Εξειδικευμένη ΚαρδιοΠνευμονική Αναζωογόνηση στο Αιμοδυναμικό Εργαστήριο

Ιωάννης Καλλικάζαρος
cardiac arrest

sudden stop
of circulation
and breathing
with final result
the inadequate oxygenated blood supply
to vital organs

4 minutes brain damage
10 minutes brain death
Closed Chest Cardiac Massage
Kouwenhoven WB, JAMA, 1960
cardiac arrest

1. **fatal 100%**
   (if do nothing, wait, etc)

2. **not that rare**
   (in one’s lifetime)

3. **manageable**
   (ERC ALS/BLS ie Evidence Based Medicine)
- **cath/PCI causes in-lab arrest**
- **arrest needs cath/PCI**
arrest & cathlab

- cath/PCI causes in-lab arrest
- arrest needs cath/PCI
**cathlab arrest**

**statistics**

- Death during PCI → ~0.1%
- Arrest during PCI → unknown
- ACS pts during PCI → increased % of arrest
- STEMI pts during PCI → ~4-5% VF/VT
- Shock pts → 6x

- Arrest (VF/VT) can even happen during a “normal artery cath”
1. special causes
2. immediate recognition (ie monitored arrest)
3. limited space & radiation hazard
4. no time for “expert opinion”
5. most pts come walking and want to leave walking
cathlab arrest
special causes

- **acute ischemia** (because of bad luck!)
  - wire/ catheter irritation (LV/RV)
  - catheter tip damping
  - balloon/ stent inflation
  - contrast
  - cold NS injection

- **acute ischemia** (as a complication)
  - air embolism
  - dissection
  - rupture
  - thrombotic occlusion etc

- **vaso-vagal**
  bradycardia/hypotension
  - fear/ pain
  - Bezold-Jarisch reflex

- **allergic reaction**
  - contrast

- **hemorrhage**
  - massive, femoral puncture site

Latsios G, ...Hellenic J Cardiol. 2017 Dec 5. pii: S1109-9666(17)30517-1
cathlab arrest

witnessed arrest

many monitors that show
many eyes that see
many hands that act
cathlab arrest

witnessed arrest

many monitors that show
many eyes that see
many hands that act
cathlab arrest

witnessed arrest

many monitors that show
many eyes that see
many hands that act

organized
skilled
educated
All medical and paramedical personnel caring for a patient with suspected myocardial infarction must have access to defibrillation equipment and be trained in cardiac life support.
cathlab arrest

space & radiation
# Automated Chest Compressions Machines

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Compressions per Minute</th>
<th>Chest Width</th>
<th>Price Range (System Only)</th>
<th>Device Type</th>
<th>Additional Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan Instruments Inc.</td>
<td>Life-Stat Model 1008</td>
<td>100</td>
<td>Up to 22”</td>
<td>$7,500 - $8,500</td>
<td>Piston</td>
<td>Comes with built-in ventilator</td>
</tr>
<tr>
<td>Physio-Control</td>
<td>LUCAS 2</td>
<td>100</td>
<td>Up to 18”</td>
<td>$12,755 - $12,610</td>
<td>Piston</td>
<td>Offers radiotranslucent backplate (PCI backplate)</td>
</tr>
<tr>
<td>Resuscitation International</td>
<td>Weil™ Mini Chest</td>
<td>100</td>
<td>Up to 15”</td>
<td></td>
<td>Piston</td>
<td>Requires Consumables ($600/each)</td>
</tr>
<tr>
<td>Zoll Medical</td>
<td>AutoPulse</td>
<td>80</td>
<td>Up to 15”</td>
<td>$10,665</td>
<td>Load-Distributing</td>
<td></td>
</tr>
</tbody>
</table>
to support patients undergoing PCI and CT scans and also for prolonged resuscitation (Class IIa)

allow defibrillation without interruption

use by properly trained personnel .. (Class IIb)
Use of an automated chest compression device during cardiopulmonary resuscitation in our cathlab - N. Koufakis

SBP during CPR in femoral ~100 mmHg
arrest & cathlab

- cath/PCI causes in-lab arrest
- arrest needs cath/PCI
Immediate angiography with a view to primary PCI is recommended in patients with resuscitated cardiac arrest whose ECG shows STEMI.


