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A long prehospital resuscitation and evacuation of a skier with cardiac arrest – a case report

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The prognosis for patients with refractory cardiac arrest transferred to hospital during ongoing resuscitation is poor.[1] Additionally in remote areas, the response time of the emergency medical services (EMS) may be long, which further decreases the likelihood of a good outcome. The most common reason for sudden death during cross-country skiing is acute coronary artery syndrome and subsequent ventricular fibrillation (VF).[2] We describe a patient who suffered a cardiac arrest during a long-distance cross-country skiing competition in northern Finland. He was transported to a university hospital and underwent a percutaneous coronary intervention supported by a mechanical chest compression device while still in cardiac arrest. He made a full recovery.

Case report

A healthy 53-year old male participated in a long-distance cross-country skiing competition at a ski resort. He had asthma but no need for medication. Lately, the patient had been suffering from heartburn and shortness of breath. A general practitioner had restarted his asthma medication. After eight kilometers he suddenly collapsed. About a minute later he was reached by other skiers. He was first set into the recovery position. Immediately afterwards more skiers arrived to the scene, one of which was an off-duty neurologist. Cardiopulmonary resuscitation (CPR) was initiated and an emergency call was made. Soon an off-duty resident in anesthesiology and intensive care arrived and took the lead. The patient reacted to CPR by agonal respiration.

The outside temperature at the nearest meteorological observation post was -0,3 degrees centigrade, wind 2,7 m/s, no snowfall. The CPR took place on the skiing track. The paramedics arrived on a snowmobile 50 minutes later. The primary rhythm was ventricular fibrillation (VF). The rhythm was mostly VF but also episodes of ventricular tachycardia (VT) and pulseless electrical activity (PEA) were observed. The patient reacted to defibrillations by moving his limbs, moaning, inhaling against ventilation and had to be sedated using midazolam and fentanyl. The airway was secured by orotracheal intubation.

Prehospital thrombolysis was initiated based on the background information and guide from a HEMS-physician on route to the scene. The patient was defibrillated 15 times on site and received epinephrine and amiodarone according to European resuscitation guidelines. A chest compression device (CCD), (LUCAS(R) (Physio-Control Canada, Lund, Sweden)) was implemented by the HEMS crew and the decision to transport the patient directly to the nearest university hospital was made. The HEMS physician performed transthoracic echocardiography (TTE) and observed weak motion in the myocardium. No pulse was palpable from carotid or femoral arteries without compressions. The cardiac rhythm varied from VT, PEA and VF during the transportation. The pupils were small. During transport the patient had some respiratory effort and reaction to suction and was ventilated mechanically. The patient's temperature was taken during the transport and it had descended to 30.4 degrees centigrade. Figure 1 represents the distance, time intervals and methods of transportation to the hospital.

The cardiac anesthesiologist on call at the university hospital was consulted regarding extracorporeal membrane oxygenation (ECMO) but the patient was not considered as a candidate due to the long prehospital response times. Despite this decision, the HEMS physician and a cardiologist on call chose to proceed with CCD-assisted percutaneous coronary intervention (PCI). PCI began 3 hours and 17 minutes after the collapse. At the hospital the cardiac rhythm was pulseless electric activity (PEA) with no blood pressure and the patient was unresponsive with no respiratory effort.

The angiography showed a culprit lesion in the left anterior descending coronary artery (LAD), which was treated with angioplasty and a drug-eluting stent. VF was defibrillated and a permanent pulsatile nodal rhythm was achieved. A temporary pacemaker was inserted and the patient's heart was paced.

It took a total of 3 hours and 41 minutes to achieve the return of spontaneous circulation (ROSC) after the collapse. The patient's blood pressure after percutaneous coronary intervention (PCI) was 90/60 mmHg supported with norepinephrine 0,157 µg/kg/min and dobutamine 2,45 µg/kg/min. TTE revealed a hypokinetic infarction area in the left ventricle, but otherwise the cardiac compressions were hyperkinetic. No cardiac contusions or other chest compression-related injuries were observed with TTE. The first blood gas analysis showed severe metabolic acidosis, the first pH was 6.9. The arterial partial pressures of carbon dioxide and oxygen were 11.3 kPa and 8.8 kPa, respectively. The plasma levels of potassium and sodium were 4.6 mmol/l and 129 mmol/l, respectively.

