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Clinical paper

Seasonal variability and influence of outdoor temperature on body temperature of cardiac arrest victims☆

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ABSTRACT

Aim of the study: Mild therapeutic hypothermia is a major advance in post-resuscitation-care. Some questions remain unclear regarding the time to initiate cooling and the time to achieve target temperature below 34 °C. We examined whether seasonal variability of outside temperature influences the body temperature of cardiac arrest victims, and if this might have an effect on outcome.
Methods: Patients with witnessed out-of-hospital cardiac arrests were enrolled retrospectively. Temperature variables from 4 climatic stations in Vienna were provided from the Central Institute for Meteorology and Geodynamics. Depending on the outside temperature at the scene the study participants were assigned to a seasonal group. To compare the seasonal groups a Student's *t*-test or Mann–Whitney *U* test was performed as appropriate.
Results: Of 134 patients, 61 suffered their cardiac arrest during winter, with an outside temperature below 10 °C; in 39 patients the event occurred during summer, with an outside temperature above 20 °C. Comparing the tympanic temperature recorded at hospital admission, the median of 36 °C (IQR 35.3–36.3) during summer differed significantly to winter with a median of 34.9 °C (IQR 34–35.6) ($p < 0.05$). This seasonal alterations in core body temperature had no impact on the time-to-target-temperature, survival rate or neurologic recovery.
Conclusion: The seasonal variability of outside temperature influences body temperature of out-of-hospital cardiac arrest victims.

1. Introduction

Mild therapeutic hypothermia is one of the major advances in post-resuscitation care within the last years. The reduction of core body temperature to 32–34 °C in comatose survivors of cardiac arrest has shown to improve neurologic outcome and long-term survival rates.[1–5] Several issues regarding the feasibility and safety of mild therapeutic hypothermia have been assessed in prior clinical trials. However, some questions remain unclear concerning appropriate time to initiate mild therapeutic hypothermia, cooling rates and the time needed to achieve target temperature.[6–8]

In this regard, the question arises whether the seasonal variability of outside temperature and climatic condition may affect the core body temperature and the temperature management of patients who have been successfully resuscitated from cardiac arrest.

Cardiovascular disease is the major cause of death in industrialized countries. Seasonal variability and the influence of climatic triggering factors have been investigated in numerous studies so far, indicating that a correlation between cold weather and an increased incidence of cardiovascular death exists.[9–14]

We questioned whether the seasonal variability of outside temperature in an urban region influences the body temperature of cardiac arrest victims, resulting in a variation of tympanic temperature and core body temperature after hospital admission. Furthermore we attempted to investigate whether this alteration in body temperature may affect the survival rate and neurologic outcome of our study participants and additionally whether it may interfere with the temperature management of patients who receive mild therapeutic hypothermia.

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2. Methods

This retrospective cohort analysis is based on the cardiac arrest registry of patients admitted and treated at the Department of Emergency Medicine at the Medical University Vienna. We enrolled patients who suffered a witnessed cardiac arrest at public places outdoors in the urban region of Vienna. The registry was accredited by the institutional ethics committee and contains prospectively compiled data of all adult patients between 1991 and 2010 who experienced a cardiac arrest of non-traumatic origin.

2.1. Meteorological factors

Meteorological data were obtained from the Central Institute for Meteorology and Geodynamics (ZAMG). It includes data from 4 different urban climatic stations in Vienna. The recorded data from these stations contains temperature variables (°C) assessed at 3 different times throughout the day (7am/2pm/5pm).

2.2. Resuscitation factors

Continuous assessment included data obtained from the emergency medical service, surveillance monitors and patient charts. Tympanic temperature assessed on admission was measured with an infrared tympanic thermometer (Ototemp LighTouch; Exergen Corporation, Watertown, MA, USA). Invasive temperature measurements were obtained with a bladder-temperature probe (Foley catheter temperature sensor; Smiths Medical, Dublin, OH, USA) or oesophageal temperature probe (Mon-a-therm General purpose; Mallinckrodt Medical Inc., now part of Covidien, Hazelwood, MO, USA). The time-to-target temperature was defined as time period from cooling initiation until a core body temperature below 34 °C was achieved.

Data acquisition and documentation was executed in accordance to the Utstein Criteria – guidelines for cardiac arrest and cardiopulmonary resuscitation outcome reports.[15] For the neurologic evaluation the Cerebral Performance Score criteria were used. Follow up of all patients were performed at regular intervals until 6 months after return of spontaneous circulation (ROSC).

