TRATAMIENTO DE LA HIPOTERMIA ASOCIADA AL TRAUMATISMO EN EL ÁMBITO EXTRAHOSPITALARIO: SCOPING REVIEW

MANAGEMENT OF HYPOTHERMIA IN TRAUMA VICTIMS IN OUT-OF-HOSPITAL SETTINGS: A SCOPING REVIEW

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RESUMEN

INTRODUCCIÓN. La hipotermia es un elemento de la tríada letal del traumatismo, que se produce en el 30-50% de las víctimas de traumatismos graves. El objetivo de este estudio fue mapear las estrategias de manejo de la hipotermia en víctimas de traumatismos en contextos extrahospitalarios, a partir de la pregunta de revisión: "¿Qué estrategias de manejo de la hipotermia se utilizan en víctimas de traumatismos en contextos extrahospitalarios?" MATERIALES Y MÉTODOS**.** Se realizó una revisión de alcance basada en el método recomendado por el Instituto Joanna Briggs. La búsqueda se realizó en las bases de datos MEDLINE y CINAHL Complete, y en el Repositorio Comum de Acesso Aberto Português

(RCAAP). Se incluyeron estudios de cualquier tipo: cuantitativos, cualitativos, mixtos y revisiones bibliográficas, publicados o no, en portugués, inglés y español**.** RESULTADOS. Siete estudios de diferentes tipos fueron elegibles. DISCUSIÓN. Las estrategias de manejo de la temperatura pueden dividirse en dos grupos principales: medidas pasivas de calentamiento, como retirar la ropa mojada y secar a las víctimas, y medidas activas de calentamiento, como la fluidoterapia calentada. CONCLUSIONES. El desarrollo de estas estrategias por parte de los profesionales extrahospitalarios, especialmente el personal de enfermería, es esencial debido a la relación entre la hipotermia y la morbilidad y mortalidad en las víctimas de traumatismos.

Palabras clave: Hipotermia; Trauma; Extrahospitalario; Enfermería

ABSTRACT

INTRODUCTION. Hypothermia is an element of the lethal triad of trauma, occurring in 30-50% of victims of severe trauma. The aim of this study is to map out hypothermia management strategies in trauma victims in out-of-hospital settings, based on the review question: "What hypothermia management strategies are used in trauma victims in out-of-hospital settings?" MATERIALS AND METHODS**.** A scoping review was carried out based on the method recommended by the Joanna Briggs Institute. The search was carried out in the MEDLINE and CINAHL Complete databases, and in the Repositório Comum de Acesso Aberto Português (RCAAP). Studies of any type were included: quantitative, qualitative, mixed and literature reviews, published or not, in Portuguese, English and Spanish. RESULTS. Seven studies of different types were eligible. DISCUSSION. Temperature management strategies can be divided into two main groups: passive warming measures, such as removing wet clothing and drying victims, and active warming measures such as heated fluid therapy. CONCLUSIONS. The development of these strategies by out-of-hospital professionals, especially nurses, is essential due to the relationship between hypothermia and morbidity and mortality in trauma victims.

Key words: Hypothermia; Trauma; Out-of-hospital; Nursing

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BACKGROUND

The multiplicity of injuries resulting from a traumatic situation puts victims at risk of death. The mortality and morbidity resulting from these events are worrying, and nursing care is essential for immediate help. The autonomous and/or interdependent interventions carried out by nurses are aimed at preserving life, with control of external bleeding, maintenance of the airway, correct immobilisation, temperature and injury control, as well as differentiated transport to reference hospital units, being measures to be implemented early on. It is also important to prevent and control the lethal triad of trauma: coagulopathy, acidosis and

hypothermia, and the interventions of the entire team involved in caring for the victim, and especially the nurses, should be directed in this direction[1].

Hypothermia is defined as a core temperature below 35ºC, and is classified as mild (35-32ºC), moderate (32-30ºC) and severe (if below 30ºC). This classification suffers particularities when associated with a trauma mechanism, as in these cases, 36ºC is already considered mild hypothermia, 36-32ºC is considered moderate hypothermia and when the temperature is below 32ºC, it is classified as severe hypothermia[1].

Hypothermia occurs in less than 10% of simple trauma victims, but this figure rises considerably to 30-50% for severe trauma victims[2]. Hypothermia is associated with worse clinical outcomes and increased mortality, and mortality and the prevalence of hypothermia also increase according to the severity of the injuries[2,3]. Hypothermic victims also tend to have an increase in the severity of their injuries[4] and when the lethal triad is present, 96% of victims die within 24 hours[5].

