Quelle réanimation pour l'arrêt cardiaque supposé d'origine coronaire?

Alain Cariou
Intensive Care Unit – Cochin University Hospital
Paris Descartes University – INSERM U970 (France)
Presenter Disclosure Information

- Alain Cariou
- RESUVAL 2015
- Quelle réanimation pour l'arrêt cardiaque supposé d'origine coronaire?

FINANCIAL DISCLOSURE:
Edwards LifeSciences (honoraria)
Bard France (honoraria)
Pulsion France (honoraria)

UNLABELED/UNAPPROVED USES DISCLOSURE: none
Outcome of sudden cardiac arrest (SCA) victims

Sudden cardiac death

- 60% CPR

15-20% ROSC...

...and ICU admission

- 5-8% survivors
- 5-6% no or minor sequel

Post-resuscitation:
  - Post-cardiac arrest shock
  - Brain damages
  - Cardiovascular diseases

Long-term
Trends in Short- and Long-Term Survival Among OHCA Patients Alive at Hospital Arrival

Wong MKY et al. Circulation 2014
ICU mortality after cardiac arrest: the relative contribution of shock and brain injury in a large cohort

Lemiale V, Dumas F, Mongardon N, Giovanetti O, Charpentier J, Chiche JD, Carli P, Mira JP, Nolan JP, Cariou A
Intensive Care Med 2013

![Graph showing delays between ICU admission and death (days)]

- n=768
- n=499
- n=269
**Post-cardiac arrest disease**
**ILCOR Consensus Statement**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate</td>
<td>ROSC 20 min</td>
</tr>
<tr>
<td>Early</td>
<td>6-12 hours</td>
</tr>
<tr>
<td>Intermediate</td>
<td>72 hours</td>
</tr>
<tr>
<td>Recovery</td>
<td>Discharge</td>
</tr>
<tr>
<td>Rehabilitation</td>
<td></td>
</tr>
</tbody>
</table>

- **Treatment targets**
  - Persistent precipitating pathology
  - Systemic ischemia-reperfusion
  - Myocardial dysfunction / shock
  - Post-anoxic brain injury
Immediate post cardiac arrest treatment

- Use ABCDE approach
- Controlled oxygenation and ventilation
- 12-lead ECG
- Treat precipitating cause
- Temperature control / Therapeutic hypothermia
Immediate coronary angiography in survivors of out-of-hospital cardiac arrest

<table>
<thead>
<tr>
<th>Variables</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVEF – %</td>
<td>33.9 ± 10.5</td>
</tr>
<tr>
<td>LV end diastolic pressure – mmHg</td>
<td>25.3 ± 9.5</td>
</tr>
<tr>
<td>Normal coronary arteries – no. (%)</td>
<td>17 (20)</td>
</tr>
<tr>
<td>Clinically insignificant CAD – no. (%)</td>
<td>7 (8)</td>
</tr>
<tr>
<td>Clinically significant CAD – no. (%)</td>
<td>60 (71)</td>
</tr>
<tr>
<td>Recent coronary occlusion – no. (%)</td>
<td>40 (48)</td>
</tr>
</tbody>
</table>

- Hospital survival rate: 38%
- Successful PTCA is protective (OR: 5.2, CI 1.1-24.5; p=0.04)
Mild therapeutic hypothermia in patients after out-of-hospital cardiac arrest due to acute ST-segment elevation myocardial infarction undergoing immediate percutaneous coronary intervention

Sebastian Wolfrum, MD; Christian Pierau; Peter W. Radke, MD; Heribert Schunkert, MD; Volkhard Kurowski, MD

Acute Ischemic Heart Disease

Acute coronary angiographic findings in survivors of out-of-hospital cardiac arrest