The local standard post-resuscitation care protocol was initiated in the ICU. The patient was extubated on the third day and was diagnosed with melena, which required several transfusions. He developed rhabdomyolysis and acute kidney failure, which was treated with renal replacement therapy. Three days after the resuscitation, TTE revealed a small hypokinetic area in the left ventricle but the ejection fraction was normal. The patient spent six days in the ICU, 18 days in the university hospital and was hospitalized altogether for 35 days. Hemodialysis was no longer needed 25 days after his initial admission.

One and a half months after discharge the patient experienced chest pain while exercising and was admitted to a local central hospital. Coronary angiography revealed an acute occlusion of the right coronary artery that was revascularized by PCI. There was no restenosis or other complications in the LAD. One month later his performance was good and no signs of myocardial ischemia was evident in an exercise stress test. TTE findings were unchanged. The patient made a full recovery (cerebral performance category 1).[3]

Discussion

The European resuscitation guidelines recommend to consider transportation to a hospital with ongoing CPR if the cardiac arrest is witnessed, ROSC is present at any moment, the initial rhythm is shockable (VF or VT) or the is a reversible cause for the cardiac arrest.[1]

Possible causes of the good outcome in our case were the relatively young age and great physical fitness of the patient before the cardiac arrest. It has recently been shown that an age below 60 years is associated with improved neurological recovery in patients with refractory cardiac arrest undergoing ECMO.[4,5] Additional positive prognostic signs and causes of good outcome were spontaneous reactions and respiratory drive during CPR and transport, an excellent chain of survival and significant hypothermia, because the CPR took place on a skiing track during winter. It is well known that patients with accidental hypothermia and cardiac arrest benefit from transportation to extracorporeal rewarming.[6] Normal levels of potassium in the first blood gas analysis despite prolonged CPR also may have indicated a better prognosis.[7]

Routine use of CCD is not recommended as there is no evidence of CCD being superior to manual CPR in terms of improved outcome.[8] However, several guidelines and a Cochrane meta-analysis suggest their use in special circumstances such as transporting a patient with cardiac arrest and PCI, when standard manual chest compressions are impractical or dangerous for the medical personnel. [9-11]

Transportation to PCI directly after the cardiac arrest has been shown to improve outcome after ROSC,[12] but it is not known whether the same applies to patients with ongoing CPR. However, CCD-assisted PCI has been shown to be associated with an increased rate of ROSC compared to PCI supported with standard CPR in a retrospective case series.[13] Even in special settings, CCDs should be used with caution as there are reports of an increased number of complications.[14] In our case, the timely evacuation by snowmobile and helicopter during ongoing CPR would have been significantly more difficult without CCD.

In our case, some cardiac motion was observed by TTE but a pulse was not palpable. PEA in cardiac arrest patients is associated with a poor prognosis. PEA is divided into real PEA and pseudo-PEA. No pulse is palpable in pseudo-PEA but there is some cardiac activity demonstrated with TTE. Pseudo-PEA should encourage more aggressive resuscitation as was done in our case.[15]

Some studies have indicated a better prognosis if ECMO is initiated within 60-80 minutes after the cardiac arrest. Even though the prehospital time in our case was long, one can speculate that recovery could have been even faster if PCI had been performed in ECMO support. If the chain of survival is excellent and there are signs of life during CPR, the ECMO option should not be withheld categorically. Effective chest compressions generate only 25 % of normal cardiac output and 30-40 % of normal cerebral blood flow while ECMO restores full cardiac output and systemic oxygenation. Furthermore, tissue perfusion is improved during ECMO when compared to the use of CCD alone, which may be beneficial in mitigating severe multi-organ failure.[16] In centers without access to ECMO, CCD should be considered to support PCI. It is imperative in improving outcome that patients are first connected to ECMO or CCD and PCI is performed afterwards. Supporting resuscitation with ECMO (E-CPR) is not, however, strongly supported by evidence as the quality of the data is low.[9] Current local guidelines in ECMO centers generally apply strict protocols when considering E-CPR.[17]

Conclusion

Our case report demonstrates that even with long prehospital response times and remote location, the outcome can be good if the patient cools quickly and regains signs of life during resuscitation and cooperation with the emergency medical services and hospital is smooth. Furthermore, mechanical chest compressions are useful during long evacuation to PCI. New approaches and protocols that allow selected patients to be delivered during CPR to a cardiac center where they may be treated and possibly connected to ECMO should be considered, even in geographically remote areas.[18]

