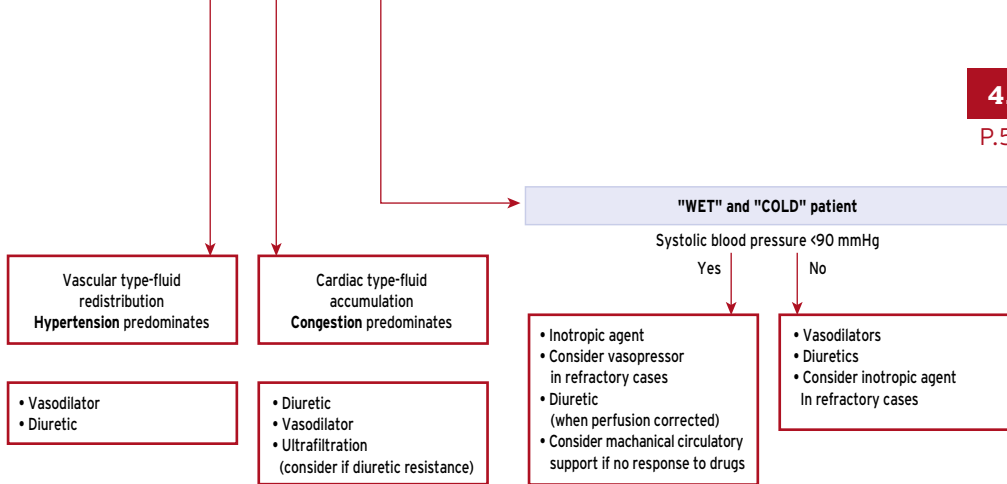
# ACUTE HEART FAILURE: Management of patients with acute heart failure based on clinical profile during an early phase

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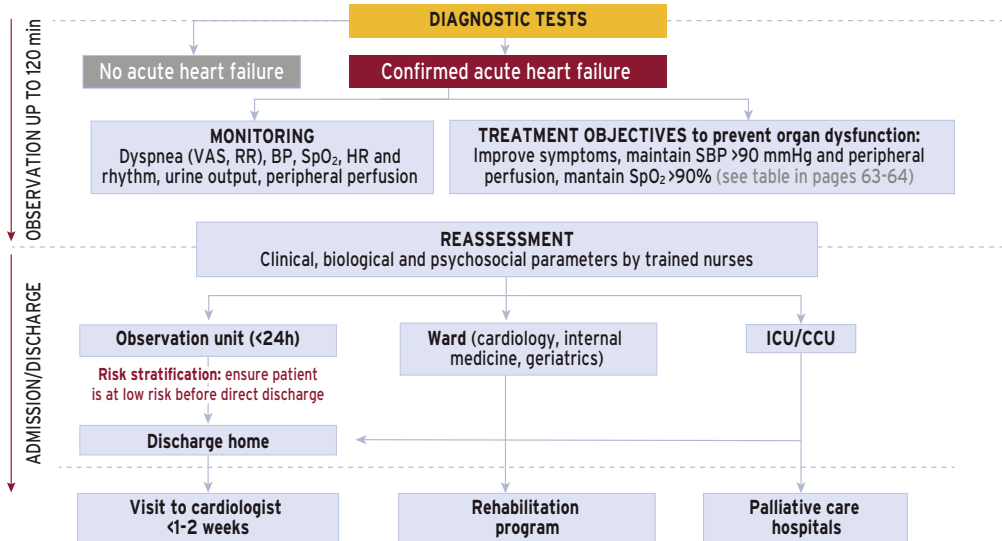


\*Symptoms/signs of congestion: orthopnoea, paroxysmal nocturnal dyspnoea, breathlessness, bi-basilar rales, abnormal blood pressure response to the Valsalva maneuver (left-sided); symptoms of gut congestion, jugular venous distension, hepatojugular reflux, hepatomegaly, ascites, and peripheral oedema (right-sided).

