Case Report

Successful resuscitation after drowning with severe hypernatraemia and prolonged time to return of spontaneous circulation

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Summary

We describe the successful resuscitation of a 23-year-old previously healthy man who had drowned. After prolonged submersion, hypothermia, severe hypernatraemia, a prolonged time to return of spontaneous circulation was possible using a combination of extracorporeal life support and early continuous veno-venous haemofiltration. This combination of clinical circumstances is rarely associated with positive outcomes, but this case demonstrates the utility of extracorporeal life support and haemofiltration in patients drowned in saltwater.

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Introduction

Cardiac arrest as a result of hypothermia alone has a good prognosis [1], however, in combination with drowning the outcome is less promising. Extracorporeal life support with cardiopulmonary bypass or extracorporeal membrane oxygenation is increasingly used in the rewarming and resuscitation process and has previously been proven successful in this setting [2]. Submersion for <10 min and drowning in ice-cold water may increase the victim's chances of survival [3] because cerebral oxygen consumption is reduced by approximately 5% for each 1°C reduction in temperature, within the range of 20°C–37°C [4]. However, submersion for >25 min is generally associated with a low chance of survival and outcomes are extremely poor if return of spontaneous circulation is not achieved within 30 min [3]. Early initiation of continuous veno-venous haemofiltration (CVVH) may result in better outcomes following saltwater drowning [5]. We report a case of successful resuscitation following saltwater drowning with prolonged submersion time, signs of aspiration, asphyxia, severe hypernatremia, hypothermia and asystole using both extracorporeal life support and CVVH.

Report

A 23-year-old previously healthy man was brought to the emergency department in the middle of a cold December night in cardiac arrest. He had been seen struggling in the nearby harbour, but bystanders were unable to rescue him from the water. Before the arrival of the emergency medical services the patient had been submerged and was recovered by divers after approximately 15–20 min. His trachea was promptly intubated, large quantities of seawater were suctioned from the lungs and cardiopulmonary resuscitation was initiated for an initial cardiac rhythm of asystole. He arrived at the hospital within 10 min where mechanical external chest compressions were immediately initiated using the LUCAS (Jolife AB, Sweden) system. On examination, there were no palpable pulses, the patient's pupils were fixed and dilated and the core body temperature was 32.1°C. The initial arterial blood gas analysis showed the following: pH 6.59, PaCO₂ 17.0 kPa, PaO₂ 6.75 kPa, base excess

–23.6, bicarbonate 4.0 mmol.l^{-1} , sodium 166 mmol.l^{-1} , chloride 127 mmol.l^{-1} , calcium 1.51 mmol.l^{-1} and lactate 18 mmol.l^{-1} . Due to severe metabolic acidosis, two boluses of 100 ml sodium bicarbonate 8.4% were administered despite hypernatraemia. Plasma sodium concentrations peaked at 178 mmol.l^{-1} while the plasma potassium concentration was 4.9 mmol.l^{-1} and thus within the normal range. Despite the anticipated poor prognosis, resuscitation was continued, especially due to the normal potassium value.

Throughout the resuscitation, the patient's cardiac rhythm varied between asystole and low-voltage ventricular fibrillation. A total of 4 mg intravenous adrenaline was administered without return of spontaneous circulation. However, an early decision was made to initialise extracorporeal life support and eventual supportive circulation was established 100 min after the patient had initially arrived in the emergency department. At commencement of extracorporeal life support, the patient's core body temperature had decreased to 27.6°C before active rewarming. When the core body temperature increased to 29°C the cardiac rhythm changed to a coarser ventricular fibrillation, but it was not possible to convert to sinus rhythm despite three 200 J biphasic DC shocks.

The patient was transferred to the cardiac intensive care unit where CVVH was initialised via the extracorporeal life support system in an attempt to correct the metabolic acidosis and hypernatraemia. A core temperature of 32°C was attained 3 h and 20 min after arrival, and after one 200 J biphasic DC shock the cardiac rhythm converted to a stable sinus rhythm. The initial arterial blood pressure was 77/55 mmHg, and the patient was rewarmed to 34°C . The body temperature was maintained at this value for 24 h in order to provide neuroprotection [6]. The pH normalised less than 3 h after a return of spontaneous circulation and the plasma lactate concentration decreased to 2.6 mmol.l^{-1} within 12 h. The patient was weaned from extracorporeal life support 8.5 h after hospital arrival. Once normothermia was achieved, sedation was reduced, and the patient's trachea was extubated uneventfully. He had total amnesia for the accident, but no other neurological deficits were found. His only complaint was chest pain following manual compressions, and a thoracic epidural catheter was inserted for pain relief. On day three after admission, the patient was transferred to the cardiac ward and discharged after an additional four days without any permanent physical or cognitive injuries.

Discussion

This case demonstrates the utility of extracorporeal life support and haemofiltration in patients drowned in saltwater, as well as the diagnostic uncertainties of evaluating the chance of survival in drowned hypothermic victims. In this particular case, the plasma potassium concentrations were within the normal range despite grossly deranged arterial blood gas results otherwise. It may be that plasma potassium concentration plays a significant role as an immediate prognostic indicator of death in hypothermic patients who have suffered a cardiac arrest [7, 8].

The patient showed signs of severe aspiration of seawater to the lungs. This condition may lead to pulmonary oedema as the hypertonic fluid draws water from the vascular system and potentially leads to acute respiratory distress syndrome due to a lack of surfactant and local inflammatory processes [9]. Additionally, the patient was at risk of developing cerebral oedema following the large changes in plasma sodium concentration. Continuous veno-venous haemofiltration was initiated early to attenuate the detrimental effects of severe metabolic acidosis and hypernatraemia. Extracorporeal life support was invaluable as a fast and effective method for rewarming after accidental hypothermia, in addition to providing oxygenation and tissue perfusion, while reducing the risk of vasodilatory shock, as initial warming occurs within the body core. Furthermore, the effect of myocardial 'stunning' after cardiac ischaemia has been shown to be attenuated during extracorporeal life support [10].

This patient survived with no long-term disabilities and remained cognitively intact despite submersion for more than 15 min, primary asystole, more than 100 min of a low cardiac output state and severe hypernatremia. In this particular case resuscitation was successful and severe pulmonary, circulatory and cerebral complications were avoided. We believe that the combination of early initiation of extracorporeal life support, and correction of electrolytes and acidosis with CVVH, in addition to the neuroprotective efforts, had combined beneficial effects on outcome.

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