The factors that contribute to hypothermia in trauma are: i) environmental exposure to cold; ii) infusion of cold fluids and blood products; iii) hypovolaemia as a consequence of haemorrhage and fluid loss (haemorrhagic shock); iv) and finally, as a side effect of anaesthetic and sedative drugs that affect thermoregulation [2,3].

Mild heat loss is generally well tolerated with compensatory pathophysiological changes that maintain homeostasis, such as increased muscle tone, shivering and increased metabolism with the release of catecholamines and thyroxine. However, when hypothermia occurs, there are changes in the various organ systems. At the muscular level, shivering increases oxygen consumption, which aggravates acidosis[2].

Changes ranging from confusion to coma may occur in the central nervous system. In cases of moderate hypothermia, below 34ºC, confusion and even unconsciousness may occur. In the case of severe hypothermia, below 32ºC, drowsiness and coma progressively set in. These situations result in a decrease in bodily reflexes, compensatory changes and alterations in other organ systems, particularly the respiratory system, which aggravate metabolic acidosis. The effect of hypothermia is also seen in the reduction of respiratory movements, with bronchospasm and even apnoea. This in turn, with the increase in lactates, aggravates coagulation, reducing platelet aggregation and adhesion, as well as the availability of fibrinogen, leading to coagulopathy. Both acidosis and hypothermia contribute to coagulopathy and should be corrected as early as possible (2,5,7).

Intestinal motility and renal diuresis decreases, with effects on renal tubule enzymes affecting bicarbonate ion reabsorption and hydrogen ion excretion, aggravating metabolic acidosis and, consequently, coagulopathy [2,6].

When the temperature is below 32ºC, it's not surprising to see disturbances in cardiac electrical conduction, and when the temperature is below 30ºC, atrial fibrillation is common. Below 28ºC, in

addition to worsening cardiac function with the appearance of supraventricular arrhythmias, ventricular fibrillation and even asystole can occur. These effects are also influenced by factors such as age and associated co-morbidities [1,2].

In the case of hypothermic patients in cardiopulmonary arrest, some guidelines should be considered. The absence of signs of life in a hypothermic victim cannot be reliably used to verify death. Good results have been reported after prolonged resuscitation in hypothermic victims, so it is acceptable to consider increasing the resuscitation and transport time until the core temperature approaches normal. Hypothermia can cause chest wall rigidity, making ventilations and compressions difficult. The use of an external mechanical compression device should therefore be considered. The hypothermic heart may not respond correctly to the drugs used in cardiopulmonary resuscitation and to the application of electrical stimuli. Drug metabolism is slowed down, which can lead to potentially toxic serum concentrations. Therefore, drugs and shocks should not be administered until the core temperature is ≥30ºC. Once this temperature is reached, the drug administration time interval should be doubled. Once normothermia has been achieved (≥35ºC), the usual protocols can be used. Defibrillation is still indicated in ventricular fibrillation. However, if it persists after 3 shocks, subsequent shocks should only be attempted once a core temperature of ≥30ºC has been achieved [8].

Hypothermia can also suppress the bone marrow and affect the splenohepatic system, decreasing platelets and leucocytes, and there is a relief of leucopenia and thrombocytopenia when the victim is rewarmed [2,3].

The most accurate method of assessing core temperature is through an esophageal probe, although this is only possible in intubated patients or those in cardiorespiratory arrest. Therefore, the ideal method for assessing body temperature should be, among those available, the least invasive, easy to use, accurate and with a quick response time [9].

Hospital transfer should ideally take place to a hospital with the capacity to perform extracorporeal life support, and is particularly important if the body temperature is <28ºC[7]. The main indications for hospital transfer of a hypothermic patient are cardiorespiratory arrest, core temperature <30ºC, hypotension and arrhythmia. If transportation impedes the performance of continuous cardiopulmonary resuscitation in the conventional manner, it is acceptable to perform it intermittently every 5 to 10 minutes if the core temperature is <28ºC[10,11].

Standard passive warming practice for trauma victims involves removing wet clothing, drying the patient and applying blankets. If hypothermia has already set in, active warming measures such as active warming blankets and the initiation of warmed fluids are initiated in addition to these. Invasive rewarming strategies, such as peritoneal lavage, are rarely used [12]. As these measures are scattered throughout the literature, they need to be mapped.

After searching MEDLINE (by PubMed), CINAHL (by EBSCOhost),

Joanna Briggs Institute (JBI) Database of Systematic Reviews, Cochrane Database of Systematic Review, PROSPERO and Open Science Framework (OSF), we identified a scoping review entitled: "Prehospital interventions to prevent hypothermia in trauma patients: a scoping review"[13], which answered our research question. Aware of the extreme importance of the subject in the rescue of trauma victims in an out-of-hospital context, and realising that there has been recent research on the same subject during preliminary research, we decided to continue the above-mentioned study by carrying out a scoping review.

