Post resuscitation care and role of urgent angiography after cardiac arrest

Georg Fuernau
Luebeck
DECLARATION OF INTEREST

- I have nothing to declare
The journey…
CPR and guidelines

<table>
<thead>
<tr>
<th>European Resuscitation Council</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>American Heart Association</td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>Date</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>European Resuscitation Council</td>
<td>15.10.2015</td>
</tr>
<tr>
<td>American Heart Association</td>
<td>03.11.2015</td>
</tr>
</tbody>
</table>

**Part 1: Executive Summary**

2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Robert W. Neumar, Chair; Michael Shusier; Clifton W. Callaway; Lana M. Gent; Dianne L. Atkins; Farhan Bhanji; Steven C. Brooks; Allan R. de Caen; Michael W. Donnino; Jose Maria E. Ferrer; Monica E. Kleinman; Steven L. Kronick; Eric J. Lavonas; Mark S. Link; Mary E. Mancini; Laurie J. Morrison; Robert E. O’Connor; Ricardo A. Samson; Steven M. Schexnayder; Eunice M. Singletary; Elizabeth H. Sinz; Andrew H. Travers; Myra H. Wyckoff; Mary Fran Hazinski
Questions in Post-Resuscitation-Care

European Resuscitation Council and European Society of Intensive Care Medicine Guidelines for Post-resuscitation Care 2015
Section 5 of the European Resuscitation Council Guidelines for Resuscitation 2015

Jerry P. Nolan, Jasmeet Soar, Alain Cariou, Tobias Cronberg, Véronique R.M. Moulaert, Charles D. Deakin, Bernd W. Bottiger, Hans Friberg, Kjetil Sunde, Claudio Sandroni

Part 8: Post–Cardiac Arrest Care
2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Clifton W. Callaway, Chair; Michael W. Donnino; Ericka L. Fink; Romergryko G. Geocadin; Eyal Golan; Karl B. Kern; Marion Leary; William J. Meurer; Mary Ann Peberdy; Trevonne M. Thompson; Janice L. Zimmerman
Questions in Post-Resuscitation-Care

- Airway and breathing
  - Control of oxygenation
  - Control of ventilation

- Optimising neurological recovery
  - Sedation
  - Seizures
  - Glucose control
  - Temperature control

- Circulation
  - Coronary reperfusion
    - PCI in ROSC with STEMI
    - PCI in ROSC without STEMI
  - Indication and timing of CT scanning
  - Hemodynamic management

- Prognostication
Questions in Post-Resuscitation-Care

- Airway and breathing
  - Control of oxygenation
  - Control of ventilation
- Optimising neurological recovery
  - Sedation
  - Seizures
  - Glucose control
  - Temperature control → own talk
- Circulation
  - Coronary reperfusion
    - PCI in ROSC with STEMI
    - PCI in ROSC without STEMI
  - Indication and timing of CT scanning
  - Hemodynamic management → own talk
- Prognostication
Airway and breathing

- Avoid hypo- and hyperoxemia, keep SaO$_2$ at 94-98%
- PaCO$_2$ within a normal physiological range (35-45 mmHg)
- Any patient with impaired neurological function should be kept intubated and ventilated
Sedation and Control of seizures

• No data to indicate whether or not the choice of sedation influences outcome
• short-acting drugs will enable more reliable and earlier neurological assessment and prognostication
• Routine seizure prophylaxis in post-cardiac arrest patients is not recommended
Sedation and Control of seizures

- No data to indicate whether or not the choice of sedation influences outcome
- Short-acting drugs will enable more reliable and earlier neurological assessment and prognostication
- Routine seizure prophylaxis in post-cardiac arrest patients is not recommended
- Maintain the blood glucose at ≤10 mmol/l (180 mg/dl) and avoid hypoglycaemia.
Coronary angiography

IMMEDIATE CORONARY ANGIOGRAPHY IN SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST

CHRISTIAN M. SPAULDING, M.D., LUC-MARIE JOLY, M.D., ALAIN ROSENBERG, M.D., MEHRAN MONCHI, M.D., SIMON N. WEBER, M.D., JEAN-FRANÇOIS A. DHAINAUT, M.D., PH.D., AND PIERRE CARLI, M.D.
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• 1994-1996: Prospective study performed in Paris France

