



## Referral of Cardiogenic Shock patients for consideration of short-term Mechanical Circulatory Support

Patients with acute cardiogenic shock (CS) can be referred to the Mater Misericordiae University Hospital for consideration of mechanical circulatory support (MCS). Referrals should be considered early in the course of CS prior to the development of multi-organ failure.

Cardiogenic shock is defined by the European Society of Cardiology (2016) as: systolic blood pressure (SBP) < 90mmHg or mean arterial pressure (MAP) < 60mmHg despite adequate intravascular volume with clinical (cool peripheries, oliguria, confusion, low pulse pressure) and laboratory (metabolic acidosis, increased lactate, creatinine) evidence of hypoperfusion (Eur Heart J 2016;37:2129-2200).

A new classification of CS (stages A - E) has been described in 2019:

- A:** At risk of CS, normal appearance and lab results
- B:** Beginning of CS: SBP < 90mmHg or MAP < 60mmHg; tachycardia but without clinical signs of hypoperfusion, lab results may be normal
- C:** Classic CS: SBP < 90mmHg or MAP < 60mmHg with signs of hypoperfusion; elevated lactate, renal or hepatic indices; low cardiac index but stable
- D:** Deteriorating for > 30 mins despite increased number and intensity of interventions
- E:** Extermis: circulatory collapse, refractory CS with ongoing CPR

A cardiac arrest (CA) is an important modifier. Patients in any CS stage who develop CA have a worse prognosis. (Jentzer JC, et al. J Am Coll Cardiol 2019;74:2117-2188).

The 30 day survival after CS has improved in adequately resourced centres using dedicated shock teams and standardised protocols (Tehrani BN, et al. J Am Coll Cardiol 2019;73:1659-1669). However, the 1 year survival of CS patients who require MCS remains low and 80% of surviving patients will have had a heart transplant or long-term left ventricular assist device (LVAD) implanted. Survival with recovery of native heart function is unusual.

In light of these results, we must be cautious about deploying short-term MCS in deteriorating CS patients unless there is a meaningful chance of benefit. Patients in stage C or D cardiogenic shock who can be safely transferred to the Mater Hospital with optimal conventional support may be considered for MCS.

## **Contra-indications to Mechanical Circulatory Support in acute CS**

- Age > 55 yrs, with no other contra-indication
- Stage E cardiogenic shock
- Aortic dissection or severe aortic regurgitation
- Significant coagulopathy or contra-indication to anticoagulation
- Cardiac arrest requiring CPR > 5 mins
- Confirmed or suspected neurological injury/disease
- Multi-organ failure including liver impairment (ALT > 1000 U/L)
- Chronic respiratory, renal or hepatic dysfunction
- Long-term diabetes mellitus with confirmed or suspected complications
- Significant malignancy or immunosuppression
- Long standing connective tissue disease with multi-organ dysfunction
- Psychological factors (substance abuse, active smoker, non-compliance)
- Overwhelming sepsis
- BMI > 35 BMI < 18

## **Referring a cardiogenic shock patient to the Mater Hospital**

To refer a CS patient for consideration of MCS, contact the Mater Hospital Critical Care Medicine Consultant on duty (Mater Hospital Swithboard: 01 803 2000). The case will be discussed immediately with the Mater Advanced Heart Failure Cardiology and Cardiothoracic Surgery consultants to formulate an appropriate management plan. The SAVE-score has also been used to predict outcome after V-A ECMO (Schmidt M, et al. Eur Heart J 2015;36:2246-2256).

If the patient is accepted, the transfer of the patient to the Mater Hospital will be facilitated as soon as possible. Prior to transfer, it would be helpful if coronary angiography/re-vascularisation was performed if acute myocardial infarction is suspected. Placement of an Intra-aortic Balloon Pump (IABP) in the referral hospital may be considered if it is judged that it might contribute to the safe transfer of the patient to the Mater Hospital.

On admission to the Mater Hospital, the patient will be assessed by the Critical Care Medicine, Cardiology and Cardiothoracic Surgery consultants. Any additional investigations (echocardiography, right heart catheterisation, myocardial biopsy) will be carried out and a decision to deploy mechanical circulatory support is made jointly.

