ACS with Out of Hospital Cardiac Arrest: Invasive Management for all?

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Disclosure Information

NONE regarding this presentation
Out of Hospital Cardiac Arrest Survival Rate

- Dismal survival to admission 25%
  - 1/3 deaths from neurologic damage
  - 1/3 deaths from myocardial injury
  - 1/3 deaths from multiorgan failure
Published Cohort Studies on Immediate Invasive Coronary Strategy

Forty-two published studies from 1995-2013 (seven from 2012 accounted for 1/3 of total patients)

- 3655 patients
  - 82% comatose
  - 62% STEMI
  - 71% underwent PCI

- 60% overall survival

- 52% cerebral performance category (CPC) 1 or 2 indicating good neurological outcome

Immediate Coronary Angiography: Meta-Analysis of 10 observational studies
Selection of patients for immediate coronary invasive strategy.

Comatose survivors of OHCA

- Coma on admission should not automatically represent a contraindication for immediate coronary angiography!
- Unfavourable for cath lab
  - Unwitnessed cardiac arrest,
  - Late arrival of a pre-hospital team without lay basic life support (>10 minutes),
  - Presence of an initial non-shockable rhythm,
  - >than 20 minutes of advanced life support without ROSC.
  - Severe pre-arrest comorbidities and limited life expectancy should be taken into account.
- There is currently no parameter which can adequately predict neurological outcome at hospital admission when the decision for immediate invasive coronary strategy is taken.

Cardiac arrest PCI (CA-PCI)

Revascularisation strategies in survivors of out-of-hospital cardiac arrest.

100 Α με OHCA → 40: ROSC, αλλά μόνο 10 τελικά επιβιώνουν, δηλαδή 25% όσων φθάνουν στο νοσοκομείο.

- Με συνδυασμό όμως ΘΗ και πρώιμης Angio+PCI αύξηση επιβίωσης έτους στο 56%!
- Τα αποτελέσματα αυτά δε διέφεραν μεταξύ STEMI και non- STEMI

Kern 2012 JACC
Immediate Percutaneous Coronary Intervention Is Associated With Better Survival After Out-of-Hospital Cardiac Arrest

Insights From the PROCAT (Parisian Region Out of Hospital Cardiac Arrest) Registry

Florence Dumas, MD; Alain Cariou, MD; Stéphane Manzo-Silberman, MD; David Grimaldi, MD; Benoît Vivien, MD; Julien Rosencher, MD; Jean-Philippe Empana, MD; Pierre Carli, MD; Jean-Paul Mira, MD; Xavier Jouven, MD; Christian Spaulding, MD

Background—Acute coronary occlusion is the leading cause of cardiac arrest. Because of limited data, the indications and timing of coronary angiography and angioplasty in patients with out-of-hospital cardiac arrest are controversial. Using data from the Parisian Region Out of hospital Cardiac ArresT prospective registry, we performed an analysis to assess the effect of an invasive strategy on hospital survival.

Methods and Results—Between January 2003 and December 2008, 714 patients with out-of-hospital cardiac arrest were referred to a tertiary center in Paris, France. In 435 patients with no obvious extracardiac cause of arrest, an immediate coronary angiogram was performed at admission followed, if indicated, by coronary angioplasty. At least 1 significant coronary artery lesion was found in 304 (70%) patients, in 128 (96%) of 134 patients with ST-segment elevation on the ECG performed after the return of spontaneous circulation, and in 176 (58%) of 301 patients without ST-segment elevation. The hospital survival rate was 40%. Multivariable analysis showed successful coronary angioplasty to be an independent predictive factor of survival, regardless of the postresuscitation ECG pattern (odds ratio, 2.06; 95% CI, 1.16 to 3.66).

Conclusions—Successful immediate coronary angioplasty is associated with improved hospital survival in patients with or without ST-segment elevation. Therefore, our findings support the use of immediate coronary angiography in patients with out-of-hospital cardiac arrest with no obvious noncardiac cause of arrest regardless of the ECG pattern. (Circ Cardiovasc Interv. 2010;3:200-207.)

