Injury, Int. J. Care Injured xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Injury

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

Review article

The prehospital management of hypothermia — An up-to-date overview☆

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ARTICLE INFO

Article history:
Accepted 3 November 2017

Keywords:
Accidental hypothermia
Pre-hospital care
Emergency medicine

ABSTRACT

Background: Accidental hypothermia concerns a body core temperature of less than 35 °C without a primary defect in the thermoregulatory system. It is a serious threat to prehospital patients and especially injured patients, since it can induce a vicious cycle of the synergistic effects of hypothermia, acidosis and coagulopathy; referred to as the trauma triad of death. To prevent or manage deterioration of a cold patient, treatment of hypothermia should ideally begin prehospital. Little effort has been made to integrate existent literature about prehospital temperature management. The aim of this study is to provide an up-to-date systematic overview of the currently available treatment modalities and their effectiveness for prehospital hypothermia management.

Data sources: Databases PubMed, EMbase and MEDLINE were searched using the terms: "hypothermia", "accidental hypothermia", "Emergency Medical Services" and "prehospital". Articles with publications dates up to October 2017 were included and selected by the authors based on relevance.

Results: The literature search produced 903 articles, out of which 51 focused on passive insulation and/or active heating. The most effective insulation systems combined insulation with a vapor barrier. Active external rewarming interventions include chemical, electrical and charcoal-burning heat packs; chemical or electrical heated blankets; and forced air warming. Mildly hypothermic patients, with significant endogenous heat production from shivering, will likely be able to rewarm themselves with only insulation and a vapor barrier, although active warming will still provide comfort and an energy-saving benefit. For colder, non-shivering patients, the addition of active warming is indicated as a non-shivering patient will not rewarm spontaneously. All intravenous fluids must be reliably warmed before infusion.

Conclusion: Although it is now accepted that prehospital warming is safe and advantageous, especially for a non-shivering hypothermic patient, this review reveals that no insulation/heating combinations stand significantly above all the others. However, modern designs of hypothermia wraps have shown promise and battery-powered inline fluid warmers are practical devices to warm intravenous fluids prior to infusion. Future research in this field is necessary to assess the effectiveness expressed in patient outcomes.

Contents

☆ A previous version of the abstract of this article was presented as a poster at the European Congress of Trauma and Emergency Surgery from May 7th to May 9th 2017, Boekarest, Romania.

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https://doi.org/10.1016/j.injury.2017.11.001
0020-1383/

Introduction

Accidental hypothermia is defined as an unintentional decrease in body temperature to below 35 °C, without the presence of a primary defect in the patient's thermoregulatory mechanism. It can be subdivided into mild (35–32 °C), moderate (32–28 °C) and severe (<28 °C) hypothermia; a temperature below which cardiac arrest or low flow state can occur [1]. Hypothermia negatively affects multiple organ systems [2–6], and is associated with poor outcomes including death [7–13]. In the United States, approximately 1500 people die of primary hypothermia each year [14]. The etiology of hypothermia is multifactorial and the assumed main causes of accidental hypothermia in injured patients are heat loss due to environmental exposure, the administration of cold intravenous fluids, hemorrhagic shock and the effects of anesthesia or sedation on thermoregulation [15–17].

All prehospital patients could become hypothermic due to their sickness or injury. Especially in the severely injured trauma patients its incidence ranges from 13.3% to 43% in various prehospital environments worldwide [11,13,18–20]. In studies of trauma patients who were hypothermic on arrival at the emergency department, the average core temperature was 33.5 °C [13,18,19,21,22]. Hypothermia is one of the components of the trauma triad of death, which is a vicious cycle caused by the synergistic effects that hypothermia, coagulopathy and acidosis have on each other [18,25–27].

One of the effects of hypothermia is poor tissue oxygenation throughout the body caused by peripheral vasoconstriction, decreased myocardial contractility and decreased oxygen release from hemoglobin to tissue [16,23–25]. This effect on tissue oxygenation causes an increase in the cell metabolism's proportion of anaerobic metabolism. Normally, during aerobic metabolism, heat is produced by the hydrolysis of adenosine triphosphate (ATP) to adenosine diphosphate (ADP); in contrast, the anaerobic metabolism results in decreased ATP synthesis and consequently decreased heat production. Anaerobic metabolism also produces higher lactate levels and causes metabolic acidosis [24].

The activity of coagulation enzymes decreases with acidosis [15] and lower body temperatures. In addition, hypothermia causes a defect in the aggregation and adhesion of platelets and a decrease of fibrinogen availability, resulting in prolonged bleeding times [26,27]. These abnormalities can be reversed by rewarming [26].

Early recognition and treatment of hypothermia is essential to oppose the deterioration of a patient's condition. Treatment ideally begins in the prehospital setting and should focus on reducing heat loss, promoting cardiovascular stability, restoring fluid volumes and reversing core cooling. Regarding core temperature maintenance, there is considerable laboratory-based literature specifically regarding properties of insulation materials and heat sources, as well as randomized controlled trials on rewarming methods for cold subjects, but little effort has been made to integrate all of this information. The most recent reviews, which focused primarily on the prehospital treatment of hypothermia, were performed 16 years ago [28,29]. As well, there is a shortage of large randomized controlled trials conducted in the pre-hospital setting.

The aim of this review article is to provide an up-to-date systematic overview of the available treatment modalities relating to insulation and/or application of heat for the prehospital management of hypothermic patients and to present the best available evidence for their effectiveness to improve patient care.

Methods

The databases PubMed, EMbase (OvidSP) and MEDLINE (OvidSP) were searched using various keywords and strategies;

Table 1
Literature search.

	EMbase (OvidSP)	MEDLINE (OvidSP)	PubMed
Search strategy	1. exp accidental hypothermia/or exp hypothermia/or hypothermia.mp. 2. hypothermia.af. 3. hypotherm* 4. prehospital.af. 5. 1 or 2 or 3 6. 4 and 5 7. limit 6 to (exclude medline journals and (dutch or english))	1. hypothermia.mp. or exp Hypothermia/ 2. hypothermia.af. 3. hypotherm* 4. prehospital.af. 5. exp Emergency Medical Services/or prehospital.mp. 6. 1 or 2 or 3 7. 4 or 5 8. 6 and 7 9. limit 8 to (dutch or english)	((("hypothermia"[All Fields]) OR (hypotherm*)) AND prehospital[All Fields]) AND (English[lang] OR Dutch[lang])
Hits	32	948	288

Conducted during October 2017.

Please cite this article in press as: F.J.C. Haverkamp, et al., The prehospital management of hypothermia — An up-to-date overview, Injury (2017), https://doi.org/10.1016/j.injury.2017.11.001