## **Modes of Short-term Mechanical Circulatory Support that may be considered**

1. **Peripheral V-A ECMO** (Veno-Arterial Extracorporeal Membrane Oxygenation) can be deployed for temporary bi-ventricular support and gas exchange failure. Consider distal limb perfusion cannula to avoid limb ischaemia. Consider Intra-aortic Balloon Pump (IABP) or Impella for left ventricle (LV) distension during peripheral V-A ECMO.
2. **Impella** can be considered for isolated LV failure with satisfactory native lung gas exchange.

## **Outcome after short-term MCS**

During the first week on short-term MCS, the suitability of the patient for heart transplantation or durable LVAD is assessed. Important parameters include:

- meaningful response when sedation is weaned or normal CT brain
- signs of native heart recovery on low flow MCS
- low mechanical ventilator requirements
- recovery of hepatic synthetic function and coagulopathy
- normal kidney size, no scarring on renal ultrasound
- appropriate family and social support

1. If there is evidence of native heart recovery, consider weaning short-term MCS.
2. If there is limited LV recovery with satisfactory resolution of multi-organ failure but the patient is not yet considered a transplant candidate, consider Impella support (axillary artery) for a more prolonged assessment.
3. If there is limited native heart recovery with satisfactory resolution of multi-organ failure and the patient is a good candidate for transplantation and is likely to be transplanted within 3 months, consider paracorporeal centrifugal pump LVAD (or BiVAD if RV function is also poor) as a bridge to transplant.
4. If there is no native heart recovery and the patient is not a candidate for transplant or longer-term VAD, consider changing patient care to comfort measures only.

**Survival Prediction with SAVE-score:**

The SAVE-score (Schmidt M, et al. Eur Heart J 2015; 36: 2246-56) predicts hospital survival for patients receiving V-A ECMO for refractory cardiogenic shock. Twelve pre-ECMO variables are used to compute the SAVE-score (range: -35 to +17). This tool is intended for use as an adjunct to clinical judgment.

**Note:**

***ECPR patients are excluded from SAVE-score***

Parameter	Score		
Acute cardiogenic shock diagnosis group (select one or more)			
Myocarditis	3		
Refractory VT/VF	2		
Post heart or lung transplantation	3		
Congenital heart disease	-3		
Other diagnoses leading to cardiogenic shock requiring VA-ECMO	0		
Age (years)			
18-38	7		
39-52	4		
53-62	3		
≥ 63	0		
Weight (kg)			
≤ 65	1		
65-89	2		
≥ 90	0		
Acute pre-ECMO organ failures (select one or more if required)			
Liver failure <sup>a</sup>	-3		
Central nervous system dysfunction <sup>b</sup>	-3		
Renal failure <sup>c</sup>	-3		
Chronic renal failure <sup>d</sup>	-6		
Duration of intubation prior to initiation of ECMO (h)			
≤ 10	0		
11-29	-2		
≥ 30	-4		
Peak inspiratory pressure ≤ 20 cmH <sub>2</sub> O	3		
Pre-ECMO cardiac arrest	-2		
Diastolic blood pressure before ECMO ≥ 40 mmHg <sup>e</sup>	3		
Pulse pressure before ECMO ≤ 20 mmHg <sup>e</sup>	-2		
HCO <sub>3</sub> before ECMO ≤ 15 mmol/L <sup>e</sup>	-3		
Constant value to add to all calculations of SAVE-score	-6		
Total score	-35 to 17		
Total SAVE-score	Risk class	Survival (%)	
Hospital survival by risk class			
> 5	I	75	
1-5	II	58	
-4 to 0	III	42	
-9 to -5	IV	30	
≤ -10	V	18	

An online calculator is available at [www.save-score.com](http://www.save-score.com)

VT, ventricular tachycardia; VF, ventricular fibrillation.

<sup>a</sup>Liver failure was defined as bilirubin ≥ 33 μmol/L or elevation of serum aminotransferases (ALT or AST) > 70 U/L.

<sup>b</sup>CNS dysfunction combined neurotrauma, stroke, encephalopathy, cerebral embolism, as well as seizure and epileptic syndromes.

<sup>c</sup>Renal dysfunction is defined as acute renal insufficiency (e.g. creatinine > 1.5 mg/dL) with or without RRT.

<sup>d</sup>Chronic kidney disease is defined as either kidney damage or glomerular filtration rate < 60 mL/min/1.73 m<sup>2</sup> for ≥ 3 months.

<sup>e</sup>Worse value within 6 h prior ECMO cannulation.