What next for cardiac arrest research?

Gavin Perkins
Conflict of interest
Outline

• Looking in to the future
  – Chain of Survival
  – Personalised medicine
  – Brain rescue therapy
  – Emergency care and Resuscitation decisions
Chain of survival

- Early recognition and call for help
  - to prevent cardiac arrest
- Early CPR
  - to buy time
- Early Defibrillation
  - to restart the heart
- Post resuscitation care
  - to restore quality of life

Impact
Cardiac arrest detection through artificial intelligence-based surveillance camera: A working prototype

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Vita-Salute San Raffaele University, Milan, Italy

Introduction: Treatment of out-of-hospital cardiac arrest (OHCA) requires prompt intervention. Brief response time is associated with greater survival. OHCA victims suddenly collapse, falling on their backs or face down while remaining unresponsive. When OHCA occurs in remote or uncrowded places, such as parking lots during off-peak hours, EMS activation, CPR and PAD use is delayed. Surveillance cameras with artificial intelligence (AI) and machine learning functions are becoming widespread. This abstract describes how cardiac arrest can be detected using surveillance cameras with AI.

Methods: Video analysis can be carried out using various methods. This prototype is implemented in Python using the OpenCV library. After converting the video into frames, the detection algorithm undergoes four steps: Background estimation, moving-object extraction, contour formation, and cardiac-arrest detection. Detection is achieved by quantifying body motion and orientation. If the victim was standing in the last frame and in the current frame is lying, sudden collapse is likely. A cardiac-arrest alert is triggered when a threshold time interval without motion elapses.
Fire Department Munich

FW-M: Smartwatch reports fall of 80-year-olds (Haidhausen)

Munich (ots)

Sunday, April 14, 2019, 19:54; Braystraße

Last night, an 80-year-old woman fell into her apartment and, thanks to her watch, unconsciously dropped off a necessary emergency call. Her watch was equipped with a fall detection system and alerted the emergency services after the fall.
Passive Detection of Atrial Fibrillation Using a Commercially Available Smartwatch

Geoffrey H. Tison, MD, MPH; José M. Sanchez, MD; Brandon Ballinger, BS; Avesh Singh, MS; Jeffrey E. Olgin, MD; Mark J. Fletcher, MD, MPH; Eric Vittinghoff, PhD; Emily S. Lee, BA; Shannon M. Fan, BA; Rachel A. Gladstone, BA; Carlos Mikell, BS; Nimit Sohoni, BS; Johnson Hsieh, MS; Gregory M. Marcus, MD, MAS

5 Second average heart rate, BPM
- <60
- 60-99
- ≥100

Normal Sinus Rhythm

Atrial Fibrillation

Heart Rate, BPM

Time
Passive Detection of Atrial Fibrillation Using a Commercially Available Smartwatch

Figure 2. Accuracy of Detecting Atrial Fibrillation in the Cardioversion Cohort

Table 3. Performance Characteristics of Deep Neural Network in Validation Cohorts

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardioversion cohort (sedentary)</td>
<td>98.0</td>
<td>90.2</td>
<td>90.9</td>
<td>97.8</td>
<td>0.97</td>
</tr>
<tr>
<td>Subset of remote cohort (ambulatory)</td>
<td>67.7</td>
<td>67.6</td>
<td>7.9</td>
<td>98.1</td>
<td>0.72</td>
</tr>
</tbody>
</table>
It looks like you’ve taken a hard fall
Analysing heart rhythm

Close  10:09
Analysing...
Ventricular Fibrillation detected
Cardiac arrest detected
CALLING EMERGENCY SERVICES
5...
Transmitting location...
SOS
Transmitting
..........
Emergency call

CAD triggers GoodSAM and dispatches Ambulance

Set determinants "not conscious / breathing"

Can feedback to CAD/Control via API or set as "Fire and Forget"

The number / type of responders and radius of the alert are set by the ambulance service

Responders can be mapped and communicated with.
Adhesive pads with long cords

AED pads hidden in back of unit

App instantly activates and guides you

The brains are inside behind the Rapid Responsive Revival logo

APL Healthcare
<table>
<thead>
<tr>
<th></th>
<th>Adrenaline</th>
<th>Placebo</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Heart Icon]</td>
<td>36.3%</td>
<td>11.7%</td>
<td></td>
</tr>
<tr>
<td>![Hospital Icon]</td>
<td>23.8%</td>
<td>8.0%</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(95% CI 3.1-4.1)</td>
</tr>
<tr>
<td>![Home Icon]</td>
<td>3.2%</td>
<td>2.4%</td>
<td>1.39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(95% CI 1.06-1.82)</td>
</tr>
<tr>
<td>![Brain Icon]</td>
<td>2.2%</td>
<td>1.9%</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(95% CI 0.86-1.61)</td>
</tr>
</tbody>
</table>
Extracorporeal cardiopulmonary resuscitation for cardiac arrest: A systematic review

Mathew J. Halakery1,2, Gailanne Ged1,2, Sebastian Wilberg3, Anna-Made Gargoroviz1, Michael W. Domino4,5, Jerry P. Nolan6, Charles D. Deakin7, Liam W. Anderson4,5, for the International Liaison Committee on Resuscitation’s (ILCOR) Advanced Life Support and Pediatric Task Forces.

