Impella for cardiogenic shock

Nijmegen, 10 Februari, 2015

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Academic Medical Center
University of Amsterdam
The Netherlands
Potential conflicts of interest

Research grant Abbott Vascular (>10,000 euro)
Research grant Abiomed Inc. (>10,000 euro)
Research grant BBraun (>10,000 euro)
Research grant Biotronik (>10,000 euro)
Research grant InspireMD (>10,000 euro)

Global Impella Advisory board member
European working group on the use of Impella
Cardiogenic shock - Agenda

1. Acute Myocardial infarction setting

2. Brief overview various target therapies

3. The role for mechanical support
Mortality in CS

Goldberg et al. NEJM 1999;
Hochman et al. NEJM 1999;
Sjauw, Henriques et al. NHJ 2012
Zeymer et al. Eurointervention 2011;
Thiele et al. ESC 2012
STEMI + CS - DEATH

<10% of all STEMI but accounts for 90% of mortality

Hochman, J. S. Circulation 2003;107:2998-3002
Inotropic and vasopressor agents

The good...

- Improve haemodynamic parameters rapidly in CS.
- The haemodynamic benefits are perceived to outweigh the risks because hypotension itself compromises myocardial perfusion.
- Pharmacological circulatory support is recommended in CS
Inotropic and vasopressor agents

The bad…

• Increase myocardial oxygen consumption
• Can cause myocardial ischaemia
• Can cause ventricular arrhythmias,
• Can cause contraction band necrosis
• Can cause infarct expansion

• Pharmacological circulatory support is recommended in CS….

..........Although these drugs have not shown to improve patient outcomes in RCT’s.
SHOCK TRIAL @ 30 days

46.7% vs 56.0%, P=0.11

Proportion Alive

Days after Randomization

Hochmann, NEJM 1999
SHOCK TRIAL @ long term

Hochmann, NEJM 1999, JAMA 2006

@ 6 months mortality 50.3% vs 63.1%, p=0.03, NNT 8
Mechanical assist devices

Mechanical Circulatory Support

- **STEMI**
  - Myocardial recovery

- **STEMI + CS**
  - Myocardial recovery
  - Organ recovery

**Mechanisms**
- Acceleration recovery of contractility in stunned myocardium by increasing postischemic myocardial (microvascular) blood flow.

- Unloading effect:
  - Peak left ventricular wall stress ↓
  - Myocardial workload ↓
  - Reduced myocardial oxygen consumption.

Sjauw KD, Engström AE, Henriques JPS; Percutaneous Mechanical Cardiac Assist In Myocardial Infarction. Where Are we Now, Where Are We Going? Acute Card Care 2007;9(4):222-30
Currently available devices

Mechanical assist devices

- IABP
- TandemHeart
- Impella 2.5
- Impella 3.7 (CP)
- Impella 5.0 (surgical insertion)
- Minituarized ECMO
IABP - The guidelines in 2010

ACC/AHA

Class 1a

ESC

Class 1b
## IABP in STEMI

### Randomized controlled trials

<table>
<thead>
<tr>
<th>Trial</th>
<th>IABP</th>
<th>no IABP</th>
<th>30-day mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No reperfusion</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O’Rourke</td>
<td>8/14</td>
<td>10/16</td>
<td>0.01 (-0.26 to 0.28)</td>
</tr>
<tr>
<td>Flaherty</td>
<td>4/10</td>
<td>3/10</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>12/24</td>
<td>13/26</td>
<td></td>
</tr>
<tr>
<td><strong>Thrombolysis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kono</td>
<td>0/23</td>
<td>0/22</td>
<td></td>
</tr>
<tr>
<td>TACTICS</td>
<td>10/30</td>
<td>12/27</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>10/53</td>
<td>12/49</td>
<td>-0.06 (-0.21 to 0.08)</td>
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<tr>
<td><strong>Primary PCI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohman</td>
<td>2/96</td>
<td>2/86</td>
<td></td>
</tr>
<tr>
<td>PAMI-II</td>
<td>9/211</td>
<td>7/226</td>
<td></td>
</tr>
<tr>
<td>van ’t Hof</td>
<td>12/118</td>
<td>9/120</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>23/435</td>
<td>18/432</td>
<td>0.01 (-0.02 to 0.04)</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>45/502</td>
<td>43/507</td>
<td>0.01 (-0.03 to 0.04)</td>
</tr>
</tbody>
</table>