Zacharias Alexandros Anyfantakis, MD, a, b, c Gabriel Baron, MSc, d Pierre Aubry, MD, e Dominique Himbert, MD, e Laurent J. Feldman, MD, PhD, a Jean-Michel Juliard, MD, a Agnès Ricard-Hibon, MD, d Alexis Burnod, MD, e Dennis V. Cokkinos, MD, f and Philippe Gabriel Steg, MD f Paris and Clichy, France; and Athens, Greece

Six-Month Outcome of Emergency Percutaneous Coronary Intervention in Resuscitated Patients After Cardiac Arrest Complicating ST-Elevation Myocardial Infarction

Philippe Garot, MD; Thierry Lefevre, MD; Hélène Eltchaninoff, MD, PhD; Marie-Claude Morice, MD; Fabienne Tamion, MD; Bernard Aby, MD; Pierre-François Lesault, MD; Jean-Yves Le Tarnec, MD; Claude Pouges, MD; Alain Margenet, MD; Mehran Monchi, MD; Ivan Laurent, MD; Pierre Dumas, MD; Jérôme Garot, MD, PhD; Yves Louvard, MD


Corrado Lettieri, MD, a Stefano Savonitto, MD, b Stefano De Servi, MD, c Giulio Guaglioni, MD, d Guido Belli, MD, c Alessandra Repetto, MD, c Emanuela Piccaluga, MD, c Alessandro Politi, MD, c Federica Ettori, MD, d Battistina Castiglioni, MD, d Franco Fabbiocchi, MD, d Nicoletta De Cesare, MD, d Giuseppe Sanguinetti, MD, d Giuseppe Musumeci, MD, d Marco Onofri, MD, a Maurizio D’Urbano, MD, d Salvatore Pirelli, MD, d Roberto Zanini, MD, d and Silvio Klugmann, MD, d on behalf of the LombardiMA Study Group Mantova, Milano.
Should We Perform an Immediate Coronary Angiogram in All Survivors of OHCA With No Obvious Extra-Cardiac Cause? Insights from the PROCAT registry

Multivariate analysis of early predictors of survival in OHCA pts without obvious extra-cardiac etiology

- BLS to ROSC > 15 minutes: OR 0.28, 95% CI (0.19-0.55), p < 0.001
- Collapse to BLS > 5 minutes: OR 0.32, 95% CI (0.17-0.49), p <0.001
- Diabete mellitus: OR 0.42, 95% CI (0.20-0.84), p = 0.015
- Age > 59 yrs: OR 0.45, 95% CI (0.27-0.75), p = 0.002
- Blood lactate: OR 0.55, 95% CI (0.44-0.70), p < 0.001
- ST segment elevation: OR 1.09, 95% CI (0.60-1.98), p = 0.778
- Initial Arrest Rhythm: VT/VF: OR 1.82, 95% CI (1.04-3.19), p = 0.035
- Successful PCI: OR 2.06, 95% CI (1.16-3.66), p = 0.013

Dumas F, Cariou A, Spaulding C. Circulation Cardiovasc Interv 2010
Immediate percutaneous coronary intervention is associated with improved short and long-term outcome after out-of-hospital cardiac arrest

Should We Perform an Immediate Coronary Angiogram in All Survivors of OHCA With No Obvious Extra-Cardiac Cause? Insights from the PROCAT registry