• All survivors of OHCA with no obvious non cardiac cause of arrest regardless of clinical and ECG data

• Aged between 30 and 75 years of age

• Coronary angiography at admission followed if necessary by PCI
Coronary angiography

84 patients

- Significant coronary lesion: 60 patients (71%)
- No significant Stenosis: 24 patients (29%)

Types of coronary-artery lesions
- Recent coronary artery occlusion: 40 (67%)
- Type II lesion: 18 (30%)
- Type I lesion: 2 (3%)

Angioplasty
- Attempted: 37/40
- Successful: 28/40 (70%)

Table 4. Relation between ST-Segment Elevation, Chest Pain before Cardiac Arrest, and Recent Coronary-Artery Occlusion in the 84 Patients Who Underwent Coronary Angiography.*

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>NO. OF PATIENTS</th>
<th>NO. WITH RECENT CORONARY-ARTERY OCCLUSION (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-segment elevation and chest pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>15</td>
<td>13 (87)</td>
</tr>
<tr>
<td>Absent</td>
<td>69</td>
<td>27 (39)</td>
</tr>
<tr>
<td>ST-segment elevation or chest pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>49</td>
<td>31 (63)</td>
</tr>
<tr>
<td>Absent</td>
<td>35</td>
<td>9 (26)</td>
</tr>
</tbody>
</table>

*ST-segment elevation was defined as an elevation of more than 1 mm in two contiguous leads.
Predictors of survival

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR</th>
<th>95%CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of the need for inotropic drugs during transportation to the hospital</td>
<td>3.6</td>
<td>1.10-11.8</td>
<td>0.03</td>
</tr>
<tr>
<td>Delay between onset of cardiac arrest and ROSC (per 1 min)</td>
<td>1.1</td>
<td>1.02-1.12</td>
<td>0.003</td>
</tr>
<tr>
<td>Successful coronary angioplasty</td>
<td>5.2</td>
<td>1.10-24.5</td>
<td>0.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>Intervention</th>
<th>OR</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spaulding et al., 1997</td>
<td>PCI: 5.2</td>
<td>1.10-24.5</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Werling et al., 2006</td>
<td>CAG: 9.1</td>
<td>3.6-21.5</td>
<td>&lt;0.001*</td>
<td></td>
</tr>
<tr>
<td>Merchant et al., 2008</td>
<td>With STE: CAG: 3.8</td>
<td>1.35-10.9</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Without STE: CAG: 3.01</td>
<td>0.84-10.8</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Reynolds et al., 2009</td>
<td>CAG: 2.16</td>
<td>1.12-4.19</td>
<td>&lt;0.02</td>
<td></td>
</tr>
<tr>
<td>Anyfantakis et al., 2009</td>
<td>PCI no predictor of survival in multivariable analysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dumas et al., 2010</td>
<td>PCI: 2.06</td>
<td>1.16-3.66</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>Nanjayya et al., 2011</td>
<td>CAG: 1.32</td>
<td>0.26-7.37</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Tømte et al., 2011</td>
<td>CAG: 11.21</td>
<td>2.96-42.49</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Stub et al., 2011</td>
<td>CAG: 7.6</td>
<td>3.2-17.5</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Strote et al., 2011</td>
<td>Tertile with high vs. low CAG: 73 vs 3%</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zanuttini et al., 2012</td>
<td>PCI success: 2.32</td>
<td>1.23-4.38</td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>Cronier et al., 2011</td>
<td>CAG: 3.33</td>
<td>1.27-9.09</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Bro-Jeppesen et al., 2012</td>
<td>CAG, no STE: 0.69</td>
<td>0.4-1.2</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Søholm et al., 2013</td>
<td>Univariat significant</td>
<td>Multivariable no significance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hollenbeck et al., 2014</td>
<td>CAG: 2.86</td>
<td>1.42-5.56</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>Callaway et al., 2014</td>
<td>CAG: 1.69</td>
<td>1.06-2.70</td>
<td>&lt;0.005</td>
<td></td>
</tr>
</tbody>
</table>
Findings in patients after OHCA