Key Words: cardiac arrest  PCI  angioplasty  catheterization  electrocardiography
Successful PCI Associated With Improved Post-Cardiac Arrest Outcome With or Without STEMI

Dumas, Cardiovasc Interv, 2010
Immediate percutaneous coronary intervention is associated with improved short and long-term outcome after out-of-hospital cardiac arrest


<table>
<thead>
<tr>
<th></th>
<th>No PCI</th>
<th>PCI</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short-term outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted unpaired analysis</td>
<td>901/1243 (72.5)</td>
<td>273/479 (57.0)</td>
<td>0.50 [0.40, 0.63]</td>
</tr>
<tr>
<td>Adjusted unpaired analysis</td>
<td>706/989 (71.4)</td>
<td>182/415 (43.9)</td>
<td>0.71 [0.53, 0.94]</td>
</tr>
<tr>
<td>Adjusted paired analysis</td>
<td>80/184 (43.5)</td>
<td>104/184 (56.5)</td>
<td>0.64 [0.38, 1.08]</td>
</tr>
<tr>
<td><strong>Long-term outcome</strong></td>
<td></td>
<td></td>
<td>Hazard ratio</td>
</tr>
<tr>
<td>Unadjusted unpaired analysis</td>
<td>197/288 (68.4)</td>
<td>154/178 (86.5)</td>
<td>0.35 [0.23, 0.56]</td>
</tr>
<tr>
<td>Adjusted unpaired analysis</td>
<td>166/240 (69.2)</td>
<td>137/157 (87.3)</td>
<td>0.41 [0.25, 0.68]</td>
</tr>
<tr>
<td>Adjusted paired analysis</td>
<td>99/135 (73.3)</td>
<td>137/157 (87.3)</td>
<td>0.39 [0.22, 0.70]</td>
</tr>
</tbody>
</table>

ESICM Barcelona 2014
Emergency Percutaneous Coronary Intervention in Post-Cardiac Arrest Patients Without ST-Segment Elevation Pattern

Insights From the PROCAT II Registry

Florence Dumas, MD, PhD,¹,b Wulfran Bougouin, MD, MPH,¹,b,c Guillaume Gerli, MD, ScD,¹,b,c Lionel Lambhaut, MD,²,d Julien Rosencher, MD,² Frédéric Pène, MD, PhD,² Jean-Daniel Chiche, MD, PhD,² Olivier Varenne, MD, PhD,² Pierre Carli, MD, PhD,² Xavier Jouven, MD, PhD,² Jean-Paul Mira, MD, PhD,² Christian Spaulding, MD, PhD,² Alain Cariou, MD, PhD,²,c

FIGURE 1 Flowchart of Studied Population

2004-2013
1430 patients

Obvious extra cardiac cause: n=472
STE on post-ROSC ECG: n=251
Missing post resuscitation ECG: n=12

No STE
No obvious non cardiac cause of arrest
Immediate coronary angiogram
n=695

Successful PCI
n=199 (29%)

No culprit lesion
n=496 (71%)

87/200 CPC 1-2
(43%)

164/495 CPC 1-2
(33%)

CPC = cerebral performance category; ECG = electrocardiography; PCI = percutaneous coronary intervention; ROSC = return of spontaneous circulation; STE = ST-segment elevation.
### Table 2: Predictive Factors of Good Neurological Outcome At Discharge (Multivariable Analysis)

