Case report: Resuscitation of a 55-year old physician

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Abstract

A 55-year old man experienced near drowning in a public swimming pool. After BLS performed by the pool attendant first documented heart rhythm by the paramedic was ventricular fibrillation. ALS was started and the patient was defibrillated 6 times and ROSC was achieved after 20 minutes. Triggering event for ventricular fibrillation was NSTEMI. After arrival in hospital acute coronary angiography and PCI of a subtotal proximal LAD stenosis took place. Mild therapeutic hypothermia was conducted for almost 24 hours. Afterwards the patient developed a septic shock due to pneumonia caused by aspiration of chlorinated pool water and, as a second line complication, hemolysis due to fresh water aspiration. After 16 days on Intensive Care Unit the patient could be transferred to the normal ward and was discharged without a cognitive, neurological or any functional deficit.

Key words: mild therapeutic hypothermia, cardiac arrest, drowning, fresh water aspiration

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>ECG</td>
<td>Electrocardiography</td>
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<tr>
<td>LAD</td>
<td>Left Anterior Descending coronary artery</td>
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<td>ARDS</td>
<td>Acute Respiratory Distress Syndrome</td>
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<td>NSTEMI</td>
<td>Non ST-Elevation Myocardial Infarction</td>
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<td>PCI</td>
<td>Percutaneous Coronary Intervention</td>
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<td>RCA</td>
<td>Right Coronary Artery</td>
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<tr>
<td>ROSC</td>
<td>Return Of Spontaneous Circulation</td>
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<td>STEMI</td>
<td>ST-Elevation Myocardial Infarction</td>
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<tr>
<td>TIMI</td>
<td>Thrombolysis In Myocardial Infarction</td>
</tr>
</tbody>
</table>

Case report

Prehospital incident

A 55-year old physician was found dead in a public swimming pool and urgent basic life support with chest compression and mouth to mouth ventilation was initiated by the pool attendant. An emergency call was made and when the emergency medical officers and the emergency physician arrived at the scene they took over and assessed ventricular fibrillation as initial rhythm. Advanced adult life support was initiated with ongoing chest compressions, external defibrillations for 6 times, placing an i.v.-line and orotrachael intubation. ROSC was established after a total resuscitation time of 20 minutes. The patient was referred to our hospital. Pre-hospital therapeutic hypothermia was initiated with cold saline infusion.
Intrahospital course

Coronary angiography

When arriving at our hospital an acute coronary angiography was immediately performed although the ECG revealed no signs of ST-segment elevation. The coronary angiogram showed a two-vessel disease. The posterior interventricular branch was occluded and the LAD-artery showed a proximal stenosis of 60% with TIMI I coronary blood flow. The LAD-stenosis was dilated and a Tacrolimus-eluting stent was implanted. After the procedure coronary blood flow normalized to TIMI III-flow. The occluded distal branch of the RCA could not be reopened.

Intensive care unit

The patient was referred to our Medical Intensive Care Unit where he was provided with an Icy-Catheter for intravascular mild therapeutic hypothermia, a second central venous line, arterial line, gastric probe and bladder catheter. Mild therapeutic hypothermia was conducted for 24 hours with target core temperature of 33 °C using the Cool-Guard-System (Zoll Medical Deutschland, Cologne, Germany).

Bronchoscopic suctioning was done and revealed foamy sanguineous secretion. Transthoracic echocardiography showed a moderate diminished left ventricular function. Pericardial effusion could be ruled out. Due to low blood pressure despite an adequate volume status vasopressor therapy with noradrenaline and inotropic therapy with dobutamine was initiated.

On day 2 a pulmonary artery catheter was inserted to improve hemodynamic monitoring and therapy with catecholamines was adapted (s. table 1). The patient was in a state of septic shock due to aspiration of the chlorinated pool water and developed a bilateral pneumonia with a consecutive ARDS. Multiple microbiological specimen revealed no diagnostic findings. Antiinfective therapy with piperacillin/combactam was started as a calculated antibiotic therapy covering most of the suspicious bacilli.

Multi-organ failure emerged with acute renal failure and hemolysis was observed (s. table 2). The underlying cause was probably fresh water aspiration. In conjunction with septic shock we administered hydrocortisol 200 mg/d. Acute renal failure was treated with continuous renal replacement therapy.

