9. Guarro-Agustí L, Mòdol-Deltell JM, Orozco-Sándigo J, Carreres-Molas A. Infarto agudo de miocardio en paciente con coronarias sanas. Rev Clin Esp. 2014;214:545–6.
10. Kounis NG. Attack the ATAK: οὓς ὸ θεὸς συνέζευξε, ἄνθρωπος μὴ χωριζέτω (ous o theos synezeuxe anthropos me horizeto) what therefore God hath joined together, let not man put asunder. Int J Cardiol. 2016;203:960–1.

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Extracorporeal membrane oxygenation to resuscitate a 14-year-old boy after 43 min drowning

Oxigenación de la membrana extracorpórea para resucitar a un niño de 14 años después de 43 minutos de ahogamiento

Dear Editor,

Introduction

More than 500,000 people die each year for unintentional drowning, accounting for near 0.7% of all deaths worldwide.[1] If not promptly resolved, drowning rapidly causes asphyxia and subsequent cardiac arrest which drastically reduces survival possibilities and worsens neurological outcome.[2]

Many factors influence the overall prognosis, especially age.[3] Duration of submersion and water temperature are other critical aspects to consider since survival is extremely rare and full neurological recovery near impossible if submersion is longer than 30 min in water warmer than 6 °C.[2] Hypothermia induced by cold water has a protective effect on the brain possibly allowing a better neurological prognosis even after a prolonged submersion.[3] Cooling rapidity could be more important than the body temperature itself in predicting survival after drowning.[4]

This case report will discuss the management of a young boy, drowned in an Italian river during spring who had 43 min of documented drowning followed by 85 min of ineffective advanced life support for cardiac arrest who had recovery of cardiac function after extracorporeal membrane oxygenation (ECMO) and full neurological recovery.

Case report

An Italian 14-year-old healthy boy drowned and was trapped two meters under water in a river near Milan.

The firefighters extracted him from water 43 min after drowning and 29 min after the activation of the emergency system. Water temperature was 15 °C. The ECG showed the presence of asystole, Glasgow Coma Scale (GCS) score was three, skin was cyanotic, pupils were symmetrically midriatic, nasopharyngeal temperature was 29.5 °C. Cardiopulmonary resuscitation (CPR) was performed with manual chest compressions, orotracheal intubation performed, and epinephrine administered via an intraosseous access. Transient return of spontaneous circulation (ROSC) with junctional rhythm was obtained after 25 min of advanced life support (ALS). The patient was thus transferred on a helicopter and transported to our hospital. During the flight, refractory ventricular fibrillation occurred and ALS immediately re-started. The patient arrived at our institute at 6:46 pm, 100 min after the emergency system activation, under manual chest compression and directly transferred to the Cardiothoracic Intensive Care Unit (ICU). At 7:00 pm, extracorporeal life support (ECLS) was started at a flow of 3 L/min, after the percutaneous cannulation of the right femoral vein and artery under transesophageal guidance. For the persistence of ventricular fibrillation, a direct current shock was delivered and atrial fibrillation achieved. Intra-aortic balloon pump (IABP) was placed via the left femoral artery and a continuous infusion of inotropes was started to facilitate ventricular unloading.

Propofol, remifentanil, and mannitol infusions were started. He was progressively rewarmed to 36 °C in 14 h via the heat-exchange connected to the ECMO circuit.

First arterial blood gas analysis, performed immediately after ECMO start, showed pH 7.26, pO_2 176 mmHg, pCO_2 43 mmHg, HCO_3^- 9.6 mmol/L, base excess −20, lactate higher than the upper limit detectable by the analyzer, potassium 2.7 mEq/L, sodium 147 mEq/L, glucose 311 mg/dL.

Starting immediately after ICU admission, overt disseminated intravascular coagulation (hemoglobin: 11.5 g/dL, platelets count: 87,000/mm^3, INR: 1.70, aPTT: 42.5 s, D-dimer: >20 μg/mL, fibrinogen: 123 mg/dL) with massive bleeding (more than 2500 mL of bloody material aspirated from respiratory, gastrointestinal and urinary tract) was managed with multiple transfusions of red blood cells and fresh frozen.

Fourteen hours after ICU admission, propofol and remifentanil administration was stopped to allow the first neurological assessment which showed the patient comatose, areflexic, with muscular hypertonia at both lower extremities and at the right arm. Only the ciliospinal reflex

was evocable after intense stimulation. Propofol infusion was thus restarted.

The second day, acute renal failure requiring renal replacement therapy (highest value of serum creatinine registered = 2.83 mg/dL) and acute liver failure (highest transaminase value = 4925 U/L; highest total bilirubin value = 6.29 mg/dL) were evident. On the third day of hospitalization, propofol infusion was stopped again to permit a second neurological assessment that showed the patient with open eyes and able to obey to simple orders. After four days, in light of myocardial recovery, ECMO and IABP were removed. The fifth day, brain magnetic resonance was performed and showed thalamic ischemia and signs of reduced cortical diffusion and intracranial hypertension. Furthermore, during the same day amputation of the right leg was performed since irreversible ischemia of the right inferior limb occurred. Pharmacological inotropic support was stopped ten days after hospital admission. On the same day, the patient was transferred to the neurosurgical ICU.

Neurological status progressively improved, after 13 days of hospitalization the patient was awake and neurologically intact, reaching a complete recovery after 37 days of hospitalization, the day in which he was discharged at home. After few months, he went back to school and he speaks the four languages he spoke before the accident.

Patient's relatives signed a written consent for the scientific use of the patient's data. Ethics committee approval was waived according to Italian law.

This is the longest mild hypothermic drowning with excellent neurological recovery reported in literature. Indeed, the patient had near one hour and a half CRP before ECMO start; water temperature was 15 °C and patient's body was found at 29.5 °C. Furthermore, the two years follow up confirmed the absence of neurological deficits. The only report with longer duration of submersion (83 min estimated) happened in icy water with the patient retrieved at 13.8 °C (profound hypothermia).[5] The authors described an excellent neurological outcome even though ten months after the episode described the patient had generalized seizures requiring antiepileptic therapy initiation. Furthermore, in this case the patient was first treated with cardiopulmonary by-pass and only subsequently with ECMO.

This report questions the borders of futility of extracorporeal CPR and when ''to stop'' it. As a matter of fact, strict cooperation of emergence medical service and ECMO unit allowed this boy ''back to life''.

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Conflicts of interest

The authors declare no conflict of interest.

References

1. Szpilman D, Bierens JJ, Handley AJ, Orlowski JP. Drowning. N Engl J Med. 2012;366:2102–10.
2. Champigneulle B, Bellenfant-Zegdi F, Follin A, Lebard C, Guinvarch A, Thomas F, et al. Extracorporeal life support (ECLS) for refractory cardiac arrest after drowning: an 11-year experience. Resuscitation. 2015;88:126–31.
3. Suominen P, Baillie C, Korpela R, Rautanen S, Ranta S, Olkkola KT. Impact of age, submersion time and water temperature on outcome in near-drowning. Resuscitation. 2002;52:247–54.
4. Youn CS, Choi SP, Yim HW, Park KN. Out-of-hospital cardiac arrest due to drowning: an Utstein Style report of 10 years of experience from St. Mary's Hospital. Resuscitation. 2009;80:778–83.
5. Romlin BS, Winberg H, Janson M, Nilsson B, Björk K, Jeppsson A, et al. Excellent outcome with extracorporeal membrane oxygenation after accidental profound hypothermia (13.8 °C) and drowning. Crit Care Med. 2015;43:e521–5.

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