714 OHCA admitted

No obvious extra-cardiac etiology → CAG
n=435 (61%)

Respiratory failure = 131
Brain injury = 17
Metabolic disorders = 15
Haemorrhage = 10
Miscellaneous = 106

ST-elevation
n=134 (31%)

Sign. Coronary lesion
n=118 (96%)

Successfull PCI
n=99 (74%)

No or failed PCI
n=35 (26%)

No sign. lesion
n=6 (4%)

Other ECG
n=301 (69%)

Sign. Coronary lesion
n=176 (58%)

Successfull PCI
n=78 (26%)

No or failed PCI
n=223 (74%)

Sign. Coronary lesion
n=118 (96%)

NSTEMI and PCI after OHCA

![Graph showing percent death over time with logrank test p < 0.01.](image)

- **No coro**
- **Coro w/o PCI**
- **Coro w/ PCI**

<table>
<thead>
<tr>
<th>Time (y)</th>
<th>No Coro</th>
<th>Coro w/o PCI</th>
<th>Coro w/ PCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>D30</td>
<td>70</td>
<td>100</td>
<td>118</td>
</tr>
<tr>
<td>2</td>
<td>47</td>
<td>65</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>31</td>
<td>40</td>
<td>67</td>
</tr>
<tr>
<td>6</td>
<td>21</td>
<td>20</td>
<td>46</td>
</tr>
<tr>
<td>8</td>
<td>13</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### NSTEMI and PCI after OHCA

#### Short-term outcome

<table>
<thead>
<tr>
<th></th>
<th>No coro</th>
<th>Coro w/o PCI</th>
<th>Coro w/ PCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted unpaired analysis</td>
<td>129/628 (20.5)</td>
<td>213/615 (34.6)</td>
<td>208/479 (43.0)</td>
</tr>
<tr>
<td>Adjusted unpaired analysis</td>
<td>125/592 (21.1)</td>
<td>195/574 (34.0)</td>
<td>194/444 (43.7)</td>
</tr>
<tr>
<td>Adjusted paired analysis</td>
<td>80/184 (43.5)</td>
<td>104/184 (56.5)</td>
<td></td>
</tr>
</tbody>
</table>

**Odds Ratio [95%CI]**

- (Coro w/ PCI vs. no coro)
- 0.34 [0.26, 0.45]
- 0.61 [0.43, 0.85]
- 0.64 [0.38, 1.08]

#### Long-term outcome

<table>
<thead>
<tr>
<th></th>
<th>No coro</th>
<th>Coro w/o PCI</th>
<th>Coro w/ PCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted unpaired analysis</td>
<td>55/111 (49.6)</td>
<td>139/177 (78.5)</td>
<td>152/178 (85.4)</td>
</tr>
<tr>
<td>Adjusted unpaired analysis</td>
<td>54/107 (50.5)</td>
<td>127/163 (77.9)</td>
<td>143/167 (85.6)</td>
</tr>
<tr>
<td>Adjusted paired analysis</td>
<td>89/125 (71.2)</td>
<td>115/125 (92.0)</td>
<td></td>
</tr>
</tbody>
</table>

**Hazard Ratio [95%CI]**

- (Coro w/ PCI vs. no coro)
- 0.25 [0.16, 0.41]
- 0.40 [0.23, 0.70]
- 0.29 [0.14, 0.61]

### Table

<table>
<thead>
<tr>
<th>Variable</th>
<th>All Patients, n=1722</th>
<th>No Coronary Angiography, n=628</th>
<th>Coronary Angiography Without PCI, n=615</th>
<th>Coronary Angiography With PCI, n=479</th>
<th>P Value*</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-segment–elevation on post-ROSC ECG</td>
<td>318 (18.5)</td>
<td>23 (3.7)</td>
<td>70 (11.4)</td>
<td>225 (47.0)</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

*UK SH Universitätsklinikum Schleswig-Holstein    
Universitäres Herzzentrum Lübeck