P (heterogeneity)=0.94  
I²=0%  
P (overall effect)=0.75

## IABP in STEMI

### Randomized controlled trials

<table>
<thead>
<tr>
<th>Trial</th>
<th>IABP N</th>
<th>mean (SD)</th>
<th>no IABP N</th>
<th>mean (SD)</th>
<th>LVEF difference</th>
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<tbody>
<tr>
<td>No reperfusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flaherty</td>
<td>8</td>
<td>36 (17)</td>
<td>8</td>
<td>15 (12)</td>
<td></td>
</tr>
<tr>
<td>Primary PCI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAMI-II</td>
<td>107</td>
<td>50 (9)</td>
<td>110</td>
<td>51 (9)</td>
<td>-0.10 (-2.24 to 2.04)</td>
</tr>
<tr>
<td>van ’t Hof</td>
<td>84</td>
<td>42 (13)</td>
<td>84</td>
<td>40 (10)</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>191</td>
<td>42 (13)</td>
<td>194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>199</td>
<td>202</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

P (heterogeneity) = 0.49

I² = 0%

P (overall effect) = 0.93

The CRISP AMI Trial

N=337

<table>
<thead>
<tr>
<th></th>
<th>IABC Plus PCI (n = 161)</th>
<th>PCI Alone (n = 176)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infarct size, % of left ventricular mass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per-protocol analysis, No. (%)</td>
<td>133 (82.6)</td>
<td>142 (80.7)</td>
<td></td>
</tr>
<tr>
<td>Mean (95% CI)</td>
<td>42.1 (38.7-45.6)</td>
<td>37.5 (34.3-40.8)</td>
<td>.06</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>42.8 (27.2-54.7)</td>
<td>36.2 (25.9-49.4)</td>
<td></td>
</tr>
<tr>
<td>Multiple imputation analysis</td>
<td>42.1 (38.6-45.6)</td>
<td>37.6 (34.3-40.9)</td>
<td>.07</td>
</tr>
<tr>
<td>Mean (95% CI)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>42.5 (27.1-55.9)</td>
<td>36.4 (24.9-49.9)</td>
<td></td>
</tr>
</tbody>
</table>

Patel MRet al, JAMA, 2011
No Hemodynamic Benefit IABP

Inotrope dosage was similar between the 2 groups

Prondzinsky et al. SHOCK 2012;37:378-384
(Clinical Trials.gov ID NCT 00469248)
IABP-SHOCK 2 - Lactate

Thiele et al. Presented ESC Congress Munchen 2012
IABP-SHOCK 2

Primary endpoint Mortality @ 30 days

Mortality (%)

Time after Randomization (Days)

P = 0.92 by log-rank test
Relative risk 0.96; 95% CI 0.79-1.17; P = 0.69 by Chi²-Test

Control
41.3%

IABP
39.7%
IT’S MORE THAN JUST A PASSING CRUSH.

IABP endures as the go-to standard for hemodynamic support

Other more costly and more invasive procedures may attract attention, but IABP therapy is the one that has earned your trust and loyalty. For years, it’s offered minimal complications, superior ease of use, and positive results. No wonder it’s the most-used, most-studied, and most-published cardiac assist device. Recent clinical guidelines have reaffirmed your clinical observations: it’s the first-line device for acute hemodynamic support.

MAQUET has been a driving force in IABP since its beginnings, and is pleased to lead the way in its future.