We started with the following review question: "What hypothermia management strategies are used in trauma victims in an out-of-hospital context?", and where possible we would also like to identify "What types of trauma involve hypothermia management in an out-of-hospital context?".

METHODOLOGY

This scoping review was carried out in accordance with the methodological recommendations of the Joanna Briggs (JBI) Institute Reviewer's Manual and in compliance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses in its extension for Scoping Reviews (PRISMA-ScR) [14].

The objective was to map the evidence on hypothermia management strategies (Concept) in trauma victims (Population) in the out-of-hospital setting (Context), and to identify the most frequent type of trauma in victims where hypothermia management takes place, recognising gaps in knowledge and directing towards a future systematic review of the literature on the same subject.

In order to check the eligibility of the studies, we considered the following inclusion criteria:

Population

Studies were included that included trauma victims, i.e. victims with injuries or suspected injuries caused by exacerbated force mechanisms, penetrating injuries, burns, falls or explosions. Victims of paediatric age were excluded.

Concept

All the measures implemented in trauma victims with the aim of managing hypothermia were considered. Warming measures include all types of treatment carried out in emergency care, defined by type and their characteristics. Studies depicting induced or therapeutic hypothermia were excluded.

Context

All emergency care carried out in an out-of-hospital environment was taken into account. In-hospital or non-emergency care will not be included in the study.

Types of sources

Quantitative and qualitative studies, mixed methods, systematic reviews, texts and opinion articles, published or unpublished, were eligible for analysis.

Language

Documents in English, Portuguese and Spanish were included.

The research was carried out in the MEDLINE by PubMed, CINAHL Complete by EBSCOhost databases, and also in the Portuguese Open Access Common Repository. This research was structured in three phases and with the following search strategy.

Initially, a search was carried out in the MEDLINE by PubMed and CINAHL Complete by EBSCOhost databases to identify the most commonly used words in the titles and abstracts of the studies, as well as the indexing terms (according to each database used).

In the second phase, the indexed terms were combined with natural language and combined into a single search strategy, adjusted according to the specificities of each database/repository included in the review.

The time limit used in this review was from 1 January 2019 to 1 April 2023, due to the existence of the aforementioned scoping review which worked on the same theme/objectives until the end of 2018. In the third and final phase, the bibliographical references of the eligible articles were analysed in order to identify more studies of interest, but without success.

Once the above search phases had been completed, the duplicate studies were extracted by exporting them to the Mendeley Desktop software (version 1.19.3). This was followed by the inclusion of the potential studies in the Rayyan platform, where the studies were screened according to title and abstract in order to check that they met the inclusion criteria. This process was carried out independently by two reviewers, with a third element being used whenever there were differences. The studies that met the eligibility criteria went on to the next stage, which consisted of reading the article in full and analysing it.

Potentially relevant articles were retrieved in full and their citation details imported into the Mendeley Desktop software (version 1.19.3). They were analysed independently by two reviewers, with the third reviewer being called in when any discrepancies were found. Full-text studies that did not fulfil the inclusion criteria were excluded. This process is represented in Figure 1, in the Prisma flowchart.

RESULTS

The search yielded 192 articles, 161 from the Medline database and 31 from Cinahl Complete, to which 2 articles from free searches and 1 from Repositório Comum de Acesso Aberto Português were added. Of the 195 results obtained, after removing 21 duplicates, 174 articles were submitted to title and abstract analysis, 160 of which were excluded. Fourteen articles were read in full and seven were excluded, one for not fitting the population, five for the concept and one for the context of the study. Thus, 7 articles were eligible for this scoping review, 6 from database searches and 1 from grey literature.

The data was extracted by two independent reviewers using previously developed data extraction grids. Table 1 shows the studies obtained, chronologically.

