Exceptional Case

Survival after 5-h resuscitation attempt for hypothermic cardiac arrest using CVVH for extracorporeal rewarming

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Abstract

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Background
Mortality from hypothermic cardiac arrest varies from 30 to 80%, depending on the severity, mechanism of hypothermia, patient population and rewarming strategy used [1,2–4]. Mortality has also been correlated with age, comorbidity, initial core temperature and the presenting cardiac arrest rhythm [1]. Rewarming is essential in the management of hypothermic cardiac arrest; however, there is little evidence base for the choice of rewarming strategy. Consequently, management is usually guided by the clinical setting, local facilities and expertise.

Case report
A 23-year-old woman was brought into the Emergency Department at 9.31 am on 2 January 2008. She had been found on a beach by passers-by and had taken a mixed overdose of zopiclone, diclofenac, citalopram, mirtazapine and fluoxetine. At the scene, Glasgow Coma Score (GCS) was 3, respiratory effort was weak, blood pressure was 134/65 and there were no signs of trauma. On arrival to hospital, she was confirmed to be in cardiac arrest with an agonal rhythm, and cardiopulmonary resuscitation (CPR) was commenced. Tympanic temperature was unrecordable. Initial arterial blood gas analysis showed a mixed acidosis. Electrolytes and haematological profile were normal and toxicology screen was negative.

Rewarming was initiated with a forced warm air blanket called a ‘bear-hugger’ and warmed intravenous fluids. The cardiac rhythm changed to ventricular fibrillation (VF) and DC shock at 150J (biphasic) was performed for two cycles. After 45 min, core temperature was measured at 25.1°C with an oesophageal probe. Nasogastric, bladder and peritoneal lavage with warmed fluids were all attempted with no change in core temperature.

No facilities for extracorporeal rewarming were available at the hospital. The nearest Renal Unit was 13 miles away and Cardiothoracic Unit 32 miles away. After logistical
coordination, dialysis equipment and staff (nephrologist and two renal nurses) were transported by ambulance. The dialysis machine (Aquarius 3.51, Edwards) was prepared using an Aquamax HF19 polyethersulfone membrane haemofilter (Edwards Lifesciences). The haemofiltration fluid was Accusol 35 (Baxter) with potassium added to each bag guided by serial potassium measurements. Approximately 2 h after initiation of resuscitation, continuous veno-venous haemofiltration (CVVH) was commenced via a femoral venous dual-lumen catheter. Three litre volume exchanges were performed using tight heparin (250 units/h), a blood flow rate of 150–200 ml/min and temperature setting of 38.5°C (maximum available). Core temperature rose to 26.5°C 4 h after resuscitation was commenced.

Referral was made to the regional Cardio-thoracic Unit; however, CPB was deemed inappropriate given the duration of CPR. Her family expressed a wish for organ donation, but she was also declined by the transplant team. Resuscitation was continued and core temperature rose to 27.6°C at 5 h. Remarkably, return of spontaneous circulation (ROSC) was achieved after 3 further shocks, 3 h on CVVH and a total of 5.5 h of manual CPR. CVVH was continued until core temperature rose to 30.2°C 7 h after initiation of resuscitation attempt. Typical electrocardiographic features of hypothermia immediately post-resuscitation are shown in Figure 1A with resolution in recovery in Figure 1B.

During the first 24 h in the ICU, she became inotrope independent and core temperature rose to 36.5°C with passive rewarming. Sedation was weaned and GCS dramatically improved with spontaneous eye opening and obeying commands. Over the next 48 h, she developed evidence of multiple organ dysfunction with oliguria (serum creatinine 451 µmol/l), raised creatinine kinase (5567 U/L), deranged liver function (alanine transaminase 5670 U/L) and raised serum amylase (210 U/L).

She required inter-hospital transfer for renal replacement therapy on Day 3. Early extubation failed due to acute pulmonary oedema but was achieved on Day 8. She remained oliguric and was transferred to the Renal Unit on Day 9, but required only a brief period of intermittent haemodialysis as shown in Figure 2. She was assessed by the psychiatrists and was fit for hospital discharge on Day 16 with full neurological recovery. Her renal function returned to normal at approximately 5 weeks and she returned to work within 6 weeks.

**Discussion**

Dialysis modalities have been used for rewarming the non-arrested patient since the 1960s, but evidence is sparse in the context of a cardiac arrest. Haemodialysis (HD) is more efficient at rewarming than peritoneal dialysis (PD), but there are no studies comparing these modalities [7]. In recent years, CVVH has become more widely available making it an attractive means of rewarming [6,8,9,10]. CVVH achieves slower rewarming (2–3°C/h) than CPB (7–10°C/h), but is less invasive, requires lower anticoagulation and no interruption to CPR.

In our case, we achieved a slower rate of rewarming than anticipated (1°C/h), but this may be partly explained by the limited maximum temperature setting available on our machine. However, this rate is comparable to previous reports using CVVH in an arrested patient with an initial
temperature of 18°C despite the use of a hotline blood warmer (1.4°C/h) and in a non-arrested patient with an initial temperature of 24°C (1.3°C/h) [9].

There are few reports of the initiation of dialysis during cardiac arrest. This is largely because technique failure due to poor blood flow is usually anticipated. Our case illustrates the feasibility of performing CVVH for a prolonged period during cardiac arrest without technical difficulties. There also remains uncertainty about defibrillation practice in patients attached to dialysis equipment. This is particularly relevant in hypothermia as defibrillation is usually attempted whilst active rewarming is still in progress. In the CVVH circuit, the dialysate fluid is physically isolated from the machine such that there is no electrical path to earth rendering defibrillation safe without disconnecting the patient from the machine [11]. Although no adverse events have been reported, disconnection would be required prior to defibrillation when using conventional haemodialysis or haemodiafiltration [11]. To our knowledge, this case provides the first report of defibrillation during CVVH in a hypothermic victim, without interruption of dialysis.

In summary, CVVH can be used safely and successfully for rewarming in hypothermic cardiac arrest. To our knowledge, there exists only one previous case of hypothermic cardiac arrest with full neurological recovery using CVVH for active rewarming [8]. A standard protocol in the hypothermic victim and comparative studies with CPB is needed. We propose that CVVH should be considered in the absence of CPB facilities including the district general hospital setting.

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References


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