Safe, effective, and easy to use — it’s the choice that’s easy to love.

IT'S THE CHOICE THAT'S EASY TO LOVE
SAFE, EFFECTIVE, EASY TO USE
LEARN MORE >
New devices provide more support

Thiele Eur Heart J 2005
Burkhoff Am Heart J 2006
Feasibility of EMCO by nonsurgeons

7 patients included in 1 year
6 patients died
Death rate 86%

Lamhaut L et al. Resuscitation 2013 July
Regional Cardiogenic Shock Centers

1. Go out to the patient
2. Start support @ local facility
3. Transfer to expert shock center

In hospital survival rate 36.8% Not statistically different from that of 123 consecutive patients who received ECMO at our institution during the same period

Impella LV-Support

Physiological Results of Impella® Support

INFLOW (ventricle)

OUTFLOW (aortic root)

EDV, EDP

AOP

Flow

O₂ Demand

O₂ Supply

Cardiac Power Output
Impella family
# Impella family

<table>
<thead>
<tr>
<th></th>
<th>Impella 2.5</th>
<th>Impella CP</th>
<th>Impella 5.0/LD</th>
<th>Impella RP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access</strong></td>
<td>Percutaneous, Femoral</td>
<td>Percutaneous, Femoral</td>
<td>Surgical, Axillary/Fem or Ascend aorta</td>
<td>Percutaneous, Femoral Vein</td>
</tr>
<tr>
<td><strong>Output (max)</strong></td>
<td>2.5 L/min</td>
<td>3.7-4.0 L/min</td>
<td>5.0 L/min</td>
<td>4.6 L/min</td>
</tr>
<tr>
<td><strong>Guiding catheter size</strong></td>
<td>9F</td>
<td>9F</td>
<td>9F</td>
<td>11F</td>
</tr>
<tr>
<td><strong>Motor Size</strong></td>
<td>12F</td>
<td>14F</td>
<td>21F</td>
<td>22F</td>
</tr>
<tr>
<td><strong>Introducer Size</strong></td>
<td>13F Peel away</td>
<td>14F Peel away</td>
<td>Dacron graft 10mm</td>
<td>23F Peel away</td>
</tr>
<tr>
<td><strong>RPM (max)</strong></td>
<td>51,000</td>
<td>46,000</td>
<td>33,000</td>
<td>33,000</td>
</tr>
<tr>
<td><strong>EU approval</strong></td>
<td>5 days CE Mark</td>
<td>5 days CE Mark</td>
<td>10 days CE Mark</td>
<td>14 days CE Mark</td>
</tr>
</tbody>
</table>
Impella
Impella

Sjauw KD, Acute Cardiac Care 2007
Impella
Better unloading + more support

Change in Cardiac Index
IABP vs. Impella 2.5

Cardiac Power Index (CPI)
IABP vs. Impella 2.5

- Impella (native heart CPI)
- Impella (pump contribution)
- IABP

*Adapted from Seyfarth, et al., J Am Coll Cardiol. 2008 Nov 4;52(19):1584-8
The AMC MACH/Impella program

1: Elective high-risk PCI procedures$^{1,2}$

1a: Safety and feasibility of elective high-risk PCI with Impella 2.5 support*
1b: Intracoronary flow measurements high-risk PCI Procedures Impella 2.5 support §
1c: Europella short term FUP
1d: Europella long term FUP
1e: Protect 1
1f: Protect 2

2: Acute myocardial infarction

2a: Safety and Feasibility in STEMI patients$^3$
2b: STEMI patients in cardiogenic pre-shock
2c: STEMI patients in severe cardiogenic shock
2d: P/V loop measurements and/or intracoronary flow measurements$^4$

Phase 3: End-stage heart failure
Phase 4: Left ventricular assistance after cardiac surgery
Phase 5: All other patients