Immediate angiography with a view to primary PCI should be considered in survivors of cardiac arrest without diagnostic ECG ST-segment elevation but with a high suspicion of ongoing infarction.


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.)
Comparison of Role of Early (<6 Hours) to Later (>6 Hours) or No Cardiac Catheterization Following Resuscitation From Out-of-hospital Cardiac Arrest

240 patients with out-of-hospital 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>Awaken</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>Comatose</td>
<td>5/43 (12%)</td>
<td>9/86 (10%)</td>
<td></td>
</tr>
</tbody>
</table>

Danish Cardiac Arrest Registry

<table>
<thead>
<tr>
<th>Covariates included in the analyses</th>
<th>No.</th>
<th>Univariable analysis HR (95% CI)</th>
<th>P-value</th>
<th>Multivariable analysis HR (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male gender</td>
<td>41 186</td>
<td>0.92 (0.91–0.94)</td>
<td>&lt;0.001</td>
<td>0.99 (0.97–1.01)</td>
<td>0.46</td>
</tr>
<tr>
<td>Age, per 10 year increase</td>
<td>41 186</td>
<td>1.06 (1.05–1.06)</td>
<td>&lt;0.001</td>
<td>1.04 (1.03–1.05)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bystander CPR</td>
<td>37 039</td>
<td>0.87 (0.85–0.89)</td>
<td>&lt;0.001</td>
<td>0.97 (0.95–0.99)</td>
<td>0.005</td>
</tr>
<tr>
<td>Non-shockable heart rhythm</td>
<td>37 517</td>
<td>1.68 (1.63–1.72)</td>
<td>&lt;0.001</td>
<td>1.48 (1.43–1.52)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Witnessed OHCA</td>
<td>37 322</td>
<td>0.79 (0.78–0.81)</td>
<td>&lt;0.001</td>
<td>0.87 (0.85–0.89)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Comorbidity index ≥1 (0 reference)</td>
<td>41 186</td>
<td>1.14 (1.12–1.16)</td>
<td>&lt;0.001</td>
<td>1.08 (1.06–1.11)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Admission to invasive centre (reference: local hospital)</td>
<td>25 364</td>
<td>0.78 (0.76–0.81)</td>
<td>&lt;0.001</td>
<td>0.91 (0.89–0.93)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Acute CAG/PCI per region and year (index)</td>
<td>41 186</td>
<td>0.33 (0.25–0.42)</td>
<td>&lt;0.001</td>
<td>0.33 (0.25–0.45)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Population density per zip code per km²

<table>
<thead>
<tr>
<th>Reference</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–100</td>
<td>0.98 (0.95–1.01)</td>
</tr>
<tr>
<td>100–300</td>
<td>0.98 (0.95–1.00)</td>
</tr>
<tr>
<td>300–2000</td>
<td>0.95 (0.92–0.97)</td>
</tr>
</tbody>
</table>

Distance to invasive centre, kilometres

<table>
<thead>
<tr>
<th>Reference</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–5 (n = 5414)</td>
<td>0.93 (0.89–0.96)</td>
</tr>
<tr>
<td>5–10 (n = 5749)</td>
<td>0.97 (0.94–1.01)</td>
</tr>
<tr>
<td>10–20 (n = 4779)</td>
<td>0.98 (0.94–1.02)</td>
</tr>
<tr>
<td>20–50 (n = 8513)</td>
<td>0.99 (0.96–1.03)</td>
</tr>
<tr>
<td>50–100 (n = 10315)</td>
<td>1.01 (0.98–1.05)</td>
</tr>
<tr>
<td>100–210 (n = 6416)</td>
<td>Reference</td>
</tr>
</tbody>
</table>

Trannberg T et al. European Heart Journal 2017; 38, 1645–1652
But we should make sure that the nonSTEMI arrested patient wakes up or does not have severe neurological damage before we proceed to the cath lab!!!
Prognosis Assessment