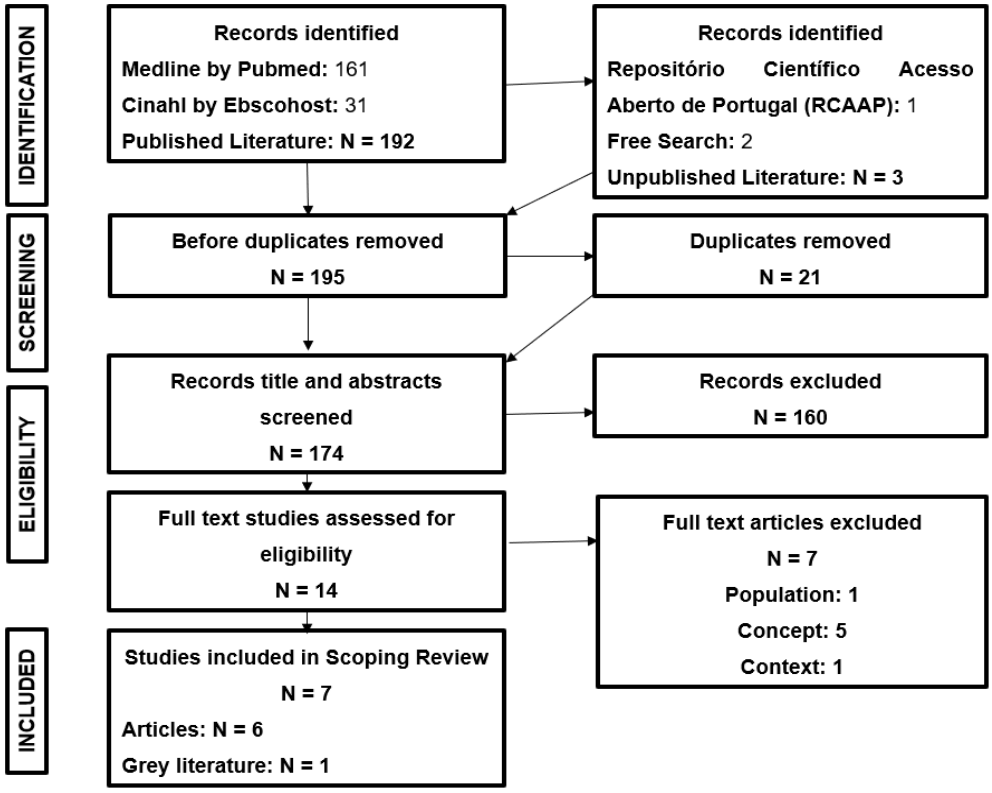

Figure 1: *Study Selection Prism Flowchart*
Adapted from The Joanna Briggs Institute (2015)

Table 1: *Presentation of Scoping Review studies*

Study	Authors and Year	Country	Type of study and Participants	Objectives
S1	Stroop et al., (2019)[15]	Germany	Retrospective study (n=292) + Descriptive study with simulated practice (n=20).	To estimate the incidence of road accidents with incarceration, comparing the time of incarceration with the integration of warm-up methods and their practicability.
S2	Meléndez-Lugo et al., (2020)[16]	Columbia	Descriptive retrospective study.	Describe the principles of out-of-hospital care with the "Stop the Bleed" Campaign.
S3	Lapostolle et al., (2021)[17]	France	Multicentre, prospective, cluster-	To assess the impact of an out-of-hospital hypothermia

			randomised study (n=1200)	management strategy on hypothermia prevention. Note: Implement if room temperature <18ºC; body temperature < 35ºC; ECG < 15 or systolic blood pressure < 100mmHg.
S4	Lavado, (2021)[18]	Portugal	Opinion article	Not defined
S5	Van Veelen & Brodmann Maeder, (2021)[19]	Switzerland	Narrative review	To describe the main factors to consider when hypothermia occurs in out-of-hospital trauma victims.
S6	Mota et al., (2021)[20]	Portugal	Prospective cohort study (n=586)	To assess the prevalence of hypothermia associated with trauma, the impact of rewarming measures and the management of discomfort caused by cold.
S7	Stevens et al., (2022)[21]	United States of America	Experimental study	To warm and humidify the airway in out-of-hospital trauma victims with an advanced airway.

The identification of the study fulfils the criteria stipulated above, using the designation S for study, accompanied by the study number described above, to make it easier to read.

S1 is a retrospective study, carried out in Germany, which aimed to estimate the incidence of serious road accidents with trapped victims and the estimated environmental temperature in a total sample of 292 extrication situations. It also included a descriptive component, comparing total extrication time with the integration of heating methods and their practicality, through simulated practices with 20 participants.

S2 is a descriptive retrospective study carried out in Columbia, with the aim of describing the out-of-hospital principles of the "Stop the Bleed" Campaign, which has existed in Latin America for around 30 years.

S3 reflects the protocol of a French, multicentre, prospective, randomised study with a sample of 1200 participants, inspired by a previous study

(Hypotraum), in which the aim was to assess the impact of an out-of-hospital hypothermia management strategy on hypothermia prevention. This strategy should be applied whenever at least one of the following conditions is met: ambient temperature <18ºC, body temperature <35ºC, Glasgow coma scale <15 or systolic blood pressure <100mmHg. The temperature assessment method used is continuous monitoring using an epitympanic thermometer.