2.3. Inclusion criteria

Patients, who suffered a witnessed out-of-hospital cardiac arrest of non-traumatic origin regardless of the initial cardiac rhythm were included. In order to achieve a close correlation between the events and the outside temperature data, patients were only included if the cardiac arrest occurred at one of the 3 time points ±90 min of outside-temperature-measurements by the ZAMG. The geographic location where the cardiac arrest occurred was correlated to the nearest located urban climatic station. All patients who met the inclusion criteria were assigned to one of the three climatic subgroups, depending on the designated outside temperature on the scene: The winter group, with an outside temperature equal or lower than 10 °C, and a summer group, with an outside temperature equal or greater than 20 °C. Cardiac arrest victims with an outside temperature between 10 and 20 °C on the scene were assigned to the intermediate group.

2.4. Endpoints

The primary endpoint was defined as first assessed tympanic temperature at hospital admission and the first obtained invasive temperature, if available, correlated to the designated outside temperature at the scene. The secondary endpoint was defined as 6-month survival rate and favourable neurologic recovery within 6 months after cardiac arrest.[15] Favourable neurologic recovery was defined as Pittsburgh cerebral-performance category (CPC) of good neurologic recovery (CPC 1) or moderate disability (CPC 2). Other categories included severe disability (CPC 3), vegetative state (CPC 4) or death (CPC 5). A patient who did not regain consciousness due to necessary anaesthesia before death or 6 months was categorized as CPC 4. For patients who received mild therapeutic hypothermia the time period to reach the target temperature below 34.0 °C and the cooling rate (°C/h) was calculated.

2.5. Statistical analysis

Categorical variables are presented as counts and percentage, for continuous variables mean and standard deviation (SD), or median and interquartile range (IQR) were calculated. Differences between the climatic subgroups were calculated using Chi-square for random variables and Student's *t*-test or Mann–Whitney *U* test for continuous variables. A linear regression analysis was carried out to differentiate influence factors on body temperature at admission. In order to examine whether the first measured tympanic temperature at admission may affect the overall 6-month survival-rate and neurologic recovery, a logistic regression analysis was performed.

Data were handled with Microsoft Excel 2008 for MAC (Microsoft Corporation® Redmond, USA), statistical analysis was performed using PASW Statistics 18.0 for MAC (SPSS Inc., Chicago, USA).

3. Results

Between 1991 and 2009 on outdoor public places 230 patients with a witnessed out-of-hospital cardiac have been identified. For 176 patients a correlation to the defined time point of outdoor temperature measurement could be established; 42 patients had to be withdrawn from analysis, because no initial tympanic temperature, measured at hospital admission, was available. The remaining 134 patients were divided into three subgroups. The winter group, with an outside temperature equal or lower than 10 °C, comprised 61 patients (46%), 39 patients (29%) were assigned to the summer group, with an outside temperature equal or higher than 20 °C. The intermediate group, with an outside temperature between 10 and 20 °C enclosed 34 patients (25%). Comparing demographic factors between winter and summer group, no significant differences were found (Table 1).

3.1. Resuscitation factors

Concerning the aetiology of cardiac arrest, an underlying cardiovascular disease was determined in the vast majority of all cases (81%), showing a similar distribution in winter (79%) and summer (77%). Regarding the initial rhythm, ventricular fibrillation was present in 103 patients (77%) with an equal distribution in winter and summer groups.

All 134 out-of-hospital cardiac arrests were witnessed. In 123 cases the event was witnessed by a bystander (92%), in 11 cases (8%) the arrest occurred in the presence of the emergency medical service (EMS) on the scene, before getting ready for transportation. Initial basic life support provided by bystanders was documented in 64 cases and equally distributed in both seasonal groups (Table 1). The time from collapse to initiation of cardiopulmonary resuscitation (CPR) defined as 'no-flow' time, was a median of 3 min (IQR 1–8), which did not differ significantly comparing the winter group, with a median of 5 min (IQR 1–7) to the summer group, with a median of 3 min (IQR 1–8) ($p = 0.93$). Also the time from initiation of CPR to ROSC, defined as 'low-flow' time, was not different between subgroups, showing an overall median time of 17 min (IQR 11–25). In 119 patients ROSC was achieved before admission to hospital, 15 patients were admitted with ongoing CPR. Out of these 15