Contemporary Look At The Treatment Of Cardiogenic Shock

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Objectives

- Definition of Cardiogenic shock
- Identify diagnostic Criteria of Cardiogenic Shock
- Identify Management of Cardiogenic Shock
- Identify Peripheral Ventricular Assist Devices
  - IABP (Intra-Aortic Balloon Pump)
  - TandemHeart PVAD
  - (Impella) Axial Flow Catheter
  - ECMO (Extracorporeal Membrane Oxygenation)
Cardiogenic shock

- A condition in which the heart can’t pump enough blood to meet the body’s needs.
- The overall incidence 7.9% (n=157,892)
- Despite advances in the treatment of myocardial infarction (MI), the incidence of cardiogenic shock in-hospital mortality is still estimated to be about 50%.

Diagnostic Criteria of Cardiogenic Shock

<table>
<thead>
<tr>
<th>Cardiogenic Shock</th>
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</thead>
<tbody>
<tr>
<td>Hypotension:</td>
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<tr>
<td>Systolic blood pressure &lt;90 mmHg for &gt;30 min, or</td>
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<tr>
<td>Vasopressors required to achieve a blood pressure ≥90 mmHg</td>
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<tr>
<td>Elevated Left Ventricular Filling Pressures:</td>
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<tr>
<td>Pulmonary congestion, or</td>
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<tr>
<td>Adequate or elevated filling pressures (wedge pressure &gt;20 mmHg)</td>
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<tr>
<td>Signs of impaired organ perfusion (at least one of the following):</td>
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<tr>
<td>Altered mental status</td>
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<tr>
<td>Cold, clammy skin</td>
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<tr>
<td>Oliguria</td>
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<tr>
<td>Increased serum lactate levels</td>
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</tbody>
</table>
Management of Cardiogenic Shock

AMI
- If no pulmonary oedema, IV fluid challenge
- If pulmonary oedema
  - Aggressive I.V diuretics therapy
  - Dopamine- will increase HR and thus cardiac work
  - Dobutamine- may drop blood pressure
  - Combination therapy may be more effective
- PCI or thrombolytic therapy

RV infarct
- Fluids and Dobutamine (no NTG)

Acute mitral regurgitation or VSD
- Pressors (Dobutamine and Nitroprusside)
- On occasion an intra aortic balloon pump

Thought and consideration must be given to the family and friends


<table>
<thead>
<tr>
<th>Procedure</th>
<th>1995</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac catheterization (%)</td>
<td>51.5</td>
<td>74.4</td>
</tr>
<tr>
<td>Intra-aortic balloon pump use (%)</td>
<td>39.2</td>
<td>39.2</td>
</tr>
<tr>
<td>Fibrinolytic therapy (%)</td>
<td>19.9</td>
<td>5.6</td>
</tr>
<tr>
<td>Percutaneous coronary intervention Primary (%)</td>
<td>27.4</td>
<td>54.4</td>
</tr>
<tr>
<td>Total (%)</td>
<td>34.3</td>
<td>64.1</td>
</tr>
<tr>
<td>Coronary artery bypass graft surgery (%)</td>
<td>11.5</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Source: Cardiosource © 2006 by the American College of Cardiology Foundation
Decompensated Heart Failure

Flowchart

Cardiac Output

Warm and Dry
- Compensated
- Optimize oral therapy
- Outpatient

Warm and Wet
- Congested
- Diuretics
- ED or Inpatient

Cold and Dry
- Low Flow State
- Inotropes, vasodilators, 7IA BP
- ICU

Cold and Wet
- Decompensated
- Diuretics, vasodilators, inotropes
- ICU

Pulmonary Capillary Wedge Pressure

Adapted from Nohria J Cardiac Failure 2000:6 64

Patient with Acute Heart Failure

Bedside assessment to identify haemodynamic 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
- Vascular type - fluid redistribution
  - Hypertension predominates
  - Vasoconstrictor
  - Diuretic

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

NO

‘Dry and cold’ patient
- Hypoperfused, hypovolemic
- ‘Dry and warm’
  - Adequately perfused
  - Compensated
  - Adjust oral therapy
- ‘Dry and cold’
  - Hypoperfused, hypovolemic
  - Consider fluid challenge
  - Consider inotropic agent if still hypoperfused

‘Wet and Cold’ patient
- Systolic blood pressure <90 mm Hg
- NO
- Consider mechanical circulatory support
- If no response to drugs
- Inotropic agent
  - Consider vasopressor in refractory cases
  - Diuretic (when perfusion corrected)
- Vasodilators
- Diuretics
- Consider inotropic agent in refractory cases
Peripheral Ventricular Assist Devices

IABP (intra-aortic balloon pump)

- placed in the emergency department (ED) for support during high-risk percutaneous coronary intervention (PCI) or as a bridge to coronary artery bypass grafting (CABG).

