Cardiogenic Shock Due to Myocardial Infarction: Diagnosis, Monitoring and Treatment

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Infarction-related cardiogenic shock (ICS): usually due to left-ventricular pump failure.

Mortality: 30-80% (ICS: most common cause of death from acute myocardial infarction AMI)
Guideline characterizes the current evidence-based treatment of ICS:

- Early revascularization,
- Treatment of shock,
- Intensive care treatment of multi-organ dysfunction syndrome (MODS) if it arises.
- The success or failure of treatment for MODS determines the outcome in ICS.

Experts (German and Austrian) analyzed approximately 3600 publications:
Results

- Early revascularization (PCI): paramount importance.
- The medical treatment consists:
  - dobutamine
  - norepinephrine
  - levosimendan: addition to treat catecholamine-resistant shock.
  - IABP (+/-), ECMO
- Optimal intensive-care interventions:
  - prevention and treatment of MODS,
  - ventilation, nutrition, erythrocyte-concentrate transfusion,
  - prevention of thrombosis and stress ulcers,
  - follow-up care, and rehabilitation.
Diagnosis and monitoring: initial phase

- A preliminary diagnosis of ICS:
  - ECG ("STEMI," ST-segment elevation myocardial infarction) + clinical findings ("cardiogenic shock")
    (recommendation ↑↑).
  - Even in the rare case of ICS following NSTEMI (no ST elevation): diagnose ICS on the basis of clinical criteria in a pts with ACS.
Diagnosis and monitoring: initial phase (cont.)

- The most important symptom of ICS:
  - SBP <90 mm Hg (at least 30 min + signs of reduced organ perfusion - ROP).
  - 1/4 ICS without initial hypotension: diagnosis rest on clinical signs of ROP (cold extremities, oliguria, altered mental status, e.g., agitation).
Revascularization

- Revascularization of the infarcted coronary artery: performed as early as possible, usually by PCI.
- Initial cardiovascular and respiratory stabilization of the PCS patient:
  - dobutamine/norepinephrine,
  - ventilation (respiratory failure)
  - adequate volume (right ventricular infarction)
Results of the SHOCK study: 30 day to 6 years survival rates of two groups

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<thead>
<tr>
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<th>Early revascularization</th>
<th>Conservative medical treatment</th>
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<tbody>
<tr>
<td><strong>Primary endpoint</strong></td>
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<tr>
<td>Survival 30 days</td>
<td>56.0%</td>
<td>47.6% (p=0.11)</td>
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<td><strong>Secondary endpoint</strong></td>
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<tr>
<td>Survival 6 months</td>
<td>49.7%</td>
<td>36.9% (p=0.027)</td>
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<td>Survival 12 months</td>
<td>46.7%</td>
<td>33.6% (p&lt;0.04)</td>
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<tr>
<td>Survival 6 years</td>
<td>32.8%</td>
<td>19.6% (p=0.03)</td>
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Revascularization (cont.)

- PCI on the coronary infarct artery: usually stent implantation + intensive use of platelet aggregation inhibitors.

- If PCI unsuccessful: surgery should be rapidly as possible.
Revascularization (cont.)

- Resuscitated patients form a special subgroup, which may make up as much as 30% of all ICS.
- Early PCI should be considered in rapidly defibrillated patients and mild hypothermia (12-24h).

Resuscitation. 2010;81:1353–1363
Curr Opin Crit Care. 2010;16:216–222
The goals of hemodynamic management if shock symptoms persist:

- BP stabilization
- Adequate organ perfusion

Close invasive monitoring: BP, CO

MAP: 65-75 mm Hg, CI: >2.5 L × min⁻¹ × m⁻², SVR: 800 to 1000 dyn × s × cm⁻⁵, SvO₂ >65%
Persistent shock (cont.)

- The cardiac power (product of cardiac output and mean arterial pressure as a measure of overall cardiac hydraulic performance) or cardiac power index (CP > 0.6 W or CPI > 0.4 W × m⁻²) may be chosen instead of cardiac index.
Which vasopressor and which inotrope?

- Norepinephrine: is the vasopressor of choice in patients with MAP < 65 mm Hg.
- The MAP can usually be effectively raised by intravenous infusion of 0.1 to 1 µg × kg⁻¹ × min⁻¹.
In the SOAP II study (1679 patients), norepinephrine showed a tendency to:

- lower mortality than dopamine (28-day mortality 45.9% vs. 50.2%; OR 1.19; CI 0.98-1.44; p = 0.07)
- significantly fewer arrhythmias (12.4% vs. 24.1%), especially atrial fibrillation.

In the prospectively defined subgroup of ICS patients, norepinephrine treatment led to a significantly better survival rate than the dopamine treatment (OR 0.75; p = 0.03).