1. Henriques JP, Remmelink M; Am J Cardiol. 2006
Cardiogenic shock
Impella - AMC

Impella in AMC
2004-2014
N=222

- High-risk PCI
  n=71

- Cardiogenic shock
  n=141

- LAD infarction
  n=10

- AMI
  n=111

- Postcardiotomy
  n=23

- Cardiomyopathy
  n=3

- Heart failure
  n=2

- Right ventricular failure
  n=2
PV-loops

European working group on the clinical use of Impella. Submitted
Unloading even prior to reperfusion

Kapur NK et al. Circulation 2013
Unloading after MI without reperfusion

Wei X al. JACC Cardiovasc Interv 2013
Myocardial recovery – IMPELLA 2,5 Unloading in STEMI

Non randomized pilot study

Figure 2. Serial evaluation of left ventricular ejection fraction (LVEF) in STEMI patients treated with IMPella vs. Control. *P < 0.01 vs. Control Group.

Are all devices equal? – Upgrade?

Engstrom AE, et al. Critical Care Medicine, 2012

Impella 2,5/5,0
Impella 2,5 Euroshock registry

Implemented AMC strategy

Postcardiotomy CS  STEMI + CS

Impella CP 14 Fr providing >3,7 L/min

Responder -  Responder +  Recovery

†  LVAD  Recovery

Transplant  Destination
Ongoing trials with LV assist devices

**IMPRESS Severe Shock**
(= postarrest SHOCK)

- **IABP**
  - 42 patients in 24 months
  - Two sites
  - 48 patients planned

- **Impella CP**
  - AMC, Amsterdam, NL
  - Haukeland, Bergen, N

**Danish National Shock**
routine care vs CP

- **Standard care**
  - Impella CP

- **Impella CP**
  - 32 patients in 24 months
  - 360 patients planned
# Percutaneous circulatory support

<table>
<thead>
<tr>
<th></th>
<th>IABP</th>
<th>ECMO</th>
<th>TandemHeart</th>
<th>Impella 2.5</th>
<th>Impella CP</th>
<th>Impella 5.0</th>
<th>Impella RP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pump mechanism</strong></td>
<td>Pneumatic</td>
<td>Centrifugal</td>
<td>Centrifugal</td>
<td>Axial flow</td>
<td>Axial flow</td>
<td>Axial flow</td>
<td>Axial flow</td>
</tr>
<tr>
<td><strong>Cannula size</strong></td>
<td>7-9 F</td>
<td>18-21 F inflow; 15-22 F outflow</td>
<td>21 F inflow</td>
<td>13 F</td>
<td>14 F</td>
<td>22 F Surgical cut-down</td>
<td>23 F</td>
</tr>
<tr>
<td><strong>Insertion technique</strong></td>
<td>descending aorta via the femoral artery, inflow in RA via femoral vein, outflow in desc aorta via femoral artery</td>
<td>inflow in LA via femoral vein and trans-septal puncture outflow</td>
<td>Across aortic valve via femoral artery</td>
<td>Across aortic valve via femoral artery</td>
<td>Across aortic valve via surgical cut-down of femoral artery</td>
<td>Via femoral vein across tricuspid and pulmonary valve</td>
<td></td>
</tr>
<tr>
<td><strong>Haemodynamic support</strong></td>
<td>0.5 -1.0 L/min</td>
<td>&gt; 4.5 L/min</td>
<td>4 L/min</td>
<td>2.5 L/min</td>
<td>3.7 – 4.0 L/min</td>
<td>5.0 L/min</td>
<td>4.0 L/min</td>
</tr>
<tr>
<td><strong>Implantation time</strong></td>
<td>+</td>
<td>++</td>
<td>++++</td>
<td>++</td>
<td>++</td>
<td>++++</td>
<td>++</td>
</tr>
<tr>
<td><strong>Risk of limb ischaemia</strong></td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
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<tr>
<td><strong>Anticoagulation</strong></td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td><strong>Haemolysis</strong></td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td><strong>Requires stable rhythm management</strong></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td><strong>complexity</strong></td>
<td>+</td>
<td>+++</td>
<td>++++</td>
<td>++</td>
<td>++</td>
<td>++</td>
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</table>