In turn, S4 is an opinion piece published in a Portuguese academic journal, with no defined objectives, but with reference to the importance of hypothermia in the lethal triad and the continuity of care recommended between out-of-hospital and in-hospital care.

S5 is a narrative review carried out in Switzerland, with the aim of describing the main factors to consider when hypothermia occurs in out-of-hospital trauma victims.

S6 is a prospective cohort study carried out in Portugal with a sample of 586 trauma victims, whose objectives were to assess the prevalence of hypothermia associated with trauma, the impact of rewarming measures and the management of discomfort caused by cold. The method used to assess temperature was the axillary thermometer.

Finally, E7 presents a proposal for an innovative device, subjected to experimental testing and improvement, to be used in out-of-hospital settings, with the aim of warming and humidifying the airway of trauma victims in need of an advanced airway.

Table 2 shows the answers to our research questions.

Table 2: *Scoping Review results*

Study	Hypothermia Management Measures (Type and Characterisation)	Type of Trauma
S1	**Type:** Active heating **Characterisation:** "Mölnlycke Barrier® EasyWarm®" active heating blanket, or infrared radiator, or "3M Bair Hugger® 750" forced air heater with torso blanket.	Multiple Trauma
S2	**Type:** Active heating. **Characterisation:** Active heating blankets and heating of intravenous fluids to 39°C.	Not mentioned
S3	**Type:** Active and passive warming. **Characterisation:** Conventional interventions: initial temperature assessment and on arrival at hospital; completely undress the victim. Interventions to be implemented: continuous temperature assessment; do not undress unless wet; rapid placement in ambulance and warming up to >30ºC; aluminium blanket; warmed fluids (35ºC).	Not mentioned
S4	**Type:** Active warming.	Not mentioned

	Characterisation: Thermal blanket, heated fluids and heater.	
S5	**Type:** Active and passive heating. **Characterisation:** Passive heating methods: no undressing unless wet, blanket and increased room temperature. Active heating methods: heat pads, forced hot air systems; serum perfusion heaters.	Not mentioned
S6	**Type:** Active and passive heating. **Characterisation:** Passive warming measures: removing wet clothing; drying body surface; isothermal blanket; blankets; increasing ambulance temperature (20-24ºC). Active warming measures: heated intravenous fluids (25-28ºC), heating pads (instant heating bags).	The most common trauma was head trauma, followed by limb trauma and chest trauma.
S7	**Type:** Active heating **Characterisation:** Portable, battery-operated device that regulates the temperature and humidity of inhaled air in order to prevent and treat hypothermia.	Not mentioned

S1 refers to multiple trauma situations resulting from a road accident, in which three active warming devices were compared: the "Mölnlycke Barrier® EasyWarm®" warming blanket, an infrared radiator and a forced-air heater with blanket. Although each device may offer more or less advantages, the greatest increase in body temperature, assessed using a body surface thermometer, was recorded with the infrared radiator, underlining that the use of any of the devices did not delay the rescue process [(15)].

S2 also mentions active warming strategies, such as heated fluid therapy or active warming blankets, arguing that their use should not delay transport to the hospital but that they help to maintain body temperature above 35ºC. There is no reference to the type of trauma in this study [(16)].

S3 reflects the implementation of a hypothermia management strategy that includes passive and active warming measures. Although it doesn't define the type of associated trauma, it describes the measures to be adopted in the new hypothermia management strategy as continuous temperature assessment (using an epi-tympanic device), not removing the victim's clothing unless wet, rapid placement in the ambulance with heating above 30ºC, placement of an aluminium blanket for thermal insulation and fluid therapy heated to 35ºC, in contrast to the conventional approach to trauma victims of initial temperature assessment and hospital admission, and removal of all the victim's clothing for a full assessment [(17)].

S4 refers to active warming measures such as thermal blankets, heated fluids and heaters [18], without referring to the type of trauma, as does S5. The latter describes passive warming methods such as not undressing the victim unless wet, applying a blanket and increasing the ambient temperature, and active warming methods such as heat pads, forced hot air systems and fluid perfusion warmers [19].

On the other hand, S6, whose most common type of trauma is head trauma, followed by limb and chest trauma, refers to active and passive warming measures, emphasising their importance in managing not only hypothermia but also the discomfort associated with cold. Passive warming measures include removing wet clothing, drying the body surface, using an isothermal blanket, applying blankets and increasing the temperature in the ambulance (20-24ºC). The active warming measures described are intravenous fluids warmed to 25-28ºC and heating pads/instant warming bags [20].