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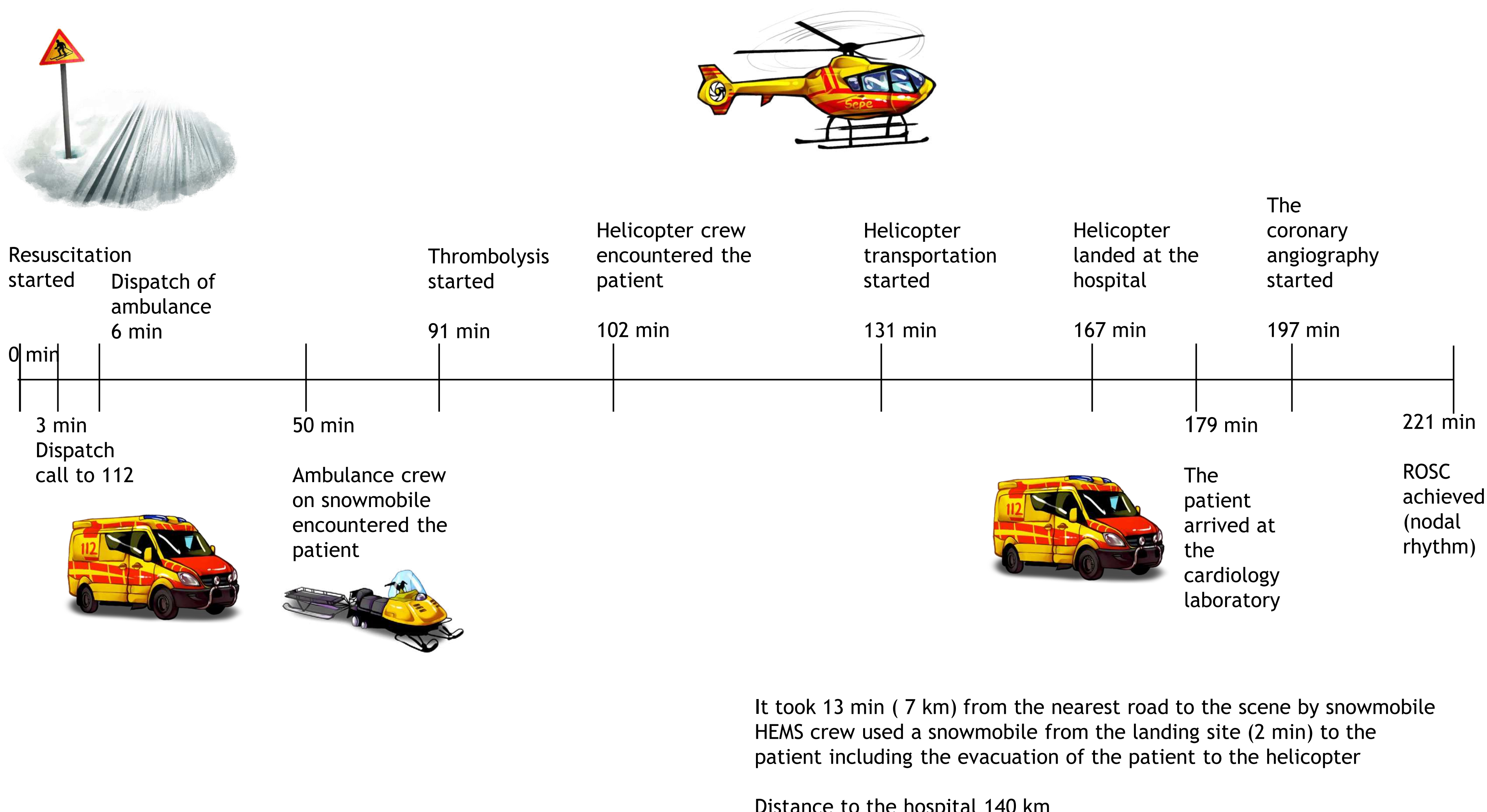
Resuscitation started
0 min
3 min Dispatch call to 112
Dispatch of ambulance 6 min
50 min
Ambulance crew on snowmobile encountered the patient
Thrombolysis started
91 min
Helicopter crew encountered the patient
102 min
Helicopter transportation started
131 min
Helicopter landed at the hospital
167 min
179 min
The patient arrived at the cardiology laboratory
The coronary angiography started
197 min
221 min
ROSC achieved (nodal rhythm)
112
It took 13 min (7 km) from the nearest road to the scene by snowmobile
HEMS crew used a snowmobile from the landing site (2 min) to the patient including the evacuation of the patient to the helicopter
Distance to the hospital 140 km

Figure 1.