<table>
<thead>
<tr>
<th>Factor</th>
<th>OR</th>
<th>95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (for each additional year)</td>
<td>0.97</td>
<td>0.95-0.99</td>
<td>0.002</td>
</tr>
<tr>
<td>Male</td>
<td>1.18</td>
<td>0.68-2.06</td>
<td>0.55</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.64</td>
<td>0.89-3.0</td>
<td>0.11</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.03</td>
<td>0.62-1.69</td>
<td>0.92</td>
</tr>
<tr>
<td>Current smoker</td>
<td>1.21</td>
<td>0.75-1.94</td>
<td>0.46</td>
</tr>
<tr>
<td>Public location of CA</td>
<td>1.27</td>
<td>0.78-2.07</td>
<td>0.34</td>
</tr>
<tr>
<td>Witnessed CA</td>
<td>3.43</td>
<td>0.89-13.26</td>
<td>0.07</td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>1.35</td>
<td>0.85-2.15</td>
<td>0.20</td>
</tr>
<tr>
<td>Initial shockable rhythm</td>
<td>3.40</td>
<td>1.95-5.91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Resuscitation length &lt;20 min</td>
<td>3.15</td>
<td>1.94-5.10</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Epinephrine &gt;2 mg</td>
<td>0.27</td>
<td>0.16-0.46</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TTM</td>
<td>0.93</td>
<td>0.41-2.07</td>
<td>0.85</td>
</tr>
<tr>
<td>Post-CA shock</td>
<td>0.58</td>
<td>0.36-0.92</td>
<td>0.02</td>
</tr>
<tr>
<td>Successful PCI</td>
<td>1.80</td>
<td>1.09-2.97</td>
<td>0.02</td>
</tr>
</tbody>
</table>

### Table 4: Pre-Hospital Predictive Factors for Successful PCI

<table>
<thead>
<tr>
<th>Factor</th>
<th>OR</th>
<th>95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (per-yr increase)</td>
<td>1.01</td>
<td>1.0-1.03</td>
<td>0.08</td>
</tr>
<tr>
<td>Sex</td>
<td>1.39</td>
<td>0.88-2.20</td>
<td>0.16</td>
</tr>
<tr>
<td>Public location</td>
<td>1.03</td>
<td>0.69-1.52</td>
<td>0.89</td>
</tr>
<tr>
<td>Witnessed CA</td>
<td>1.04</td>
<td>0.48-2.24</td>
<td>0.93</td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>1.04</td>
<td>0.71-1.52</td>
<td>0.84</td>
</tr>
<tr>
<td>Initial shockable rhythm</td>
<td>2.83</td>
<td>1.84-4.36</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Resuscitation length &lt;20 min</td>
<td>1.08</td>
<td>0.72-1.61</td>
<td>0.71</td>
</tr>
<tr>
<td>Epinephrine &gt;2 mg</td>
<td>1.00</td>
<td>0.68-1.48</td>
<td>0.98</td>
</tr>
</tbody>
</table>
• Approximately 1/4 of patients without STE have an acute occlusion
• Nearly 60% will have significant obstructive lesions

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Angiographic Findings in Patients With Cardiac Arrest and No ST-Segment Elevation on ECG</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Author, Year (Ref. #)</td>
<td>Acute Occlusion</td>
</tr>
<tr>
<td>Merchant et al., 2008 (55)</td>
<td>6/17 (35)</td>
</tr>
<tr>
<td>Reynolds et al., 2009 (14)</td>
<td>–</td>
</tr>
<tr>
<td>Anyfantakis et al., 2009 (56)</td>
<td>–</td>
</tr>
<tr>
<td>Radsel et al., 2011 (31)</td>
<td>4/54 (7)</td>
</tr>
<tr>
<td>Bro-Jeppesen et al., 2012 (30)</td>
<td>–</td>
</tr>
<tr>
<td>Dumas et al., 2010 (3)</td>
<td>–</td>
</tr>
<tr>
<td>Hollenbeck et al., 2014 (25)</td>
<td>44/163 (27)</td>
</tr>
<tr>
<td>Kern et al., 2015 (52)</td>
<td>23</td>
</tr>
<tr>
<td>Total (%)</td>
<td>23</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.
Among the 407,974 patients hospitalized after VT/VF OHCA, 143,688 (35.2%) were selected to undergo CA

- CA increased from 27.2% in 2000 to 43.9% in 2012 (odds ratio, 2.47; 95%CI, 2.25-2.71; P for trend < .001)
- PCI increased from 9.5% in 2000 to 24.1% in 2012 (odds ratio, 4.80; 95%CI, 4.21-5.66; P for trend < .001).
- CA + PCI after VT/VF OHCA increased in patients with STE (53.7% to 87.2%, P for trend < .001, and 29.7% to 77.3%, P for trend < .001, respectively) or non STE (19.3% to 33.9%, P for trend < .001, and 3.5% to 11.8%, P for trend < .001).
- Survival to discharge increased in the overall population with VT/VF (46.9% to 60.1%, P for trend < .001) either STE (59.2% to 74.3%, P for trend < .001) or non STE (43.3% to 56.8%, P for trend < .001).