After a course of only 4 days in critical condition the patient resolved septic shock, pneumonia and hemolysis. Continuous renal

<table>
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<th>Variable</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
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<tbody>
<tr>
<td>Cardiac Output (l/min)</td>
<td>8.96</td>
<td>6.26</td>
<td>5.18</td>
</tr>
<tr>
<td>Heart rate (/min)</td>
<td>105</td>
<td>107</td>
<td>61</td>
</tr>
<tr>
<td>Mean Arterial Blood Pressure (mmHg)</td>
<td>67</td>
<td>56</td>
<td>91</td>
</tr>
<tr>
<td>Mean Pulmonary Artery Pressure (mmHg)</td>
<td>32</td>
<td>35</td>
<td>25</td>
</tr>
<tr>
<td>Mean Pulmonary Capillary Wedge Pressure (mmHg)</td>
<td>17</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>Central Venous Pressure (mmHg)</td>
<td>11</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Stroke Volume (ml)</td>
<td>85.3</td>
<td>78.7</td>
<td>84.9</td>
</tr>
<tr>
<td>Cardiac Index (l/min/BSA)</td>
<td>4.33</td>
<td>4.07</td>
<td>2.5</td>
</tr>
<tr>
<td>Pulmonary Vascular Resistance (dyn x s/cm²)</td>
<td>134</td>
<td>217</td>
<td>216</td>
</tr>
<tr>
<td>Systemic Vascular Resistance (dyn x s/cm²)</td>
<td>500</td>
<td>1060</td>
<td>1189</td>
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</table>
replacement therapy could be discontinued and mechanical ventilation could be terminated after a total of 10 days. The patient fully recovered and could be referred to the general ward. A single-chamber ICD was implanted as a secondary preventive means in combination with a moderate reduced left ventricular function. In order to regain mental and physical strength the patient was referred to a rehab hospital. Nowadays he is working in his doctor’s practice in part time.

**Conclusion**

**Basic life support and advanced life support**

When the dead corpse was found in the public swimming pool the pool attendant made an emergency call and then immediately started with basic life support according to the actual guidelines for Adult Basic Life Support (Ratio Chest Compression : Ventilation 30 : 2). External automated defibrillation could not be executed as this special public swimming pool is not equipped with an AED. After the Emergency Medical Officers and the Emergency Physician arrived at the scene they took over and extended the resuscitation efforts to Advanced Life Support according to the actual guidelines. The patient’s resuscitation was continued for 20 minutes. The first documented heart rhythm was ven-
tricular fibrillation so the patient was defibrillated for a total of 6 times. Besides chest compression and orotracheal intubation with mechanical ventilation 300 mg amiodarone was administered.

In the actual guidelines for adult basic life support a strong emphasis is on delivering high quality of chest compressions with a depth of 5 cm and a rate of 100 compressions per minute. Trained rescuers are encouraged to deliver mouth-to-mouth ventilation and chest compressions in a ratio of 2:30 [1]. In the special circumstance of rescuing a drowning victim with cardiac arrest the CPR procedure does not differ from any other situation.

The most important change in the actual guideline in contrast to the older one is the strong emphasis on continuation of chest compressions and minimizing interruptions, e.g. for placing an i.v.-line, intubation or charging the defibrillator [2]. The use of three stacked shocks for ventricular fibrillation is not recommended any longer. Between shocks 2 minutes of CPR has to be carried on, followed by a reassessment of the heart rhythm. After the third shock adrenaline 1 mg should be administered and also amiodarone 300 mg.

Mild therapeutic hypothermia

Mild therapeutic hypothermia was initiated by the emergency medical team using cold saline solution applied intravenously. When arrived at our hospital the initial core temperature was 36.3 °C. After the urgent PCI mild therapeutic hypothermia was conducted using an intravascular device which is commercially available that proved trustworthy work. A target temperature of 33°C was defined and could be achieved after 5 hours. To propagate downcooling and to fight against shivering muscle relaxation with the non-depolarizing muscle relaxant Rocuronium was initiated. Hypothermia was then continued for 24 h. After this time controlled rewarming with a temperature increase of 0.3°C per hour took place.

Mild therapeutic hypothermia is a cornerstone of post-resuscitation care and one of only few things that proved to improve functional neurological performance and to improve survival after survived pre-hospital cardiac arrest if the underlying heart rhythm is ventricular fibrillation or pulseless ventricular tachycardia [3].

Currently available are different cooling techniques for induction and sustaining hy-
pothermia. Established as a method for induction is the rapid application of cold saline infusion (2-4°C cold), 30 ml/kg bodyweight over 30 minutes. For perpetuation of target temperature a device with a feed-back-mechanism and autoregulative properties are recommended [4]. Two commercially available systems, one for surface cooling with cooling blankets and one for endovascular cooling seem to be equivalently effective [4].