Finally, S7 also makes no reference to the type of trauma, presenting a proposal for a portable device for managing hypothermia, as part of an active warming method, which allows the airway to be warmed and humidified when an advanced airway device needs to be placed, bringing to the out-of-hospital setting a reality that is still only possible after hospital admission [21].

DISCUSSION

Analysing the studies, it is clear that there is concern about the management of hypothermia and its importance in the lethal triad of trauma, in an out-of-hospital context, and the extreme importance of the subject, since publications are constant. Portugal leads the publications with two articles (S4, S6), with the existence of a scoping review that motivated the inclusion of the time factor for this review.

Studies in Europe predominate (S1, S3, S4, S5, S6), but there is one study carried out in Latin America, Columbia (S2) and another in the United States (S7). There are also two retrospective studies (S1, S2), two prospective studies (S3, S6), a narrative review (S5), an opinion article (S4) and an experimental study (S7).

Although not all the studies identify the type of trauma the victims were subjected to, S1 refers to multiple trauma and S6 highlights head trauma as the most common, followed by limb trauma and chest trauma.

Even taking into account the time limit, there are studies that portray hypothermia management strategies in this specific context, which can be included in two large groups: active heating strategies and passive heating strategies.

Active warming strategies predominate as they are described in all the articles, examples of which are active warming blankets (S1, S2, S4), forced hot air systems (S1), infrared or other warmers (S1, S4), warmed fluids and fluid perfusion warmers (S2, S3, S4, S5, S6), as well as heating pads or active heat/instant warming bags (S5, S6).

On the other hand, passive warming strategies are described by S3, S5 and S6, and are, for example, removing wet clothes (S3, S5, S6), drying victims (S3, S5, S6), avoiding removing clothes

when dry (S3, S5), placing a simple blanket (S5, S6), heating the room temperature or the sanitary cell (S3, S5, S6) and using an isothermal blanket for thermal insulation (S3, S5, S6).

In S2, as in S4, only active warm-up strategies are mentioned, and it is not described whether or not passive warm-up strategies are carried out on trauma victims, which does not reveal the complementarity recommended between them, as seen in S3, S5 and S6. However, it is clear from these studies, S2 and S4, the importance of the complementarity of care recommended between the out-of-hospital and in-hospital contexts for trauma victims.

Another important aspect is described in S5, that the level of hypothermia presented should be classified, directing the most appropriate care and managing its effects on the lethal triad of trauma, especially coagulation.

In S6, carried out in Portugal, the importance of hypothermia management in the lethal triad is clear, as is the relationship with the discomfort associated with cold. In this study, warming measures were used in 80 per cent of the victims, with a greater increase in body temperature in these victims, and it was also clear that the administration of heated fluid therapy was the measure that most contributed to the increase in body temperature. Of the total sample of 586 trauma victims, 51 were initially hypothermic, 56.9% of whom reached a normal body temperature after the rewarming measures. The effectiveness of nursing interventions in the management of hypothermia can also be seen, since the SIV (Immediate Life Support) ambulance team is led by this professional, although sometimes some of these strategies, such as active heat pads, are not available.

In S1, they not only investigated the incidence of traffic accidents with entrapment, but also used simulated practices to compare three heat-generating devices to manage hypothermia ("Mölnlycke Barrier® EasyWarm®" heating blanket, an infrared radiator and a forced air heater with blanket). The participants were members of the rescue team (firefighters and other professionals), who were distributed into several teams, and in order to avoid bias in the results, whoever assumed the role of "victim" was always the same, evaluating their experience relatively using three devices. The members of the rescue team were also always the same, with no rotation between teams, following the same order when using the devices. It was found that the use of these devices did not delay the extraction of the victim, had positive effects on hypothermia and, sometimes, even gave the victim the feeling of additional protection (for example from broken glass). Thus, simulated practices also seem to be an ally in this area, perhaps constituting a path for new research on this topic.

Research and innovation in the management of hypothermia associated with trauma, in an extra-hospital context, seem to be a pressing concern and a need, as can be seen in S3 and S7. S3, continuing a previous study, tested a new systematic and structured approach in the management of hypothermia that consists of continuous temperature assessment (by epi-tympanic device), avoiding removing clothing (except for wet victims), heating

the ambulance and rapid transfer of the victim indoors, heated fluid therapy and thermal insulation with an isothermal blanket, in order to reduce the number of victims suffering from hypothermia upon admission to the emergency department. In the previous study, hypothermia was found in 14% of trauma victims upon hospital admission, which in this case, with high-risk victims being selected, is estimated to occur in 20% of victims. A reduction in out-of-hospital hypothermia from 20% to 13% is expected with the implementation of this strategy.