For more information on individual drug doses and indications,

**SEE CHAPTER 9 DRUGS USED IN ACUTE CARDIOVASCULAR CARE**

# ACUTE HEART FAILURE: Management of acute heart failure



Reference adapted from Mebazaa A et al. Eur J Heart Fail. (2015); 17: 544-58 and Miró Ò et al. Ann Intern Med (2017); 167:698-705.

## ACUTE HEART FAILURE: Treatment (C) and preventive measures

4.1

Management of oral therapy in AHF in the first 48 hours

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|                                  | Normotension/<br>Hypertension | Hypotension      |             | Low heart rate |              | Potassium               |                     | Renal impairment     |                      |
|----------------------------------|-------------------------------|------------------|-------------|----------------|--------------|-------------------------|---------------------|----------------------|----------------------|
|                                  |                               | <100 >90<br>mmHg | <90<br>mmHg | <60<br>≥50 bpm | <50 bpm      | ≤3.5<br>mmol/L          | >5.5<br>mmol/L      | Cr <2.5,<br>eGFR >30 | Cr >2.5,<br>eGFR <30 |
| <b>ACE-I/ARB</b>                 | Review/<br>increase           | Reduce/<br>stop  | Stop        | No<br>change   | No<br>change | Review/<br>increase     | Stop                | Review               | Stop                 |
| <b>Beta-blocker</b>              | No change                     | Reduce/<br>stop  | Stop        | Reduce         | Stop         | No<br>change            | No<br>change        | No<br>change         | No<br>change         |
| <b>MRA</b>                       | No change                     | No<br>change     | Stop        | No<br>change   | No<br>change | Review/<br>increase     | Stop                | Reduce               | Stop                 |
| <b>Diuretics</b>                 | Increase                      | Reduce           | Stop        | No<br>change   | No<br>change | Review/<br>No<br>change | Review/<br>increase | No<br>change         | Review               |
| <b>Sacubitril/<br/>Valsartan</b> | Review/<br>increase           | Stop             | Stop        | No<br>change   | No<br>change | Review/<br>increase     | Stop                | Review               | Stop                 |

## ACUTE HEART FAILURE: Treatment (C) and preventive measures (Cont.)

Management of oral therapy in AHF in the first 48 hours

|   | Normotension/<br>Hypertension | Hypotension      |             | Low heart rate  |              | Potassium                      |                | Renal impairment     |                      |
|---|-------------------------------|------------------|-------------|-----------------|--------------|--------------------------------|----------------|----------------------|----------------------|
|   |                               | <100 >90<br>mmHg | <90<br>mmHg | <60<br>≥50 bpm  | <50 bpm      | ≤3.5<br>mmol/L                 | >5.5<br>mmol/L | Cr <2.5,<br>eGFR >30 | Cr >2.5,<br>eGFR <30 |
| <b>Other vasodilators (nitrates)</b>  | Increase                      | Reduce/<br>stop  | Stop        | No<br>change    | No<br>change | No<br>change                   | No<br>change   | No<br>change         | No<br>change         |
| <b>Other heart rate slowing drugs (amiodarone, non-dihydropyridine CCB, ivabradine)</b> | Review                        | Reduce/<br>stop  | Stop        | Reduce/<br>stop | Stop         | Review/<br>stop <sup>(*)</sup> | No<br>change   | No<br>change         | No<br>change         |

Thrombosis prophylaxis should be started in patients not anticoagulated.

(\*)Amiodarone.