Multivariate analysis of early predictors of survival in OHCA pts without obvious extra-cardiac etiology

```markdown
<table>
<thead>
<tr>
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<th>OR</th>
<th>[95% Conf.Interval]</th>
<th>p-value</th>
</tr>
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<tr>
<td>BLS to ROSC &gt; 15 minutes</td>
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```

Dumas F, Cariou A, Spaulding C. Circulation Cardiovasc Interv 2010

Attempted in nearly 50% of patients
Can we improve the selection of the best candidates for an early reperfusion strategy?

- ECG?
- Echocardiography?
- Biomarkers?
Is later PCI equivalent to immediate PCI?

Postresuscitation ECG

**STEMI**
- Absence of significant comorbidities and unfavorable cardiac arrest setting
  - STEMI fast track
    - Immediate coronary angiography

**No STEMI**
- Absence of obvious non-coronary cause, significant comorbidities, unfavorable cardiac arrest setting
  - ER stop for fast diagnostic work up
    - Additional history
    - Echocardiography
    - CT scan head/torax
    - Laboratory values
  - Cardiac intensive care unit

Should we perform a coronary angiography to all cardiac arrest survivors?

Geri G, Dumas F, Cariou A. Current Opinion Crit Care 2014

Early troponine sensitivity (%) for prediction of PCI requirement

<table>
<thead>
<tr>
<th>Year</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grub, 1996</td>
<td>88</td>
</tr>
<tr>
<td>Voicu, 2012</td>
<td>72</td>
</tr>
<tr>
<td>Dumas, 2012</td>
<td>67</td>
</tr>
<tr>
<td>Geri, 2013</td>
<td>36</td>
</tr>
</tbody>
</table>
Comparison of Role of Early (Less Than Six Hours) to Later (More Than Six Hours) or No Cardiac Catheterization After Resuscitation From Out-of-Hospital Cardiac Arrest

Justin A. Strote, MD\textsuperscript{a}, Charles Maynard, PhD\textsuperscript{b}, Michele Olsufka, RN\textsuperscript{a}, Graham Nichol, MD\textsuperscript{a}, Michael K. Copass, MD\textsuperscript{a}, Leonard A. Cobb, MD\textsuperscript{a}, and Francis Kim, MD\textsuperscript{a,*}


![Bar chart showing the comparison of discharges alive between early PCI and delayed or no PCI. The p-value is 0.001.](image-url)
Mrs C, 44y

- No past medical history
- Cardiac arrest during sport activity 1 hour ago
- Prodrome: headache

Post-ROSC:
- ECG: negative T-waves V3-V6
- Pupillary reactivity: none

- If early imaging, which one?

“I think you should have perform a CT-scan, don’t you?”
Objective:

While sudden cardiac death has been broadly studied, little is known on cerebrovascular events revealed by out-of-hospital cardiac arrest (OHCA). We aimed to describe clinical features and prognosis of these patients, and to identify characteristics that could suggest a cerebrovascular aetiology of the OHCA.

Methods:

Retrospective review (1999-2012) of databases of three ICUs. Patients admitted for management of successfully resuscitated OHCA were considered if subarachnoid haemorrhage, intracranial haemorrhage, ischemic stroke, sub/epidural hematoma, cerebral thrombophlebitis was the primary cause of OHCA, excluding traumatic or infectious causes. Included patients were compared with a group of OHCA of non-neurological origin.
Sudden death from brain cause: clinical features and outcome in a multicenter cohort
Arnaout M, Mongardon N, Deye N, Legriel S, Dumas F, Sauneuf B, Charpentier J, Pène F, Baud F, Chiche JD, Mira JP, Cariou A
Crit Care Med 2015
Sudden death from brain cause: clinical features and outcome in a multicenter cohort
Arnaout M, Mongardon N, Deye N, Legriel S, Dumas F, Sauneuf B, Charpentier J, Pène F, Baud F, Chiche JD, Mira JP, Cariou A
Crit Care Med 2015