The S7 is a proposal for an innovative device, in order to heat and humidify the air, preventing and managing hypothermia in trauma victims with an advanced airway, in an out-of-hospital context. Since heating and humidification is still a reality closely associated with in-hospital care, and a victim after endotracheal intubation loses around 30% of body heat through this route, this portable device can be a great method for managing hypothermia in these victims [21]. The management of out-of-hospital hypothermia has remained stagnant over the years, which is why some innovation and new devices are required to improve the response to trauma victims in this context [21].

S3 refers to regulating the environmental temperature in the ambulance above 30ºC, while S6 refers to a temperature between 20-24ºC. This aspect can be justified by the heating capacity available in different realities, with international recommendations describing an average environmental temperature of 28ºC as ideal when managing the temperature of the hypothermic victim [22].

There is also disagreement regarding the recommended temperature for fluid therapy. S3 refers to the administration of fluids at 35ºC, while S6 refers to temperatures between 25 to 28ºC. In the literature, the temperature for administering fluid therapy is not unanimous, and there are still guidelines for the administration of crystalloids between 40 and 42ºC. Due to the risks of rapid body rewarming, such as cardiac collapse, endocrine-metabolic changes, among others and, based on the availability of fluid heating, it is recommended to titrate rewarming measures to a body warming rate of less than 2ºC per hour [22].

The availability of heated fluid therapy, outside the hospital, depends on the existence of heating stoves in vehicles and other means, or on the possibility of heating the fluids at the time of administration. In Portugal this active heating strategy is available.

Active warming of a hypothermic victim is not entirely free of complications: burns can occur due to external warming devices, thrombosis, cardiac collapse due to rapid vasodilation, worsening acidosis, rhabdomyolysis, kidney damage, cerebral edema, among others [10]. However, the risks of not carrying out active warming measures are greater, influencing mortality, the general condition of the victim and their comfort [20,23]. Passive and active out-of-hospital warming devices should therefore be available so that they can be used safely on hypothermic victims.

The management of hypothermia associated with trauma is a constant concern for rescue teams, from the first contact with the victim to hospital admission and recovery. Regardless of the professional group responsible for providing assistance (nurse, firefighter, emergency technician, paramedic or other), strategies are developed to warm victims, and when they do not do so or do not have them available, the consequences can be harmful. Hypothermia is a predictor of mortality, with the mortality rate in hypothermic trauma victims being 38.5%, while in normothermic victims it is 4.3% [(12)]. A decrease of just 1ºC in body temperature is associated with a 10% decrease in the function of coagulation factors, altering platelet function, inhibiting enzymatic function and increasing fibrinolysis[(19)]. It is therefore important to continue care from out-of-hospital until admission to the hospital or emergency department. In Portugal, nurses are present in the out-of-hospital context, which is why it is this professional who is responsible for developing strategies for managing hypothermia associated with trauma.

Podsiadlo et al.[(24)] studied the knowledge of doctors, nurses and paramedics about prevention and management of hypothermia, finding that professionals who work in an extra-hospital context have more knowledge on this topic than those who work in emergency services. Training was provided in the area of hypothermia management to professionals who worked outside the hospital and to those who worked in the emergency service, with a pre-test and post-test carried out in relation to the training. Although everyone improved their knowledge, grades were lower for those who worked in the emergency department, and the failure rate in the pre-test was also higher in this group [(24)]. It is then clear the importance of out-of-hospital professionals in approaching trauma victims, with up-to-date knowledge and availability of resources to improve the care provided, the training of in-hospital professionals in their continuity, as well as a teamwork that guarantees continuity of care.

In answering the review question, we can then classify the strategies into active and passive heating groups, denoting that the first are widely mentioned, with special importance of fluid therapy, followed by heat pads/instant heating bags and heating blankets active.

Regarding the types of trauma, most studies do not specify this data. Only S6 refers to the predominance of traumatic brain injury in the victims of his study and S1 refers to multiple trauma resulting from road accidents, but in a simulated practice context. It can be seen that, regardless of the type of trauma, hypothermia management strategies are transversal.