## CARDIOGENIC SHOCK: Definition

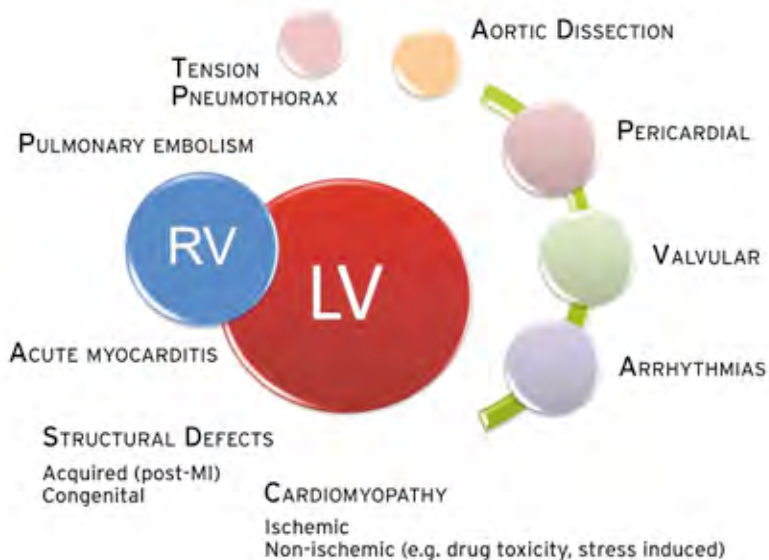
Clinical condition defined as the inability of the heart to deliver an adequate amount of blood to the tissues to meet resting metabolic demands as a result of impairment of its pumping function. Cardiogenic shock is equal to wet-cold phenotype. The clinical signs of hypoperfusion are listed in page 65. In addition, blood lactate is typically elevated above 2 mmol/L.

### Hemodynamic criteria to define cardiogenic shock

- Systolic blood pressure <80 to 90 mmHg  
or mean arterial pressure 30 mmHg lower than baseline
- Severe reduction in cardiac index:  
<1.8 l/min/m<sup>2</sup> without support  
or <2.0 to 2.2 l/min/m<sup>2</sup> with support
- Adequate or elevated filling pressure:  
Left ventricular end-diastolic pressure >18 mmHg  
or Right atrial pressure >10 to 15 mmHg

## CARDIOGENIC SHOCK: Causes

LV pump failure is the primary insult in most forms of CS, but other parts of the circulatory system contribute to shock with inadequate compensation or additional defects



## CARDIOGENIC SHOCK: Initial triage and management

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This protocol should be initiated as soon as cardiogenic shock/end organ hypoperfusion is recognised and should not be delayed pending intensive care admission.

|                             |        |   |  |
|-----------------------------|--------|---|--|
| EMERGENCY DEPARTMENT        | 0 min  | <b>EARLY TRIAGE &amp; MONITORING</b><br>Start high flow O <sub>2</sub><br>Establish i.v. access   | <ul style="list-style-type: none"> <li>• Age: 65-74, ≥75</li> <li>• Heart rate &gt;100 beats per minute</li> <li>• Systolic blood pressure &lt;100 mmHg</li> <li>• Proportional pulse pressure ≤25 % (CI &lt;2.2 l/min/m<sup>2</sup>)</li> <li>• Orthopnea (PCWP &gt;22 mmHg)</li> <li>• Tachypnea (&gt;20/min), &gt;30/min (!)</li> <li>• Killip class IV</li> <li>• Clinical symptoms of tissue hypoperfusion/hypoxia:               <ul style="list-style-type: none"> <li>- cool extremities</li> <li>- decreased urine output (urine output &lt;40 ml/h)</li> <li>- decreased capillary refill or mottling - alteration in mental status</li> </ul> </li> </ul> |
|                             | 5 min  |   |  |
| CARDIAC INTENSIVE CARE UNIT | 15 min | <b>INITIAL RESUSCITATION</b> <ul style="list-style-type: none"> <li>• Arterial and a central venous catheterization with a catheter capable of measuring central venous oxygen saturation</li> <li>• Standard transthoracic echocardiogram to assess left (and right) ventricular function and for the detection of potential mechanical complications following MI</li> <li>• Early coronary angiography in specialized myocardial intervention centre when signs and/or symptoms of ongoing myocardial ischemia (e.g. ST-segment elevation myocardial infarction).</li> </ul> | <ul style="list-style-type: none"> <li>• CORRECT: hypoglycemia &amp; hypocalcemia,</li> <li>• TREAT: sustained arrhythmias: brady- or tachycardia</li> <li>• Isotonic saline-fluid challenge - 200-300 ml over 30 min period to achieve a central venous pressure of 8 to 12 mmHg or until perfusion improves (with a maximum of 500 ml)</li> <li>• CONSIDER NIMV for comfort (fatigue, distress) or as needed:               <ul style="list-style-type: none"> <li>- To correct acidosis</li> <li>- To correct hypoxemia</li> </ul> </li> <li>• INOTROPIC SUPPORT (dobutamine, levosimendan and/or vasopressor support)</li> </ul>                                 |
|                             | 60 min |   |  |
|                             |        |   | <b>TREATMENT GOALS</b> <ul style="list-style-type: none"> <li>• a mean arterial pressure of 60 mmHg or above,</li> <li>• a mean pulmonary artery wedge pressure of 18 mmHg or below,</li> <li>• a central venous pressure of 8 to 12 mmHg,</li> <li>• a urinary output of 0,5 ml or more per hour per kilogram of body weight</li> <li>• an arterial pH of 7.3 to 7.5</li> <li>• a central venous saturation (ScvO<sub>2</sub>) ≥70% (provided SpO<sub>2</sub> ≥93% and Hb level ≥9 g/dl)</li> </ul>   |
|                             |        |   | <b>In persistent drug-resistant cardiogenic shock, consider mechanical circulatory support</b>   |