A definite survival benefit was shown for patients with pre-hospital cardiac arrest if the underlying heart rhythm is ventricular fibrillation or pulseless ventricular tachycardia. For all other circumstances of survived cardiac arrest (e.g. intra-hospital cardiac arrest, non ventricular fibrillation cardiac arrest) the published data are inconsistent concerning the improvement of survival but showed that mild therapeutic hypothermia does not harm survivors of cardiac arrest [5].

**Acute coronary angiography after resuscitation**

The first written ECG was unremarkable and especially revealed no signs of ST-segment elevation myocardial infarction (STEMI). As in almost all cases of cardiac arrest a cardiac disease is the underlying cause we decided to perform a Coronary Angiography immediately. The findings of this examination were suggestive of an acute anterior wall myocardial infarction. The angiogram revealed a ruptured plaque in the proximal LAD and we assumed spontaneous fibrinolysis of a thrombus to be the source of myocardial infarction and the subsequent cardiac arrest.

Previous studies showed a benefit for patients with STEMI after out-of-hospital cardiac arrest undergoing emergency PCI compared to those who were treated conservatively [6]. In patients presenting with NSTEMI after survived out-of-hospital cardiac arrest published data are missing [5]. Both therapeutic strategies could be combined without a time delay for establishing therapeutic hypothermia [5]. The effect of hypothermia on cardioprotec-

**Water aspiration**

The patient went to swimming for recreation in a public swimming pool and experienced a cardiac arrest due to an acute myocardial infarction. He was found dead in the swimming pool by the pool attendant who begun resuscitative measures.

Drowning circumstances vary very much from sweet water to salt water, from boat or beach accidents to bathtub, involving children or adults [7]. Drowning is defined as the process of experiencing respiratory impairment from submersion or immersion of liquid. The immediate response to hypoxia is a distinctive vagal response of the diving reflex so the victim becomes progressively bradycardic, associated with severe ventricular ectopy. Hypoxia leads itself to hypotension and this may lead to a profound cardiac dysfunction resulting in cardiac arrest with different pulseless heart rhythms to be documented (pulseless electrical activity, ventricular fibrillation, pulseless ventricular tachycardia). In primary cardiac arrest as the underlying cause of drowning the same mechanisms are present to initiate the former described hypoxia-associated cardiovascular consequences.

The amount of patients with signs of aspiration differ regionally from 10-100% [8]. In a series of 125 submersion victims in the Netherlands 72% developed pulmonary edema as a result of water aspiration and 14,7% showed signs of pneumonia requiring mechanical ventilation. The mortality of these patients presenting with cardiac arrest is about 24% high.

Fresh water in the alveoli causes a washout of surfactant. As a result of different osmotic gradients water could be drained from the lung in the circulation which may lead to a disruption of the alveolar-capillary
membrane resulting in an exacerbation of fluid, plasma and electrolyte shifts [7]. The combination of accumulation of fluids in the lungs, loss of surfactant and the increase in alveolar-capillary permeability leads to reduced lung compliance, increased right-to-left shunting and ends up in ARDS.

Additionally the patient developed an anemia (hemoglobin level 7.2 g/dl) without any bleeding signs. Gastroscopic and colonoscopic examination were unremarkable. A haptoglobin-test was executed and showed all haptoglobin to be consumed as an expression of hemolysis. Hemolysis after drowning is described only in an animal study [9]. This study showed that hemolysis occurred only after fresh water aspiration and not after sea water aspiration. We decided to apply hydrocortisone in a dosage of 200 mg/day and the patient resolved immediately from hemolysis.

**Conclusion**

This case report depicts the unusual coincidence of acute myocardial infarction with concommitant ventricular fibrillation and drowning and aspiration of chlorinated fresh water. After successful resuscitation an emergency PCI was executed although the patient showed no signs of STEMI in the completely unremarkable ECG. After implantation of a drug eluting stent in the proximal LAD mild therapeutic hypothermia was executed. As a cause of fresh water aspiration the patient developed septic shock due to pneumonia and subsequently an ARDS with multi organ failure requiring continuous renal replacement therapy and vasopressor therapy. As an extraordinary complication due to fresh water aspiration hemolysis occurred and could easily be treated with hydrocortisone. After only 10 days the patient recovered and was referred in good neurological and otherwise physical condition to the rehab hospital. Nowadays he is working as a physician again in part time in his own doctor’s office.

**References**


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