Crit Care Med.2006;34:589–597
Dobutamine: inotrope of choice:

- Dose 2.5-10 µg × kg⁻¹ × min⁻¹:

- In a multicenter cohort observation study (1058 shock patients treated with catecholamines):
  - dopamine was an independent risk factor for mortality, while application of dobutamine or norpinephrine was not.

Levosimendan:

- ICS refractory to catecholamine treatment
- additional use
- loading dose 12-24 µg × kg\(^{-1}\) over 10 minutes,
- followed by 0.05-0.2 µg × kg\(^{-1}\) × min\(^{-1}\)
- more than phosphodiesterase III inhibitors
  (enoximone, milrinone)
Skepticism about intraaortic balloon counterpulsation

- European and the American myocardial infarction guidelines regard the use of IABP as a class IIa recommendation (STEMI-SC).

- In ICS patients, however, the hemodynamic effects of IABP are moderate:
  - These results of the randomized controlled IABP SHOCK trial
  - Cochrane analysis of six randomized studies of a total of 190 ICS patients
  - Meta-analysis of 10 529 ICS patients from nine cohort studies:
    - are confirmed by the negative results of a IABP

_Crit Care Med._ 2010;38:152–160
_Cochrane Database Syst Rev._ 2011CD007398
_Eur Heart J._ 2009;30:459–468
The ICS patients PCI: no benefit from adjunctive IABP treatment (rather even showed an absolute increase in mortality of 6% (ARR +6%; RRR +15%))

Only when used together with systemic fibrinolysis: + IABP lead to an 18% reduction in mortality (ARR –18%; RRR –26%)

The German–Austrian guideline gives only a weak recommendation for the use of IABP in ICS patients treated with systemic fibrinolysis, and only “may” information for patients treated with PCI.
ECMO
(ExtraCorporeal Membrane Oxygenation)

- High mortality and frequent bleeding complications limited use in the 1970s and 1980s
- Now: veno-arterial ECMO for cardiogenic shock can be placed centrally
- Can be instituted quickly and provide full support
- A review of 10 patients with acute MI and cardiovascular collapse supported with ECMO showed a 40% long-term survival.
- The University of Pittsburgh: 33 patients with AMI-CS showed a 1-year survival rate of 64%.
- In another series: 27 patients with AMI-CS supported with ECMO, 59% survived to discharge
- A study of 20 patients with AMI-CS + ECMO: 50% survival to discharge.

Ventilation

- Mechanical ventilation of an ICS patient ensures oxygenation and relieves the heart of the work of breathing.
- Should be preferred in patients with ICS invasive ventilation
- The reasons: constant, stable ventilation conditions, avoidance of psychomotor excitement in the patient.
- The advantages of lung-protective ventilation should be made use of at the earliest possible moment
- The depth of analgesia/sedation should be recorded three times a day.

Clin Res Cardiol. 2011;100:235–239
**Intensive care**

- Continuous intravenous insulin therapy with the aim of achieving normoglycemia (+/-)
- High blood glucose levels are unfavorable prognostic indicators in heart attack patients
- Recommendation in ICS patients: \( G < 8.3 \text{ mmol} \times \text{L-1} \)

*References:*


*Jama.* 2005;293:2596–2597. 2597; Letters and authors’ reply: 2005; 293
Intensive care (cont.)

- The use of insulin–glucose–potassium infusions: should therefore not be used in ICS patients

Jama. 2005;293:2596–2597. 2597; Letters and authors’ reply: 2005; 293
At what Hb threshold value should intensive care patients receive red cell concentrates?

- Red cell concentrates given from a Hb value < 7.0 g × dL-1/<4.3 mmol × L-1 or hematocrit < 25%.
- Target values are Hb 7.0-9.0 g × dL-1/4.3 to 5.6 mmol × L-1 or hematocrit >25%
- In older patients (>75 years), Ht>30%.

Mandatory measures are thrombosis, stress ulcer prophylaxis (heparin, PPI).
Recommendations for aftercare/rehabilitation

- Inpatient rehabilitation lasting usually about 3 to 4 weeks should be aimed at if possible, because of the severity of the infarction event.
A retrospective study analyzed 138 patients with AMI-CS, all of whom who received intensive medical therapy and IABP:

- 43 patients were treated with intensive medical therapy,
- 77 were treated with PCI or CABG,
- 18 were treated with circulatory support with VAD/ECMO or transplant, in-hospital mortality:
  
  - The circulatory support/transplant group: 33%
  - The revascularization group: 63%
  - The medical therapy group: 81%.
  - Five-year survival for the VAD/ECMO/heart transplant group: 63%; the revascularization group: 21%, the intensive therapy group: 6%.
Thanks for your attention!