- To decrease myocardial workload and to improve end-organ perfusion.
IABP in AMI Cardiogenic Shock: No Hemodynamic or Survival Benefit

Higher Stroke with IABP in AMI Cardiogenic Shock

IABP increased hazard risk of stroke, downgraded to Class III (harm), Level of Evidence A, ESC STEMI Guidelines 2014

1- Prondzynski R. et al. J. Critical Care Medicine IABP SHOCK I 2010 – Clinical trials.gov # NCT00488248

Routine use of IABP in patients with cardiogenic shock is not recommended.
Clinical outcomes by support strategy

Archimedes Screw: Is Impella the Future of Mechanical Circulatory Support?
Axial Flow Catheter (Impella)

- A motor drive in the device rotates at a maximum speed of 51,000 rpm, drawing blood out of the left ventricle.
- Impella 2.5
- Impella CP
- Impella 5.0

Hemodynamic Effects of Impella Support
Clinical Society Guidelines for Impella Therapy

<table>
<thead>
<tr>
<th>Clinical Society Guideline Populations (SCAI, ACCF, HFSA, STS, ISHLT, HRS)</th>
<th>Class</th>
<th>Latest Update</th>
<th>FDA Approval</th>
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<tbody>
<tr>
<td>PCI in Cardiogenic Shock</td>
<td>I</td>
<td>2013</td>
<td>2016</td>
</tr>
<tr>
<td>Multi-organ failure, Cardiogenic Shock</td>
<td>I</td>
<td>2013</td>
<td>2016</td>
</tr>
<tr>
<td>PCI in Low Ejection Fraction, Complex CAD</td>
<td>IIb</td>
<td>2011*</td>
<td>2015</td>
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<tr>
<td>Bridge to Recovery or Decision, Cardiogenic Shock</td>
<td>IIa</td>
<td>2013</td>
<td>2016</td>
</tr>
<tr>
<td>STEMI and Cardiogenic Shock</td>
<td>IIb</td>
<td>2013</td>
<td>2016</td>
</tr>
<tr>
<td>STEMI and Urgent CABG</td>
<td>IIa</td>
<td>2013</td>
<td>2016</td>
</tr>
<tr>
<td>Acutely Decompensated Heart Failure</td>
<td>IIa</td>
<td>2012</td>
<td>TBD</td>
</tr>
<tr>
<td>Consensus Document on Hemodynamic Support</td>
<td>N/A</td>
<td>2015</td>
<td>2015/16</td>
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</tbody>
</table>

* Categories referencing Impella include Percutaneous LVAD, PVAD, Non-durable MCS, TCS and percutaneous MCSD
* Excludes Protek II Randomized Controlled Trial, and FDA PMA approval studies due to timing of available data in 2011

Impella Reduces Need for Inotropes/Pressors

- **Impella 2.5**
  - Reduction in Inotropes/Pressors in 24 Hours
  - ISAR-SHOCK RCT
    - N=25
    - 44% IABP vs 75% Impella

- **Impella 5.0**
  - Reduction in Inotropes/Pressors Over days
  - RECOVER I FDA IDE Study
    - N=16
TandemHeart pVAD

- Provides short-term support from a few hours up to 14 days.
- The system provides localized anticoagulation to the blood inside the pump, reducing the need for systemic anticoagulation.

The TandemHeart™ Percutaneous Ventricular Assist Device (pVAD)

ECMO
Extracorporeal Membrane Oxygenation

Advantages
- Can be placed percutaneously anywhere
- Provides full heart and lung support
- Allows for bridge to decision

Disadvantages
- Must be removed surgically
- Need trained staff to monitor and adjust 24 hrs/day while on support
- Have increased bleeding and vascular complications
ECMO
Extracorporeal Membrane Oxygenation

- Using a large international cohort of 3846 patients treated with ECMO for cardiogenic shock
- Based on the findings, the SAVE-score and its online calculator () offer a validated tool to predict survival for patients receiving ECMO for refractory cardiogenic shock.

SAVE
Survival After Veno-arterial ECMO
Impella added to ECMO

Soft robot helps the heart beat
Sleeve attaches directly around the heart

The soft robotic sleeve twists and compresses in synch with a beating heart, augmenting cardiovascular functions weakened by heart failure.

The device may one day be able to bridge a cardiogenic shock patient to transplant.

In vivo demonstration of cardiac assist in a porcine model of acute heart failure
Key Points

- Cardiogenic shock is a life threatening condition, and a growing clinical challenge in daily practice.
- Conventional therapeutic approach using inotropic support with or without IABP has not improved outcomes.
- Establish protocols for early identification, early support, and changing the focus to myocardial recovery for better outcomes and quality of life.
- Impella is the Future of Mechanical Circulatory Support with FDA approval in cardiogenic shock.
- SAVE score is important to estimate Survival After Veno-arterial ECMO.