Geri et al. Circ Cardiovasc Interv 2015;8;
# Early ECG after ROSC

<table>
<thead>
<tr>
<th>Group</th>
<th>ECG</th>
<th>Stenosis &gt;90%</th>
<th>TIMI flow 0-1</th>
<th>PCI performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>STEMI or new LBBB</td>
<td>26% STEMI 24% LBBB</td>
<td>49% STEMI 21% LBBB</td>
<td>64% STEMI 24% LBBB</td>
</tr>
<tr>
<td>Group 2</td>
<td>No STEMI but suspicious of coronary ischemia</td>
<td>27%</td>
<td>20%</td>
<td>41%</td>
</tr>
<tr>
<td>Group 3</td>
<td>No ECG findings indicating coronary ischemia</td>
<td>19%</td>
<td>11%</td>
<td>24%</td>
</tr>
</tbody>
</table>
### Table 4. Multivariable Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>OR (95% CI)</th>
<th>Coefficient</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>−3.881</td>
<td>...</td>
<td>−3.393</td>
<td>...</td>
</tr>
<tr>
<td>Angina</td>
<td>1.429</td>
<td>4.17 (1.23–14.17)</td>
<td>1.249</td>
<td>3.49 (1.03–11.84)</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>1.459</td>
<td>4.30 (1.04–17.87)</td>
<td>1.276</td>
<td>3.58 (0.86–14.88)</td>
</tr>
<tr>
<td>Shockable arrest rhythm</td>
<td>1.899</td>
<td>6.68 (1.61–27.79)</td>
<td>1.660</td>
<td>5.26 (1.26–21.89)</td>
</tr>
<tr>
<td>ST-elevation</td>
<td>2.593</td>
<td>13.37 (3.51–50.89)</td>
<td>2.267</td>
<td>9.65 (2.54–36.74)</td>
</tr>
</tbody>
</table>

Bias-corrected coefficients were determined via multiplication by the calibration slope (0.8743). CI indicates confidence interval; and OR, odds ratio.

### Table 5. Point Score (ACS²)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angina</td>
<td>1</td>
</tr>
<tr>
<td>Congestive heart failure symptoms</td>
<td>1</td>
</tr>
<tr>
<td>Shockable rhythm (ventricular fibrillation/ventricular tachycardia)</td>
<td>1</td>
</tr>
<tr>
<td>ST-elevation (2 contiguous leads)</td>
<td>2</td>
</tr>
</tbody>
</table>
Prediction of significant coronary lesions

A All patients

B With STE

C Without STE
STEMI with OHCA and CS
Cardiogenic shock

Potential revascularization strategies

- Culprit Lesion only
- Culprit lesion only + Staged Revasc.
- CABG
- Immediat MV-PCI
If you don’t know: Randomize!
Primary Endpoint: Mortality and/or Acute renal failure requiring dialysis 30 days
CULPRIT-SHOCK Trial

PI + Coordinator:
Holger Thiele

Co-PI:
Steffen Desch
Uwe Zeymer

National coordinators:
- Kurt Huber
- Gilles Montalescot
- Jan Piek
- Holger Thiele
- Pranas Serpytis
- Janina Stepinska
- Christiaan Vrints
- Marko Noc
- Keith Oldroyd
- Stefan Windecker
- Stefano Savonitto
STEMI with OHCA and CS
STEMI with OHCA and CS
Algorithm in OHCA

Central Illustration: Algorithm for Risk Stratification of Comatose Cardiac Arrest Patients

Out-of-hospital cardiac arrest (OHCA) patients who have achieved return of spontaneous circulation (ROSC), but remain comatose

Within 10 minutes of hospital arrival:
Perform 12-lead electrocardiography (ECG) to identify patients who benefit from emergent angiography
Induce targeted temperature management (TTM) with mild therapeutic hypothermia (TH) to limit tissue injury following cardiac arrest

ST-segment elevation on the ECG

- Activate ST-segment elevation myocardial infarction (STEMI) team
  - Consider survival benefit/risk ratio, especially if multiple unfavorable resuscitation features are present

No ST-segment elevation on the ECG

- “ACT”
  - Assess for unfavorable resuscitation features
  - Consult with interventional cardiology & intensive care services
  - Transport to cardiac catheterization laboratory (CCL)
    (once a decision is made to proceed with coronary angiography)