JAMA Cardiol. 2016 Nov 1;1(8):890-899
Clinical Reports of Combined TH and Coronary Angiography/PCI After OHCA

- Thirteen studies including 1563 patients
- Patients who received TH and emergent cardiac catheterization after resuscitation from OHCA but remained unconscious
- Overall survival was 54% with 88% of survivors having a favorable neurologic outcome

Kern KB JACC Cardiovascular Interventions 2012
Patients treated with early cardiac catheterization were more likely to survive hospital discharge with good CPC 60.7% vs. 44.5% (p<0.017)

Independently associated with a significant reduction in risk of death (OR 0.35, 95% CI 0.18--0.70, p=0.003)

Hollenbeck RD et al, Resuscitation 2014
Timing of Cardiac Catheterization

- Retrospective cohort of 240 patients with OHCA caused by VT/VF at 11 institutions in Seattle, Washington from 1999-2002
- Patients grouped into those receiving cath within 6 hrs. and those deferred >6 hrs.

Outcomes of cardiac arrest

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group ≤ 6 hours (n=61)</th>
<th>Group &gt; 6 hours or No Cath (n=179)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharged alive</td>
<td>44 (72%)</td>
<td>87 (49%)</td>
<td>0.001</td>
</tr>
<tr>
<td>Days hospitalized</td>
<td>9.1±6.0</td>
<td>9.8±21.7</td>
<td>0.81</td>
</tr>
<tr>
<td>Percutaneous coronary intervention</td>
<td>38 (62%)</td>
<td>13 (7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Awakened</td>
<td>40/60 (67%)</td>
<td>93/174 (53%)</td>
<td>0.08</td>
</tr>
<tr>
<td>Best neurologic status</td>
<td></td>
<td></td>
<td>0.30</td>
</tr>
<tr>
<td>Full recovery</td>
<td>18/43 (42%)</td>
<td>47/86 (55%)</td>
<td></td>
</tr>
<tr>
<td>Mild impairment</td>
<td>16/43 (37%)</td>
<td>19/86 (22%)</td>
<td></td>
</tr>
<tr>
<td>Severe impairment</td>
<td>4/43 (9%)</td>
<td>11/86 (13%)</td>
<td></td>
</tr>
<tr>
<td>Coma</td>
<td>5/43 (12%)</td>
<td>9/86 (10%)</td>
<td></td>
</tr>
</tbody>
</table>

Clinical outcomes of patients treated with early cardiac catheterization

<table>
<thead>
<tr>
<th>Variable</th>
<th>PCI (%) N=40</th>
<th>No PCI (%) N=82</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dead at hospital discharge</td>
<td>OR=0.72 (95% CI: 0.33, 1.56)</td>
<td>OR=0.85 (95% CI: 0.40, 1.82)</td>
<td></td>
</tr>
<tr>
<td>No (i.e. CPC 1-4)</td>
<td>24 (60.0)</td>
<td>56 (68.3)</td>
<td>0.388</td>
</tr>
<tr>
<td>Yes (i.e. CPC 5)</td>
<td>16 (40.0)</td>
<td>26 (31.7)</td>
<td></td>
</tr>
<tr>
<td>CPC at hospital discharge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good (i.e. CPC-2)</td>
<td>23 (57.5)</td>
<td>51 (62.2)</td>
<td>0.669</td>
</tr>
<tr>
<td>Bad (i.e. CPC-3)</td>
<td>17 (42.5)</td>
<td>31 (37.8)</td>
<td></td>
</tr>
<tr>
<td>CPC at hospital discharge</td>
<td></td>
<td></td>
<td>0.684</td>
</tr>
</tbody>
</table>

1Strote JA et al, Am J Cardiol 2012; 2Hollenbeck RD et al, Resuscitation 2014

Early cath: either immediately upon admission or during TH
Late cath: after TH or 24 hrs.
Coronary angiography should be performed emergently (rather than later in the hospital stay or not at all) for OHCA patients with suspected cardiac etiology of arrest and ST elevation on ECG. (Class I, LOE B-NR)