## CARDIOGENIC SHOCK: Treatment and ventilator procedures

For more informations on individual drug doses and indications:

Ventilator mode  
Tidal Volume goal  
Plateau Pressure goal  
Anticipated PEEP levels  
Ventilator rate and pH goal  
Inspiration: Expiration time  
Oxygenation goal:  
• PaO<sub>2</sub>  
• SpO<sub>2</sub>

Pressure assist/control  
Reduce tidal volume to 6-8 ml/kg lean body weight  
≤30 cm H<sub>2</sub>O  
5-10 cm H<sub>2</sub>O  
12-20, adjusted to achieve a pH ≥7.30 if possible  
1:1 to 1:2  
  
50-80 mmHg  
>90%

Predicted body weight calculation:

- Male:  $50 + 0.91(\text{height in cm} - 152.4)$
- Female:  $45.5 + 0.91(\text{height in cm} - 152.4)$

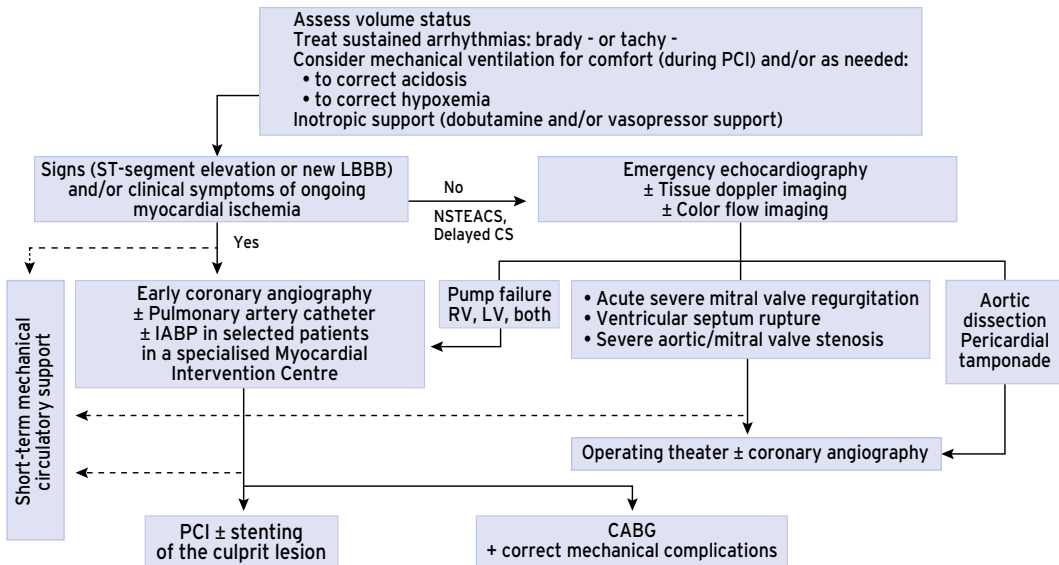
Some patients with CS will require increased PEEP to attain functional residual capacity and maintain oxygenation, and peak pressures above 30 cm H<sub>2</sub>O to attain effective tidal volumes of 6-8 ml/kg with adequate CO<sub>2</sub> removal.