Patients deemed suitable

- Emergency angiography
- Define coronary anatomy
- Identify coronary lesion
- Percutaneous coronary intervention (PCI)
- Left ventricular (LV) function and hemodynamic assessment
- Provide mechanical LV support if needed

Patients with multiple unfavorable resuscitation features

- Unwitnessed arrest
- Initial rhythm: Non-VF
- No bystander CPR
- >30 min to ROSC
- Ongoing CPR

- pH <7.2
- Lactate >7
- Age >85
- End stage renal disease
- Noncardiac causes (e.g., traumatic arrest)

Patients are less likely to benefit from coronary intervention
Individualized patient care and interventional cardiology consultation are strongly recommended

Patients deemed suitable

- Early angiography
- Define coronary anatomy
- Identify coronary lesion
- Percutaneous coronary intervention (PCI)
- Left ventricular (LV) function and hemodynamic assessment
- Provide mechanical LV support if needed

# Angiographic findings in NSTEMI after CA?

## TABLE 2  Angiographic Findings in Patients With Cardiac Arrest and No ST-Segment Elevation on ECG

<table>
<thead>
<tr>
<th>First Author, Year (Ref. #)</th>
<th>Acute Occlusion</th>
<th>Culprit Lesion*</th>
<th>Significant CAD†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merchant et al., 2008 (55)</td>
<td>6/17 (35)</td>
<td>—</td>
<td>10/17 (55)</td>
</tr>
<tr>
<td>Reynolds et al., 2009 (14)</td>
<td>—</td>
<td>—</td>
<td>31/54 (57)</td>
</tr>
<tr>
<td>Anyfantakis et al., 2009 (56)</td>
<td>—</td>
<td>—</td>
<td>27/44 (61)</td>
</tr>
<tr>
<td>Radsel et al., 2011 (31)</td>
<td>4/54 (7)</td>
<td>13/54 (24)</td>
<td>32/54 (59)</td>
</tr>
<tr>
<td>Bro-Jeppesen et al., 2012 (30)</td>
<td>—</td>
<td>—</td>
<td>43/82 (52)</td>
</tr>
<tr>
<td>Dumas et al., 2010 (3)</td>
<td>—</td>
<td>—</td>
<td>176/301 (58)</td>
</tr>
<tr>
<td>Hollenbeck et al., 2014 (25)</td>
<td>44/163 (27)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Kern et al., 2015 (52)</td>
<td>23</td>
<td>33</td>
<td>—</td>
</tr>
<tr>
<td>Total (%)</td>
<td>23</td>
<td>29</td>
<td>58</td>
</tr>
</tbody>
</table>

Values are n/N (%) or %. *Defined as acute occlusion or irregular plaque morphology with or without thrombus. †Defined according to the definition used in each study.

CAD = coronary artery disease; ECG = electrocardiogram.
### Table 2 Unadjusted and adjusted hazard ratios for death in patients with no acute ST elevation on the admission ECG

<table>
<thead>
<tr>
<th></th>
<th>Univariate HR (95% CI)</th>
<th>Multivariate HR (95% CI)</th>
<th>Multivariate p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early CAG</td>
<td>0.82 (0.64–1.03)</td>
<td>1.03 (0.80–1.32)</td>
<td>0.82</td>
</tr>
<tr>
<td>Age (per year)</td>
<td>1.04 (1.03–1.05)</td>
<td>1.03 (1.02–1.04)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>0.83 (0.63–1.09)</td>
<td>0.89 (0.67–1.19)</td>
<td>0.43</td>
</tr>
<tr>
<td>Previous AMI</td>
<td>1.27 (0.98–1.65)</td>
<td>0.95 (0.68–1.34)</td>
<td>0.77</td>
</tr>
<tr>
<td>Previous arrhythmia</td>
<td>1.38 (1.06–1.79)</td>
<td>1.09 (0.82–1.46)</td>
<td>0.56</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>1.51 (1.19–1.92)</td>
<td>1.15 (0.83–1.59)</td>
<td>0.39</td>
</tr>
<tr>
<td>Heart failure, NYHA 3–4</td>
<td>1.58 (1.09–2.29)</td>
<td>1.30 (0.86–1.96)</td>
<td>0.22</td>
</tr>
<tr>
<td>Witnessed arrest</td>
<td>0.74 (0.52–1.06)</td>
<td>0.91 (0.63–1.33)</td>
<td>0.64</td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>0.58 (0.45–0.73)</td>
<td>0.83 (0.64–1.08)</td>
<td>0.18</td>
</tr>
<tr>
<td>Shockable initial rhythm</td>
<td>0.28 (0.22–0.35)</td>
<td>0.32 (0.25–0.42)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Minutes to ROSC</td>
<td>1.02 (1.02–1.02)</td>
<td>1.02 (1.02–1.02)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Shock on admission</td>
<td>2.85 (2.15–3.78)</td>
<td>1.97 (1.45–2.67)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Sitea</td>
<td>0.66 (0.47–0.92)</td>
<td>0.91 (0.64–1.29)</td>
<td>0.59</td>
</tr>
<tr>
<td>Target temperature 33 °C</td>
<td>1.19 (0.94–1.50)</td>
<td>1.21 (0.95–1.54)</td>
<td>0.13</td>
</tr>
</tbody>
</table>