Benefit of an early and systematic imaging procedure after cardiac arrest: insights from the PROCAT (Parisian Region Out of Hospital Cardiac Arrest) registry.

J CHELLY, N MONGARDON, F DUMAS, O VARENNE, C SPAULDING, O VIGNAUX, P CARLI, J CHARPENTIER, F PENE, JD CHICHE, JP MIRA, A CARIOU

Resuscitation 2009

**OHCA with ROSC**

- **Obvious cause?**
  - Yes
  - **(trauma, bleeding, sepsis..)**
  - **ICU admission**
  - **No**
  - **Prodromes?**
    - Absent or cardiac
      - **Coronary angiography**
      - **If negative**
        - **CT-scan**
      - **ICU admission**
    - Neurologic or respiratory
      - **CT-scan**
      - **ICU admission**
Benefit of an early and systematic imaging procedure after cardiac arrest: insights from the PROCAT (Parisian Region Out of Hospital Cardiac Arrest) registry

J CHELLY, N MONGARDON, F DUMAS, O VARENNE, C SPAULDING, O VIGNAUX, P CARLI, J CHARPENTIER, F PENE, JD CHICHE, JP MIRA, A CARIOU

Resuscitation 2009
Post-cardiac arrest disease
ILCOR Consensus Statement

Phase

ROSC
20 min
Immediate
Early
Intermediate
6-12 hours
Recovery
72 hours
Rehabilitation
Discharge

Persistent precipitating pathology
Myocardial dysfunction / shock
Systemic ischemia-reperfusion
Post-anoxic brain injury

Treatment targets
Reversible Myocardial Dysfunction in Survivors of Out-of-Hospital Cardiac Arrest
J Am Coll Cardiol 2002
Post-CA myocardial dysfunction

- Coronary occlusion
- Defibrillation
- Ischemia-reperfusion
- Drug toxicity (epinephrine?)
- SIRS
Reversible Myocardial Dysfunction in Survivors of Out-of-Hospital Cardiac Arrest
J Am Coll Cardiol 2002

Laurent et al. JACC. 2002;40:2110-6
High-Volume Hemofiltration after Out-of-Hospital Cardiac Arrest. A randomized study.
J Am Coll Cardiol 2005

Six-month survival:
- Controls 21%
- HF alone 42% $p=0.28$
- HF + HT 32%

Death by intractable shock (IS):
- Controls 42%
- HF alone 10% $p=0.009$
- HF + HT 14%

Relative risk of death by IS:
- HF alone 0.21 (95% CI 0.5-0.85)
- HF + HT 0.29 (95% CI 0.09-0.91)

Multivariate analysis:
- HF and six-month death: OR 0.21 (95% CI 0.5-0.85)
- HF and death by IS: OR 0.29 (95% CI 0.09-0.91)
## Percutaneous Circulatory Support

<table>
<thead>
<tr>
<th></th>
<th>IABP</th>
<th>TandemHeart</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pump mechanism</strong></td>
<td>Pneumatic</td>
<td>Centrifugal</td>
</tr>
<tr>
<td><strong>Insertion</strong></td>
<td>Retrograde 7–9F balloon catheter into the descending aorta via the femoral artery</td>
<td>21F inflow cannula inserted into the left atrium via the descending aorta, 15–22F outflow cannula inserted into the femoral vein via the femoral artery</td>
</tr>
<tr>
<td><strong>Difficulty of insertion</strong></td>
<td>++</td>
<td>++++ (Increased CO by 2.5 L/min)</td>
</tr>
<tr>
<td><strong>Degree of circulatory support (with ideal SVR)</strong></td>
<td>++</td>
<td>+++++ (Increased CO to ≥4.5 L/min)</td>
</tr>
<tr>
<td><strong>Implantation time, min</strong></td>
<td>8</td>
<td>11–25</td>
</tr>
<tr>
<td><strong>Limb ischemia</strong></td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td><strong>Hemolysis</strong></td>
<td>+++</td>
<td>+++++</td>
</tr>
<tr>
<td><strong>Bleeding risk</strong></td>
<td>++</td>
<td>++++++</td>
</tr>
<tr>
<td><strong>510k Approval date</strong></td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Evidence of efficacy</strong></td>
<td>Increased CO and coronary and peripheral perfusion; deceased afterload</td>
<td>Increased CO, MAP, MvO₂, and urine output; decreased lactic acid and creatinine, and PCWP</td>
</tr>
</tbody>
</table>

**SVR** indicates systemic vascular resistance; **CO**, cardiac output; **MAP**, mean arterial pressure; **MVO₂**, mixed venous oxygen saturation; and **PCWP**, pulmonary capillary wedge pressure.

Bridges to neurological evaluation