For more information on individual drug doses and indications,

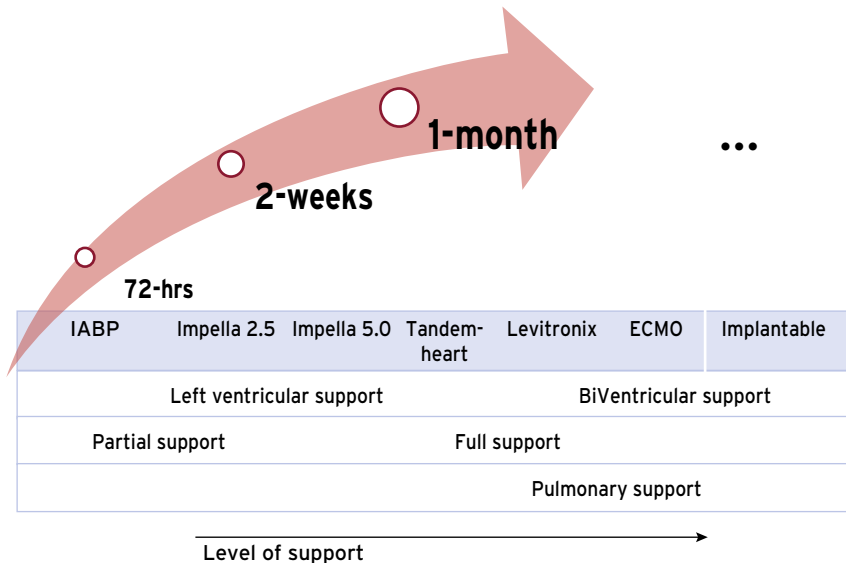
SEE CHAPTER 9 **DRUGS USED IN ACUTE CARDIOVASCULAR CARE**



## CARDIOGENIC SHOCK: management following STEMI



## CARDIOGENIC SHOCK: Mechanical circulatory support, basic characteristics



|  | Type                     | Support                                       | Access  |
|--|--------------------------|---|---|
| <b>Intra-aortic balloon pump</b>                 | Balloon counterpulsation | Pulsatile flow<br><0.5 L                      | Arterial: 7.5 French  |
| <b>Impella Recover</b><br>LP 2.5<br>CP<br>LP 5.0 | Axial flow               | Continuous flow<br><2.5 L<br><4.0 L<br><5.0 L | Arterial: 12 French<br>Arterial: 14 French<br>Arterial: 21 French |
| <b>Tandemheart</b>                               | Centrifugal flow         | Continuous flow<br><5.0 L                     | Venous: 21 French<br>Arterial: 15-17 French                       |
| <b>Cardiohelp</b>                                |                          |   | Venous: 15-29 French<br>Arterial: 15-29 French                    |

Different systems for mechanical circulatory support are available to the medical community. The available devices differ in terms of the insertion procedure, mechanical properties, and mode of action. A minimal flow rate of 70 ml/kg/min, representing a cardiac index of at least 2.5 L/m<sup>2</sup>, is generally required to provide adequate organ perfusion. This flow is the sum of the mechanical circulatory support output and the remaining function of the heart.

The SAVE-score may be a tool to predict survival for patients receiving ECMO for refractory cardiogenic shock ([www.save-score.com](http://www.save-score.com)).

