Resuscitation 81 (2010) 867–871

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Esophageal temperature after out-of-hospital cardiac arrest: An observational study☆

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ARTICLE INFO

Article history:
Received 18 December 2009
Received in revised form 17 March 2010
Accepted 20 March 2010

Keywords:
Resuscitation
Cardiac arrest
Therapeutic hypothermia

ABSTRACT

Introduction: Out-of-hospital cardiac arrest (OHCA) is a significant cause of death and severe neurological disability. The only post-return of spontaneous circulation (ROSC) therapy shown to increase survival is mild therapeutic hypothermia (MTH). The relationship between esophageal temperature post OHCA and outcome is still poorly defined.

Methods: Prospective observational study of all OHCA patients admitted to a single centre for a 14-month period (1/08/2008 to 31/09/2009). Esophageal temperature was measured in the Emergency Department and Intensive Care Unit (ICU). Selected patients had pre-hospital temperature monitoring. Time taken to reach target temperature after ROSC was recorded, together with time to admission to the Emergency Department and ICU.

Results: 164 OHCA patients were included in the study. 105 (64.0%) were pronounced dead in the Emergency Department. 59 (36.0%) were admitted to ICU for cooling; 40 (24.4%) died in ICU and 19 (11.6%) survived to hospital discharge. Patients who achieved ROSC and had esophageal temperature measured pre-hospital ($n = 29$) had a mean pre-hospital temperature of 33.9 °C (95% CI 33.2–34.5). All patients arriving in the ED post OHCA had a relatively low esophageal temperature (34.3 °C, 95% CI 34.1–34.6). Patients surviving to hospital discharge were warmer on admission to ICU than patients who died in hospital (35.7 °C vs 34.3 °C, $p < 0.05$). Patients surviving to hospital discharge also took longer to reach T_{targ} than non-survivors (2 h 48 min vs 1 h 32 min, $p < 0.05$).

Conclusions: Following OHCA all patients have esophageal temperatures below normal in the pre-hospital phase and on arrival in the Emergency Department. Patients who achieve ROSC following OHCA and survive to hospital discharge are warmer on arrival in ICU and take longer to reach target MTH temperatures compared to patients who die in hospital. The mechanisms of action underlying esophageal temperature and survival from OHCA remain unclear and further research is warranted to clarify this relationship.

1. Introduction

Out-of-hospital cardiac arrest (OHCA) is a significant cause of death and severe neurological disability across Europe. Resuscitation is attempted in 66 per 100,000 population annually.[1] Despite efforts to optimise early access to advanced cardiac life support, survival rates from OHCA remain low, with survival to hospital discharge rates varying from less than 5% to over 10%.[2,3] Good quality cardiopulmonary resuscitation and prompt defibrillation are key interventions to achieve return of spontaneous circulation (ROSC) and neurologically intact survival. Following ROSC the aim is to limit further brain injury and minimise subsequent morbidity and mortality. The only post-ROSC therapy shown to increase survival and improve neurological outcome following OHCA is mild therapeutic hypothermia (MTH).

In 2002 two prospective randomised trials found that inducing MTH (32–34 °C) after OHCA could increase survival and reduce neurological morbidity.[4,5] Both trials had similar recruitment criteria and included patients with ROSC who remained intubated and ventilated after OHCA due to ventricular fibrillation (VF) of presumed cardiac aetiology. Despite the uniformity of study groups, the implementation of MTH differed significantly between the two trials.

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at doi:10.1016/j.resuscitation.2010.03.017.

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doi:10.1016/j.resuscitation.2010.03.017