Advanced Life Support

Unresponsive?
Not breathing or only occasional gasps

Call Resuscitation Team

CPR 30:2
Attach defibrillator/monitor

IMMEDIATE POST CARDIAC ARREST TREATMENT

- Use ABCDE approach
- Controlled oxygenation and ventilation
- 12-lead ECG
- Treat precipitating cause
- Temperature control / Therapeutic hypothermia

Core cooling methods

Surface cooling method
- Precooled surface cooling pad
- Water circulating surface cooling pad

Cold intravenous fluids

Catheter-based endovascular device inserted in the femoral vein
WHAT LEVEL?

33° C: the dogma
Targeted temperature management in critical care: A report and recommendations from five professional societies*

**Induction phase.**
Typically, cooling as fast as possible, $3^\circ$C/hr

**Maintenance phase.**
Control to within 0.5 °C

**Reversion phase.**
Managed recovery to target level, typically normal or just below normal, warming rates typically 0.3 °C/hr
WHAT LEVEL?

33°C: the dogma

36°C: the future?
Targeted Temperature Management at 33°C versus 36°C after Cardiac Arrest

Nielsen N. NEJM 2013
Adverse events and their relation to mortality in out-of-hospital cardiac arrest patients treated with therapeutic hypothermia

Niklas Nielsen, MD, PhD; Kjetil Sunde, MD, PhD; Jan Hovdenes, MD, PhD; Richard R. Riker, MD; Sten Rubertsson, MD, PhD; Pascal Stammet, MD; Fredrik Nilsson, PhD; Hans Friberg, MD, PhD; the Hypothermia Network
Spectre des anomalies de la conscience après arrêt cardiaque

Eveil (Niveau de conscience)

Arrêt cardiaque

Conscience normale

Coma

EV persistant

Mort cérébrale

Conscience normale

ECM

ECM permanent

Séquelles graves

Prognostication in comatose survivors of cardiac arrest: An Advisory Statement from the European Resuscitation Council and the European Society of Intensive Care Medicine
Claudio Sandroni, Alain Cariou, Fabio Cavallaro, Tobias Cronberg, Hans Friberg, Cornelia Hoedemaekers, Janneke Horn, Jerry P. Nolan, Andrea O. Rossetti and Jasmeet Soar
Intensive Care Med 2014

Aims was to:

- Update and summarize the available evidence on this topic, including that on TH-treated patients;
- Provide practical recommendations on the most reliable prognostication strategies, based on a more robust analysis of the evidence, in anticipation of the next ERC Guidelines on Resuscitation to be published in October 2015;
- Identify knowledge gaps and suggest directions for future research
Cardiac arrest

Controlled temperature

Rewarming

Exclude confounders, particularly residual sedation

Unconscious patient, M=1-2 at ≥72h after ROSC

- One or both of the following:
  - No pupillary and corneal reflexes
  - Bilaterally absent N20 SSEP wave (1)

- Wait at least 24h

Two or more of the following:
- Status myoclonus ≤48h after ROSC
- High NSE levels (2)
- Unreactive burst-suppression or status epilepticus on EEG
- Diffuse anoxic injury on brain CT/MRI (2)

Indeterminate outcome
Observe and re-evaluate

Use multimodal prognostication whenever possible

Poor outcome very likely (FPR <5%, narrow 95% CIs)

Poor outcome likely

(1) At ≥24h after ROSC in patients not treated with targeted temperature
(2) See text for details.
Immediate care

Comatose survivor
- Prehospital hypothermia
- Transport to CA specialized center
- Avoid early prognostication

First 24 hours

- Early goal directed therapy
- Maintenance blood pressure
- Avoid secondary brain insults
- TTE – Assess cardiac damage
- Guide choice of inotropes if required

- Maintenance hypothermia 32-34°C for 24 hours
- Controlled oxygenation (O2 saturation 94-96%)
- Discuss mechanical assistance

Further care

- Prognostication after 72 hours
  - Clinical – SSEP – EEG - Biomarkers

Follow Up