- Reliable **prognostic factors** not established until after post-arrest **day three**
  - Wijdicks Neurology 2006

- **Observe >72h** after ROSC before predicting poor outcome
  - ERC & AHA guidelines on CPR 2010
arrested without ROSC

“refractory” VF arrest
dead
ExtraCorporeal Membrane Oxygenation

1. Dark venous blood drains out of patient (femoral vein)
2. Centrifugal pump circulates blood
3. Artificial lung membrane oxygenates blood, removes CO2
4. Bright red oxygenated blood pumped back into patient (femoral artery)
Why is this important?

four studies suggest improved neurologically intact survival if **ECPR performed during cardiac arrest**

- **“CHEER Trial”** in Australia—26 ECPR patients,
  - 50% *neuro-intact* survival

- Morimura et al in Japan—139 ECPR patients
  - 51% *neuro-intact* survival

- **“Save-J Study”** in Japan—454 ECPR cases
  - 52% *neurologically favorable* survival

- Minnesota Resus Consortium — 68 ECPR patients
  - 55% *neurologically favorable* survival
There is **insufficient evidence** to recommend the routine use of ECPR for patients with cardiac arrest.

In settings where it can be **rapidly implemented**, ECPR may be considered **for select patients** for whom the suspected etiology of the cardiac arrest is potentially **reversible** during a **limited period of mechanical cardiorespiratory support** (class IIb, LOE C).
resuscitated VF pts have ACSs
refractory VF pts have “more” ACS (ie CHD)

to save the “refractory” VF patients that are pronounced dead in the field or the ED is to bring them to the cathlab with on-going CPR and cath/PCI/resuscitate them in the CCL.
Minnesota Resuscitation Consortium’s Advanced Perfusion and Reperfusion Cardiac Life Support Strategy for Out-of-Hospital Refractory Ventricular Fibrillation

Patient (age 18-75) with on-going CPR with refractory VF/VT that met the criteria entered the CCL (All patients with LUCAS+ITD)

- Arterial and venous access under ultrasound during CPR
- Collect arterial blood gas with lactate
- Angiogram of the left and right iliac and femoral arteries
  1. Can a 17-19 Fr ECMO arterial cannula (~5.5-6.0 mm diameter) fit in the groin?
  2. Was the patient placed on the CCL table within ~ 60 min after the 911 call?

Inclusion Criteria (must have 2 of 3)
- ETCO2 at arrival > 10 mm Hg
- PaO2 > 50 mmHg or O2 Sat > 85%
- Lactate < 18

Is a reversible cause identified?

- Place AV ECMO with 25FR venous and 17-19 arterial cannulas and integrate flow
- Cannulate
- Angiography
- IABP placement if cardiac function

Continue ECMO/ACLS for 60 min if return of cardiac function has not been achieved

If return of spontaneous cardiac function is achieved then admit to CICU
If not, pronounce death.

Hospital Discharge
Survived: 10/18 (53%)
Survived with CPC 1 or 2: 9/18 (50%)

1-Month Outcome
Survival: 10/18 (53%)
Survival with CPC 1 or 2: 9/18 (50%)

Successful primary PCI during prolonged continuous cardiopulmonary resuscitation with an automated chest compression device (AutoPulse)

George Latsios, Alexios Antonopoulous, Nikos Vogiatzakis, Eleni Melidi, Nikos Koufakis, Kostas Toutouzas, Dimitris Tousoulis.
conclusions

- **cath/PCI causes in-lab arrest**: the best place for an arrest to happen

- **arrest needs cath/PCI**: the best place to bring a cardiac arrested pt

- **BLS/ALS trained people resuscitate pts**
Advanced cardiopulmonary resuscitation (CPR) in the Catheterization Laboratory

Consensus document of the Working Groups of 1) Cardiopulmonary Resuscitation/Acute Cardiac Care and 2) Hemodynamic and Interventional Cardiology, Hellenic Cardiological Society

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