Adapted from Ouweneel and Henriques. Heart 2012
<table>
<thead>
<tr>
<th>Year</th>
<th>Device</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>IABP</td>
<td>I/B A hemodynamic support device is recommended for patients with cardiogenic shock after STEMI who do not quickly stabilize with pharmacological therapy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left ventricular assist devices I/B A hemodynamic support device is recommended for patients with cardiogenic shock after STEMI who do not quickly stabilize with pharmacological therapy</td>
</tr>
<tr>
<td>2013</td>
<td>IABP</td>
<td>IIa/B The use of intra-aortic balloon pump (IABP) counterpulsation can be useful for patients with cardiogenic shock after STEMI who do not quickly stabilize with pharmacological therapy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left ventricular assist devices IIb/C Alternative LV assist devices for circulatory support may be considered in patients with refractory cardiogenic shock</td>
</tr>
</tbody>
</table>

Ouweneel DM, et al. Submitted
## ESC guidelines over the years

<table>
<thead>
<tr>
<th>Year</th>
<th>Device</th>
<th>Recommendation</th>
<th>Details</th>
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</thead>
<tbody>
<tr>
<td>2010</td>
<td>IABP</td>
<td>I/C</td>
<td>IABP insertion is recommended in patients with haemodynamic instability (particularly those in cardiogenic shock and with mechanical complications)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Left ventricular assist devices III/B Routine use of percutaneous centrifugal pumps is not recommended</td>
</tr>
<tr>
<td>2012</td>
<td>IABP</td>
<td>IIb/B</td>
<td>Intra-aortic balloon pumping may be considered (in patients with cardiogenic shock (Killip class IV)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Left ventricular assist devices IIb/C LV assist devices may be considered for circulatory support in patients in refractory shock</td>
</tr>
<tr>
<td>2014</td>
<td>IABP</td>
<td>III/A</td>
<td>Routine use of IABP in patients with cardiogenic shock is not recommended</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Left ventricular assist devices IIb/C Short-term mechanical circulatory support in ACS patients with cardiogenic shock may be considered</td>
</tr>
</tbody>
</table>

Ouweneel DM, et al. Submitted
SHOCK CASE

• 51 yr old male
• Wakes up with chest pain and shortness of breath
• Calls 112 (prehospital triage system - EMS)
• EMS calls+sends EKG: abnormal but poor clinical condition
• Immediate transfer to our hospital and cath-lab notified
• Initiate treatment: Aspirin, Clopidogrel, Heparin and Oxygen
Patient Clinical Condition on Arrival

- Severely distressed/restless on arrival @ hospital
- Pale with cold and discolored extremities
- BP 60/40
- HR 104/min
- Saturation 81 with O2
- Breathing >30/min

NOT INTUBATED YET
Just one shot....what next?
Initiate Organ and Myocardial Recovery

- Immediate Impella 2,5 placement left groin
- Immediate patient relief – less short of breath
- BP 80/70 (initial BP 60/40)
- Heart rate 105/min
PCI final result – TIMI 2-3
Clinical course - Immediately after PCI

- BP 95/85 (pulpresssure),
- heartrate 100/min
- Saturation 90% with O2
- Some ECG resolution
- No inotropes
- No vasopressors
- Not to ICU but to CCU
- Echo: LVEF 15-20% (only inferior wall contractions)
Clinical course until discharge

- CK MB 700 U/L
- Initial rise in creatinine levels and low urine production but restoration after 2-3 days
- Total Impella 2,5 support for 8 days
- Weaned well and was discharged to local hospital and home a week later – total admission time: 19 days
Post discharge FUP

- LVEF 46% @ 4 months, no residual ischemia
- Reangio after 9 months for LM PCI : good result
- Has resumed all his former activities without apparent limitations