Emergency coronary angiography is reasonable for select (eg, electrically or hemodynamically unstable) adult patients who are comatose after OHCA of suspected cardiac origin but without ST elevation on ECG. (Class IIa, LOE B-NR)

Coronary angiography is reasonable in post–cardiac arrest patients where coronary angiography is indicated regardless of whether the patient is comatose or awake. (Class IIa, LOE C-LD)
Unfavorable for cath lab

- Ανακοπή απουσία μαρτύρων
- Αρχικός καρδιακός ρυθμός (περι- ή μετά) non-VF
- Χωρίς ΚΑΡΠΑ από τους παριστάμενους
- >30 min έως την ανάκτηση αυτόματης κυκλοφορίας
- >30 min διάρκειας ΚΑΡΠΑ
- Αποδεδειγμένα υποάρδευση που συνδέεται με καταπληξία και κατάρρευση της κυκλοφορίας:
  - pH <7.2 και γαλακτικό>7
- Ηλικία>85
- Νεφρική ανεπάρκεια τελικού σταδίου
- Εμφανή μη καρδιακά αίτια: φάρμακα, πνιγμός, οξύ ΑΕΕ, τραύμα , καρκίνος τελικού σταδίου
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

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

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
- 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

ACT = assessment, consultation, transport; CCL = cardiac catheterization laboratory; CPR = cardiopulmonary resuscitation; ECG = electrocardiography; LV = left ventricular; OHCA = out-of-hospital cardiac arrest; PCI = percutaneous coronary intervention; ROSC = return of spontaneous circulation; STEMI = ST-segment elevation myocardial infarction; TH = therapeutic hypothermia; TTM = targeted temperature management; VF = ventricular fibrillation.

Why angiography should be performed early?

- Neurologic testing is unreliable within first 24-48 hours
- Growing evidence
- Chest pain and ECG were poor predictors of acute coronary occlusion
- Successful immediate coronary angioplasty was associated with improved hospital survival in pts with or without ST segment elevation.
From our cath lab

- 75-year-old male, HTN, Current smoker
- Chest pain at home, CA at 6-8 min before ED arrival only gasping
- In ED: 6 min of ALS (CPR + Intubation + 3 mg Adrenaline IV + 3 defibrillations due to VF
- Initial ECG: rough VF → After ROSC: SR
  STE in V1-V5 with EF=30% anterior wall hypokinesia
- Patient with bilateral eye meiosis!
Emergency coronary angiography
Post-PCI Care

- Early post PCI the patient had seizures
- EF: 50% early post PCI
- The following 6 hours he developed fever, leykocytosis, ↑CRP, circulatory failure (oliguria, renal insufficiency)
- Symptom of … Post-Cardiac Arrest Syndrome
The earliest time to prognosticate a poor neurologic outcome using clinical examination in patients not treated with TTM is 72 hours after cardiac arrest (Class I, LOE B-NR).

– Can be even longer than 72 hours after cardiac arrest if the residual effect of sedation or paralysis confounds the clinical examination (Class IIa, LOE C-LD).

The earliest time for prognostication using clinical examination in patients treated with TTM, where sedation or paralysis could be a confounder, may be 72 hours after return to normothermia (Class IIb, LOE C-EO).
If conscious, assess and manage them as a patient presenting with the same history but without cardiac arrest.

If unconscious, consider whether there is an obvious extracardiac cause for their presentation and if so investigate and manage that.

If no extracardiac cause is apparent, look for ST elevation or new LBBB and if present prioritise early coronary angiography in most cases ahead of other investigations.

If there is no ST elevation, discuss the merits of early coronary angiography

- Factors that guide our decision:
  - initial rhythm,
  - resuscitation time, bystander CPR
  - risk factors for coronary artery disease and history.
ΕΥΧΑΡΙΣΤΩ ΓΙΑ ΤΗΝ ΠΡΟΣΟΧΗ ΣΑΣ!

Ποια είναι η εμπειρία σας στην επεμβατική αντιμετώπιση ασθενών με εξωνοσοκομειακή ΚΑ;