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Brief Reports

DIFFERENCE BETWEEN BLADDER AND ESOPHAGEAL TEMPERATURES IN MILD INDUCED HYPOTHERMIA

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☐ **Abstract—Background: Mild induced hypothermia is an established treatment strategy for comatose survivors of cardiac arrest. The goal of the induction phase of mild induced hypothermia is to cool the patient's core body temperature to 32°–34°C. Objective: The main goal of this study was to compare temperature changes measured in the esophagus and urinary bladder in survivors of cardiac arrest undergoing mild induced hypothermia using cold saline infusion. Methods: We performed a prospective study in a 12-bed adult medical intensive care unit at a tertiary level hospital in comatose adult survivors of nontraumatic cardiac arrest admitted from January to April 2012. Paired temperature readings from bladder and esophageal probes were recorded every 5 min for 95 min (20 readings). Cold fluid infusion was terminated when the measured temperature from either of the probes reached 33.9°C. Factorial repeated-measures analysis of variance was used to determine the effect of time and site of measurement on temperature readings. Results: Measurements were performed in 8 patients. Target temperature was achieved in 33 ± 15 min in the esophagus and in 63 ± 15 min in the bladder ($p = 0.006$). We discovered a significant interaction effect ($p < 0.001$) between time and site of measurement, indicating that temperature changes differently depending on the site of measurement, with esophageal temperatures decreasing faster than temperatures measured in urinary bladder. Conclusions: Our results indicate that esophageal temperature measurements show a faster response rate compared to temperature measured in the bladder when cold saline infusion is used to induce mild hypothermia.** © 2015 Elsevier Inc.

☐ **Keywords—mild hypothermia; induced; patient monitoring; thermometer; thermometry; heart arrest**

INTRODUCTION

Mild induced hypothermia (MIH) is an established treatment strategy for comatose survivors of cardiac arrest (1). Despite widespread use of MIH it remains unclear where to assess body temperature during this procedure (2,3). Measurement of temperature changes is especially important in the induction phase of MIH, where rapid temperature changes occur (4,5).

The goal of the induction phase of MIH is to decrease the patient's core body temperature to 32°–34°C. Core body temperature is defined as central circulation temperature (measured in jugular bulb or pulmonary artery) or brain tissue temperature (2,4). Measurement of central circulation temperature or brain tissue temperature in an emergency setting is impractical, time consuming, and has additional procedure-related risk (4,5). Surrogate sites, usually bladder, rectum, or esophagus, are often used for measuring body temperature in clinical setting (1,6,7).

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Current guidelines do not prescribe the exact site for temperature measurement. Bladder, rectum, and esophagus are proposed (1). There have been reports, mostly from elective surgical patients, that bladder and rectum sites do not reflect real-time temperature changes when hypothermia is induced, and that temperature changes in these sites lag behind core body temperature changes (5–9). So far, there is little information on which temperature measuring site is closest to temperature changes measured invasively in patients where hypothermia is induced after cardiac arrest (5,10). This is important, as it might result in the patient receiving additional cold fluid infusion, leading to overcooling and associated complications, such as dysrhythmias, hypotension, reduced cardiac function, immune suppression and coagulopathy (4–9).

The main goal of the study was to compare simultaneously measured temperatures in the esophagus and the bladder in adult survivors of cardiac arrest. We hypothesized that temperature measured in the esophagus would reach target values faster compared to temperature measured in the bladder.

METHODS

This study was performed between January and April 2012. Institutional ethical committee approval was acquired (No. 67/12) and informed consent was obtained from closest relatives. Current guidelines were followed regarding patient selection for MIH treatment (1). Body temperature was measured simultaneously using urinary bladder (Foley catheter probe; Philips, Amsterdam, The Netherlands) and esophageal (Esophageal/rectal probe, adult; Philips) temperature probes. Inclusion criteria were the following: comatose adult survivors of nontraumatic cardiac arrest and induction of MIH not performed before admission to the intensive care unit (ICU). Exclusion criterion was not being able to insert esophageal or bladder temperature probes. Three attempts at nasal insertion were allowed and, if not successful, 1 additional attempt under direct laryngoscope guidance was allowed (11). Three attempts at bladder temperature probe insertion were allowed.

Two teams inserted esophageal and bladder probes simultaneously as soon as possible after admission. Esophageal probes were inserted through nasal orifices to the depth of 30 cm. Once both probes were inserted and functioning, MIH was induced using rapid infusion (target infusion rate approximately 100 mL/min, achieved using multiple infusion sites and pressure bags if necessary) of cold (4°C) normal saline. Expected volume of cooled saline was 30 mL/kg, however, cold saline infusion was terminated once the first of the two simultaneously measuring probes reached 33.9°C. Temperature of 33.9°C was selected as an arbitrary point within the recommended temperature range for MIH of 32°–34°C (1). At that point, the induction phase of MIH was concluded and maintenance phase started. If target temperature was not achieved with the expected volume, additional rapid infusions of cold saline were allowed in 500-mL increments. External cooling using external cooling blankets was used in all patients (CritiCool®; MTRE, Rehovot, Israel). Patients received fentanyl for analgesia and were sedated with midazolam or propophol. Norcuronium was applied if shivering was detected by the attending physician. Clinical data including age, sex, weight, height, first recorded rhythm, duration of cardiopulmonary resuscitation, time from return of spontaneous circulation to induction of MIH and use of norcuronium was obtained by medical records review. Ambient temperature was measured using standard ethanol room thermometers for survivors of in-hospital cardiac arrest and obtained from medical history for survivors of out-of-hospital cardiac arrest. Temperature readings were started once both probes were functional and were continued at 5-min intervals for a total of 95 min (20 readings).

Both temperatures were followed on the same monitor (Philips IntelliVue MX800). Identical modules (Philips M1029 A Temperature Module) with mean time constant of <10 s were used to connect temperature probes to the monitor.

Statistical analysis was performed using IBM SPSS statistics software for Windows, version 19.0 (IBM SPSS, Armonk, NY). A *t*-test was used to compare means of initial temperatures, time to target temperature, and the rate of temperature decline. Factorial repeated measures analysis of variance was used to assess the effects of time, site of measurement, and their interaction. All effects were considered as significant at $p < 0.05$. The Greenhouse-Geiser correction was used when Maulchy's test indicated the violation of the assumptions of sphericity for the main effect of time and the interaction effect between time and type of measurement (the number of time points included in the analysis was reduced to 7 equidistant points 15 min apart, range 0–95 min).

RESULTS

The cohort used for this study comprised 8 patients, 69.9 ± 11.7 years old, and 5 (63%) were male. In all, 30 patients were considered for inclusion; 20 were not included because MIH was induced before ICU admission and 2 patients were excluded after failure to insert urinary bladder temperature probe in 3 attempts. Five patients (63%) were survivors of in-hospital cardiac arrest. The baseline characteristics of included patients are outlined in Table 1.

There were no significant differences between initial temperatures (35.7° ± 0.7°C in the esophagus vs.