- Assessment for ICD Rehabilitation

Strub et al. Circulation 2011
Post Cardiac Arrest Team

- Rapid Emergency Service
- Brain Preservation with Hypothermia
- Cardiology
- Critical Care
- Rehabilitation
- Feedback and System Improvement
An evaluation of post-resuscitation care as a possible explanation of a difference in survival after out-of-hospital cardiac arrest

J. Hollenberg, J. Lindqvist, M. Ringh, J. Engdahl, K. Bohm, M. Rosenqvist, L. Svensson


Is hospital care of major importance for outcome after out-of-hospital cardiac arrest?
Experience acquired from patients with out-of-hospital cardiac arrest resuscitated by the same Emergency Medical Service and admitted to one of two hospitals over a 16-year period in the municipality of Göteborg

Johan Engdahl, Putte Abrahamsson, Angela Bång, Jonny Lindqvist, Thomas Karlsson, Johan Herlitz

Resuscitation 43 (2000) 201–211

Implementation of a standardised treatment protocol for post resuscitation care after out-of-hospital cardiac arrest

Kjetil Sunde, Morten Pytte, Dag Jacobsen, Arild Mangschau, Lars Petter Jensen, Christian Smedsrud, Tomas Draegni, Petter Andreas Steen


Treatment and outcome in post-resuscitation care after out-of-hospital cardiac arrest when a modern therapeutic approach was introduced

M. Werling, A.-B. Thorén, C. Axelsson, J. Herlitz

Resuscitation (2007) 73, 40–45
Finally, optimization of post–cardiac arrest care will require the commitment of hospital providers to develop and implement comprehensive multidisciplinary treatment protocols that can be executed 24 hours a day, 7 days a week.

Optimized post–cardiac arrest care is resource intensive and not feasible in every hospital that receives EMS patients.

A solution proposed by the AHA is the development and certification of specialized cardiac resuscitation centers.
In adult patients with ROSC after cardiac arrest (out-of-hospital or in-hospital), does the use of comprehensive treatment protocol, as opposed to standard care, improve outcome (eg, survival)?

**Treatment Recommendation**

- A comprehensive treatment protocol that includes multiple interventions provided in a structured way may improve survival after cardiac arrest.

**Knowledge Gaps**

- Studies are needed to determine whether a comprehensive treatment protocol after cardiac arrest with a sustained ROSC improves short- and long-term outcomes. Future studies should define what interventions other than hypo-thermia are important inclusions in an effective comprehensive treatment protocol.
« Cardiac arrest center » : les clés du succès ?

Des outils solides…

Une organisation sans faille…
Centre d’expertise mort subite (CEMS)

Université Paris Descartes
INSERM

Prise en charge médicale

SAMU BSPP

Réanimation

USIC

rythmologie

Suivi médical, prévention
Consultation mort subite du sportif
Consultation spécialisée famille + Hôpital de jour
Suivi des survivants

Expertise
-sociologie
-éthique
-psychologie

-évaluation
-aspect médico-économique

Aspect médico-légal

Enseignement
Formation des formateurs avec gestes qui sauvent (STAPS), personnel APHP

Recherche
-chaire mort subite
-Fondation Paris Descartes
-Site Web

Formation des médecins, des kinés, des pharmaciens

Recherche U970 INSERM
-épidémiologie
-génétique
-physiologie

Consultation mort subite du sportif
Suivi médical, prévention
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Formation des médecins, des kinés, des pharmaciens
Recherche U970 INSERM
-épidémiologie
-génétique
-physiologie
SDEC Registry
From 15th May 2011 to 15th May 2013

7 201 out-of-hospital cardiac arrest

1 048 extra-cardiac etiology

6 153 presumed cardiac etiology (100 %)

2 341 non resuscitated

3 812 with resuscitation attempted (62 %)