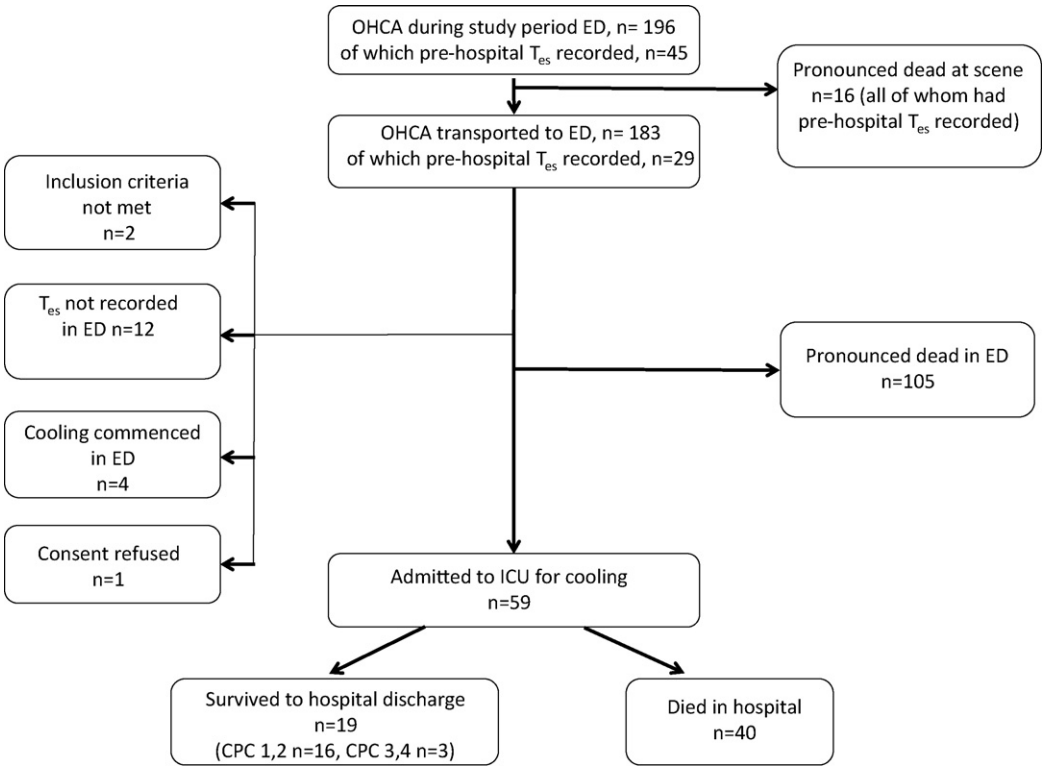

Fig. 1. Patient flow diagram.

In 2003, the Advanced Life Support Task Force of the International Liaison Committee on Resuscitation (ILCOR) published an advisory statement indicating that further research was required to establish the optimum target temperature, optimal duration of hypothermia, rates of cooling and re-warming and an understanding of the mechanism of MTH.[6] This call for further research was reiterated by ILCOR in 2007.[7] To generate explanatory hypotheses answering some of these important clinical questions baseline observational data is required. Establishing the pattern of change of body temperature after OHCA will inform decisions about the most effective time to commence cooling and may enhance understanding of the mechanisms of MTH.

This prospective study aims to describe the natural progression of esophageal temperature following OHCA from the pre-hospital phase until arrival on the Intensive Care Unit (ICU) and observe any relationship between esophageal temperature, outcome and time to reach target temperature.

2. Methods

We prospectively collected data on OHCA in the Edinburgh area (population approximately 500,000) over a 14-month period (1st of August 2008 to 31st September 2009). OHCA patients transported to the Emergency Department (ED) of a single university teaching hospital (Royal Infirmary of Edinburgh) were enrolled in the study. Inclusion criteria were adult cardiac arrest of non-traumatic cause, unwitnessed by ambulance personnel and who remained comatose after ROSC. The study was approved by the Scottish national medical research ethics committee.

The Scottish Ambulance Service routinely collect Utstein template data on all OHCA patients. Time of emergency call, ambulance dispatch and on-scene times are recorded automatically by the ambulance service computer system with the aid of real-time satellite positioning. Ambulance records were matched with the ED and ICU patient notes. Patients were followed up to the point of discharge from the admitting hospital or death. Cerebral Performance Category[8] was noted at the point of hospital discharge.

For a proportion of the OHCA episodes studied, a research doctor (RL) attended the scene with an ambulance crew. For these patients esophageal temperature (T_{es}) measurement was commenced in the field. All other OHCA patients had esophageal temperature measuring commenced on arrival in the ED. Esophageal temperature monitoring is the most practical means of accurately measuring core body temperature during the pre-hospital phase of patient care. An esophageal temperature probe was marked at 15 cm from the tip and inserted as soon as practical during the resuscitation. The thermometer tip was therefore 15 cm from the nostril and the position confirmed by laryngoscopy. The probe was linked to a digital recording thermometer (DataTherm II) with esophageal temperature recorded every 10 min to 0.1 °C accuracy. Esophageal temperature recording continued for a 24-h period.

We recorded the pattern of change in esophageal temperature from either the pre-hospital or ED phase of the OHCA patient's journey until target temperature ($T_{targ.}$ < 34 °C) was reached in the ICU. Time taken to reach $T_{targ.}$ after ROSC was recorded, together with time to admission to the ED and ICU and the time active cooling was commenced.

The study was approved by the Scottish National Research Ethics Committee. Consent from the next-of-kin was sought until the patient was able to give informed consent. If the patient did not survive, permission was granted from the Ethics Committee to use the research data.

In the receiving hospital, cooling is routinely initiated after admission to the ICU. Body surface cooling (Arctic Sun, Medivance Ltd) is used with automatic temperature feedback control. In a small proportion of cases cooling is commenced in the ED by placing ice packs on the patient. Patients who had active cooling initiated in the ED were excluded from the time point at which cooling was commenced. Data were entered into a database (Microsoft Access 2007) and analysed using statistical analysis software (Microsoft