A recovered heart and patient
SEVERE SHOCK CASE

• 46 yr old male
• No previous medical history
• Out-of-hospital-arrest and immediate BLS by friends
• Arrival of Ambulance and multiple times defibrillated
• After 20 minutes some degree of pulsatility
• ECG: large anterior STEMI
Arrival @ cathlab

• Intubated and blood through endotracheal tube
• Cold extremities
• BP 75/60
• HR 110/min
• On inotropes:
  – adrenaline high dose
  – dobutamine medium dose
  – Norepinephrine medium dose
RCA
Femoral artery
Circulatory support first

IMPELLA CP >3,7 L/min
PCI

• Wire
• Thrombus aspiration

• Complete collapse of circulation
• No pulsatility on arterial line during 10 min.
  ~60 mm Hg

• Stentys stent
- Leaving the cath-lab
- BP 90/70
- HR 100/min
- Impella CP on 3.7 L/min
- Still on norepinephrine
- No longer adrenaline
Clinical course

- ICU stay – 22 days
- Polyneuropathy
- 13 days on Impella CP support of which 10 days full support
- 3 days CCU/medium care
- Predischarge LVEF on echo and MIBI 33%
- ICD decision (?)
- Total hospital stay 43 days

- Has resumed all his former activities @ 3 months after discharge
Conclusions

Cardiogenic shock is still a condition with 50% mortality

IABP should not be used for cardiogenic shock

More potent percutaneous devices enter the cath-lab

What device for what condition?

ECMO best cards for ongoing resuscitation

Impella has best cards for cardiogenic shock

My guess for the future: Circulatory support before PCI!
Greetings from Amsterdam!
Impella® RP

- Temporary circulatory support for RV failure
- Single vascular access (femoral vein)
- Placed under fluoroscopic guidance
- No sternotomy required
- No extracorporeal circulation
- 22 Fr pump on an 11 Fr catheter
- Maximum flows > 4 L/min
Direct comparison in VF

US-Pella SHOCK registry

Survival to Discharge For ALL Patients

- Shock on Admission
  - Pre-PCI Impella Support Initiation: 57.1%, N=42, P=0.035
  - Post-PCI Impella Support Initiation: 35.7%, N=56, P=0.091

- In-hospital Onset of Shock
  - Pre-PCI Impella Support Initiation: 73.9%, N=23, P=0.035
  - Post-PCI Impella Support Initiation: 51.5%, N=33, P=0.091

Onset of Cardiogenic Shock

- Shock On admission
  - N=98, 44.9%

- In-hospital Onset of Shock
  - N=56, 60.7%

P=0.059
My personal recommendation for Impella usage:

- **Acute AMI CS**
  - Impella CP – 5,0

- **Postcardiotomy CS**
  - Impella 5,0 – CP?

- **Elective high-risk PCI**
  - Impella 2,5

- **All other CS support**
  - Impella CP – 5,0

- **All Other elective support**
  - Impella 2,5 – CP
Geographic distribution of Impella per indication
Setting up an Impella program in your hospital

ARROW

Preferably start with high risk PCI procedures (3-5 cases)

ARROW

Involve all disciplines during the initial phase:
Cardiologists (staff, fellows, (non)interventional
Cardiothoracic surgeons
Intensive Care Physicians
Nursing staff (catheterization laboratory, and CCU/ICU)
Perfusionists

ARROW

Identify a group of Impella specialists for console alarms
(eg perfusionists, nurses)

ARROW

Refrain from device usage in crash and burn cases until after initial (elective) case experience

ARROW

Evaluate every case during first 10 cases
• Increased Cardiac Power
  – Up to 3,7 L/Min Peak Flow

• Speed of the Cath Lab
  – Percutaneous implant of a 9 Fr catheter / 14 Fr pump

• Compatible with 14 Fr sheath
  – Abiomed peel-away (Oscor)
  – Cook 30cm, 14Fr