Survival after accidental hypothermia and cardiac arrest using emergency department-initiated extracorporeal membrane oxygenation

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INTRODUCTION

Across Canada accidental hypothermia is quite common. Mild and moderate cases typically respond well to conventional rewarming techniques. Cardiac arrest can complicate cases of severe hypothermia and invasive rewarming, including veno-arterial extracorporeal membrane oxygenation (ECMO), is usually recommended in these cases.[1–5] We report, to the best of our knowledge, the first successful veno-arterial ECMO resuscitation initiated in the emergency department (ED) in the province of Saskatchewan.

CASE REPORT

A 46-year-old male was found in a snowbank by law enforcement, while the outdoor temperature was -5°C. He had agonal respirations, and upon paramedics' arrival he was pulseless and cardiopulmonary resuscitation (CPR) was initiated. His initial rhythm showed ventricular fibrillation, for which he received one defibrillation and 1 mg of epinephrine. Afterward, the patient converted to asystole. He was intubated, with mechanical CPR continued on route to our tertiary care ED.

The patient arrived to the ED 28 minutes after the initial call. He had a measured blood pressure of 110/60 mmHg with ongoing mechanical CPR and a capillary glucose of 14.7 mmol/L. He remained intubated and on a ventilator with an end tidal CO2 of 12 mmHg. A continuous rectal temperature probe revealed a core temperature of 22.1°C. Mechanical CPR was paused to assess cardiac contractility with point of care ultrasound (POCUS). A parasternal long view was obtained and showed complete cardiac standstill. The monitor showed asystole and mechanical CPR was subsequently resumed. On examination, his pupils were 2 mm and sluggish, there was dried blood in the nares, but no signs of external trauma. Active external and internal rewarming techniques were started, including increasing the room temperature, placing a warming blanket on the patient, warmed intravenous fluids and continuous bladder irrigation with warmed fluids. A femoral triple lumen central venous line was placed for central access.

Laboratory testing showed significant metabolic acidosis with a venous pH <6.76 and an HCO3 of 6mmol/L (using the alpha stat method), and normal serum potassium of 4.7 mmol/L.

After 45 minutes of rewarming in the ED, the patient's core temperature increased to 23.2°C. The cardiothoracic surgeon on call was consulted to assess the patient's candidacy for rewarming by veno-arterial ECMO. Upon evaluation, he elected to place two femoral sheaths and initiate veno-arterial ECMO in our ED. Subsequently, mechanical CPR was stopped after a total estimated CPR time of 150 minutes. The monitor showed ventricular fibrillation 20 minutes later, at a core temperature of 24.9°C. The patient was defibrillated once at 150 J and reverted to a wide complex sinus bradycardia with a heart rate of 28 bpm.

One hour after cannulation, the patient began biting down on his endotracheal tube, moving his upper

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extremities and exhibited a core temperature of 27.4°C. A parasternal long view on POCUS showed improving gross cardiac activity. Sedation was administered, and he was subsequently transferred to the surgical intensive care unit (SICU).

The patient's acidosis was slowly corrected following a bicarbonate infusion. He remained on veno-arterial ECMO for a total of 7 hours and exhibited a core temperature of 37°C upon termination. He was extubated on day 5 of admission and transferred to a regular ward with intact neurological function on day 6 post-arrest. The patient's stay was complicated by rhabdomyolysis, acute kidney injury, and aspiration pneumonia. The patient survived with good neurologic outcome to hospital discharge 15-days postadmission.

DISCUSSION

Accidental hypothermia often occurs in urban areas due to higher prevalence rates of alcohol and substance abuse, comorbid mental illnesses and homelessness, and carries a high risk of mortality. Even though our center did not have a protocol for initiating veno-arterial ECMO in the ED, nor had it ever been performed before in this setting, a successful resuscitation and positive patient outcome was achieved.

Accidental hypothermia can be staged using the Swiss staging system of hypothermia (Supplemental Table 1), which takes into account vital signs, as well as core temperature, and helps guide management.[4] Our patient had a core temperature of 22.1°C and was in cardiac arrest, placing him at stage HT IV.

It is recommended that unstable hypothermic patients and those in hypothermic cardiac arrest be considered for rewarming using veno-arterial ECMO.[1] Many algorithms support the use of veno-arterial ECMO for rewarming.[1–5] These guidelines are based on observational data and expert opinion.[2] There are many advantages to using veno-arterial ECMO in these patients; the circuit can rapidly warm the patient at a rate of 2°–8°C/hour and provides respiratory and hemodynamic support.[1,2] Through the rewarming process, physicians will often notice a transition from asystole to ventricular fibrillation before returning to a sinus rhythm,[1] as it was in this case. Among patients treated with veno-arterial ECMO, the overall survival rate is approximately 40–45%.[1–4] The major risks of this resuscitation method include heparinization-related hemorrhage, sepsis, and limb ischemia,[1,4,5] which did not occur in our case.

If veno-arterial ECMO is not available, or if transport to an ECMO center is not possible, it is reasonable to support a hypothermic patient in cardiac arrest with CPR and internal rewarming techniques (thoracic lavage, peritoneal lavage, continuous bladder irrigation) until a core temperature of 30°–32°C is reached.[4]

Decision making tools exist to help predict survival outcomes in patients with hypothermic cardiac arrest treated with veno-arterial ECMO. The hypothermia outcome prediction after extracorporeal life support score (HOPE) uses age, gender, presence of asphyxia, CPR duration, serum potassium level, and core temperature to calculate the probability of survival after extracorporeal life support.[3] This score is used as an adjunct to clinical gestalt and assessment of individual cases. Our patient's calculated HOPE survival probability was 11%. Nonetheless, veno-arterial ECMO was performed, and the patient survived with no deficits and no need for rehabilitation.

CONCLUSION

Extracorporeal membrane oxygenation has improved the prognosis for patients with severe hypothermia and cardiac instability or arrest. The novelty of this case lies within the positive outcome achieved from ED-initiated veno-arterial ECMO in a centre with no previous protocol set in place. It also highlights the need for institutions to develop protocols for these situations so more patients can benefit from this resuscitation method.

Keywords: accidental hypothermia, cardiac arrest, rewarming, VA ECMO

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