*Received PCI (n=25)

- Dead (n=122) 48%
- Alive (n=130) 52%

- Dead (n=159) 54%
- Alive (n=133) 46%
NSTEMI and PCI after OHCA

746 OHCA admitted

746 OHCA admitted

ST-elevation n=198 (27%)

Other ECG n=548 (74%)

p<0.003

93 with CAG
79 no CAG
STEMI or NSTEMI and PCI after OHCA

Table 3. Unadjusted and Adjusted Association of Early Coronary Angiography With Survival to Discharge and Favorable Neurological Outcome

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Survival to Discharge</th>
<th>Favorable Neurological Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Unadjusted (before matching), (N=4029)*</td>
<td>2.16</td>
<td>1.89–2.47</td>
</tr>
<tr>
<td>Propensity matched, (N=2624)—all patients†</td>
<td>1.52</td>
<td>1.28–1.80</td>
</tr>
<tr>
<td>Propensity matched for patients identified as not having a STEMI, (N=620)†</td>
<td>1.29</td>
<td>0.87–1.90</td>
</tr>
</tbody>
</table>

Kern et al. JACC Cardiovasc Interv 2015;8;1031-40.
If you don’t know: Randomize!
TOMAHAWK flow

Survivor of out-of-hospital cardiac arrest without ST-segment elevation

Check in- and exclusion criteria

Informed consent

Not eligible → registry

Randomization

Immediate angiography (direct transport to cath) n=249

Initial intensive care evaluation with delayed angiography if indicated n=249

Primary endpoint: 30-day mortality

Follow-up at 6 and 12 months (telephone)
Anterior ST-STEMI

Inclusion criteria
• Documented resuscitated OHCA of possible cardiac origin and return of spontaneous circulation
  • Age ≥18 years
  • Informed consent

Exclusion criteria
• ST-segment elevation or new left bundle branch block
• No return of spontaneous circulation upon hospital admission
• Severe hemodynamic or electrical instability requiring immediate coronary angiography/intervention (delay clinically not acceptable)
• Obvious extra-cardiac etiology such as traumatic brain injury, primary metabolic or electrolyte disorders, intoxication, overt hemorrhage, respiratory failure due to known lung disease, suffocation, drowning
• In-hospital cardiac arrest
• Pregnancy
• Participation in another clinical trial
TOMAHAWK subprojects

- Angiographic analysis (corelab)
- Predictive prognostic model and risk score
- Biomarkers (central biobank)
- ECG
- Microcirculation
TOMAHAWK timeline

- 2014: Preparation (protocol, funding, etc.)
- 2015: Initiation of sites
- 2016: Recruitment period
- 2017: Milestone 3: 25% of patients randomized
- 2018: Milestone 4: 50% of patients randomized
- 2019: Milestone 5: Analysis of primary endpoint
- Milestone 6: 75% of patients randomized
- Milestone 7: Enrollment completed
- Milestone 8: Analysis of 32 month follow-up
- Milestone 9: Manuscript submission
- Milestone 10: Submission to authorities
- Milestone 2: First patient randomized
Thank you for your attention

Email: georg.fuernau@uksh.de