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ARTICLE INFO

Abstract

Intracardiac ECG Monitoring During Extracorporeal Cardiopulmonary Resuscitation

Abstract

I.

Introduction

Extracorporeal cardiopulmonary resuscitation (EPCR) is an advanced cardiac resuscitation technique that involves the use of extracorporeal circulation to support circulation in patients with cardiac arrest refractory to conventional CPR. EPCR maintains vital organ perfusion while providing a means to support circulation during extracorporeal circulation.

II.

Methods

The systematic review identified a total of 15 studies that met the inclusion criteria. The studies were divided into four categories: pediatric, adult, and mixed populations.

III.

Results

The results showed that EPCR was effective in improving survival rates and neurological outcomes in patients with cardiac arrest.

IV.

Discussion

The effectiveness of EPCR in improving survival and neurological outcomes in patients with cardiac arrest was confirmed by the studies included in the systematic review.

V.

Conclusion

EPCR is an advanced cardiac resuscitation technique that may be beneficial in patients with cardiac arrest refractory to conventional CPR.

References


Brain rescue therapies
Personalised medicine

Brain rescue therapies

Physiological targets

Prognostication

Rehabilitation
Personalised medicine
Physiological targets

\[ y = 0.4763x + 32.294 \]
\[ R^2 = 0.8825 \]
Here we describe the restoration and maintenance of microcirculation and molecular and cellular functions of the intact pig brain under ex vivo normothermic conditions up to four hours post-mortem.

Nature 2019
Prognostication

"On many occasions, the doctors told my family that the bystander care that I had received was incredible; and it had given me the best chance of survival possible from my cardiac arrest."

- Sam Mangoro, Cardiac Arrest Survivor
Prognostication

**Graph:**
- Y-axis: Proportion
- X-axis: Delay from sedation discontinuation (hours)
- Curves:
  - Comatose
  - Awakening
  - Death without awakening

**Flowchart:**
- 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
- Wait at least 24 h
- Yes
- No
- Magnetic Resonance Imaging (MRI)
- Days 3-5
- Two or more of the following:
  - Status myoclonus ≤48h after ROSC
  - High NSE levels
  - Unreactive burst-suppression or status epilepticus on EEG
  - Diffuse anoxic injury on brain CT/MRI
- Indeterminate outcome
  - Observe and re-evaluate
- Days 1-2
  - CT
  - Status Myoclonus
  - SSEP
  - EEG - NSE

**Warwick Clinical Trials Unit**
Hearts to good to die

Clinical Frailty Scale*

1. Very Fit – People who are robust, active, energetic and motivated. These people commonly exercise regularly. They are among the fittest for their age.

2. Well – People who have no active disease symptoms but are less fit than category 1. Often, they exercise or are very active occasionally, e.g. seasonally.

3. Managing Well – People whose medical problems are well controlled, but are not regularly active beyond routine walking.

4. Vulnerable – While not dependent on others for daily help, often symptoms limit activities. A common complaint is being “slowed up”, and/or being tired during the day.

5. Mildly Frail – These people often have more evident slowing, and need help in high order IADLs (finances, transportation, heavy housework, medications). Typically, mild frailty progressively impairs shopping and walking outside alone, meal preparation and housework.

6. Moderately Frail – People need help with all outside activities and with keeping house. Inside, they often have problems with stairs and need help with bathing and might need minimal assistance (cuing, standing) with dressing.

7. Severely Frail – Completely dependent for personal care, from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~ 6 months).

8. Very Severely Frail – Completely dependent, approaching the end of life. Typically, they could not recover even from a minor illness.

9. Terminally III – Approaching the end of life. This category applies to people with a life expectancy <6 months, who are not otherwise evidently frail.

Scoring frailty in people with dementia

The degree of frailty corresponds to the degree of dementia. Common symptoms in mild dementia include forgetting the details of a recent event, though still remembering the event itself, repeating the same question/history and social withdrawal.

In moderate dementia, recent memory is very impaired, even though they seemingly can remember their past life events well. They can do personal care with prompting.

In severe dementia, they cannot do personal care without help.

* Canadian Study on Health & Aging Revised 2008
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What should happen to you in an emergency?

ReSPECT
Recommended Summary Plan for Emergency Care and Treatment

Who is it for?

People who have a ReSPECT form, but who may have increasing difficulty for those who want to inform their carer in advance of their care and treatment preferences for any other reason.

find out more at www.respectprocess.org.uk
Cardiac arrest care

- Looking in to the future
  - Chain of survival
  - Personalised medicine
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