The management of hypothermia is part of the approach to the trauma victim, where comprehensive care is required and must be started in the out-of-hospital setting, at the risk of negatively influencing the morbidity and mortality of trauma victims [(7)]. These include early transport of severe trauma victims to specialized trauma centers, control of bleeding with direct compression or the use of tourniquets, protection of the airway, especially in people with altered

state of consciousness, hypoxemia or hypoventilation. The guidelines for out-of-hospital use of blood products are unclear, depending on their availability. The source of the bleeding should be sought if it is not visible, keeping in mind a strategy of restricted volume replacement. Systolic arterial pressures of 80-90mmHg or mean arterial pressures of 50-60mmHg are desirable until the hemorrhage resolves, unless there has been head trauma or severe spinal trauma. In this case, systolic pressures of around 110mmHg and mean arterial pressures of 80mmHg are desirable. If this is not possible with fluid replacement (crystalloid solutions) or blood products, the use of vasopressors such as noradrenaline is recommended. It is also advisable to control coagulation status as early as possible, as well as monitoring it continuously, ensuring continuity and complementary care for the trauma victim after hospital admission [7,25].

The main limitations of this study were the small databases used and the selection of languages. These limitations are justified by the time and team available to carry out this investigation. However, the desired objective was met, managing to map the hypothermia management strategies used by out-of-hospital professionals, who must have the necessary knowledge and resources available to do so, when caring for trauma victims.

CONCLUSION

Hypothermia is part of the lethal triad of trauma, together with coagulopathy and acidosis, and its presence can result in serious consequences for the victim, with increased morbidity and mortality.

The main hypothermia management strategies can be divided into two main groups: passive rewarming measures and active rewarming measures. A combination of both should be used, and the use of just one strategy is not recommended.

The creation of action protocols in the area of hypothermia associated with trauma could be the way to improve out-of-hospital care for victims. It is also recommended to invest in innovation and research in this area with randomised studies, in order to understand the effectiveness of the interventions developed by out-of-hospital professionals. It is also important to emphasise that out-of-hospital professionals must have the necessary knowledge and resources to implement the most appropriate strategies for managing hypothermia.

In Portugal, out-of-hospital nursing care is inherent, as nurses are present in this context, and most hypothermia management strategies fall within the scope of this professional's autonomous interventions. Thus, by developing and having available hypothermia management strategies, the lethal triad is intervened upon and positive effects are achieved on the morbidity and mortality of trauma victims.

REFERENCES

[1] American College of Surgeons. Advanced trauma life support. Tenth Edit. Vol. 48, American College of

Surgeons. 2018. 442 p.

(2) Søreide K. Clinical and translational aspects of hypothermia in major trauma patients: From pathophysiology to prevention, prognosis and potential preservation. Injury [Internet]. 2014;45(4):647–54. Available from: http://dx.doi.org/10.1016/j.injury.2012.12.027

(3) Moffatt SE. Hypothermia in trauma. Emerg Med J. 2013;30(12):989–96.

(4) Rösli D, Schnüriger B, Candinas D, Haltmeier T. The Impact of Accidental Hypothermia on Mortality in Trauma Patients Overall and Patients with Traumatic Brain Injury Specifically: A Systematic Review and Meta-Analysis. World J Surg. 2020 Dec;44(12):4106–17.

(5) Bozorgi F, Khatir IG, Ghanbari H, Jahanian F, Arabi M, Ahidashti HA, et al. Investigation of frequency of the lethal triad and its 24 hours prognostic value among patients with multiple traumas. Open Access Maced J Med Sci. 2019;7(6):962–6.

(6) Eidstuen SC, Uleberg O, Vangberg G, Skogvoll E. When do trauma patients lose temperature? – a prospective observational study. Acta Anaesthesiol Scand. 2018;62(3):384–93.

(7) Haverkamp FJC, Giesbrecht GG, Tan ECTH. The prehospital management of hypothermia - An up-to-date overview. Injury. 2018

Feb;49(2):149–64.

(8) INEM; DFEM. Manual de Suporte Avançado de Vida. 1ª edição. 2020.

(9) Pazos LNC, Suárez CAE. Manejo prehospitalario de la hipotermia. Vol. 33, Universidad Central del Ecuador. 2022.

(10) Van der Ploeg GJ, Goslings JC, Walpoth BH, Bierens JJLM. Accidental hypothermia: Rewarming treatments, complications and outcomes from one university medical centre. Resuscitation [Internet]. 2010;81(11):1550–5. Available from: http://dx.doi.org/10.1016/j.resuscitation.2010.05.023

(11) Quality C, Unit PS. Clinical Practice Guidelines: Environmental/Hypothermia. 2021.

(12) Balmer JC, Hieb N, Daley BJ, Many HR, Heidel E, Rowe S, et al. Continued Relevance of Initial Temperature Measurement in Trauma Patients. Am Surg. 2022;88(3):424–8.

(13) Mota M, Cunha M, Santos MR, Santos E, Melo F, Abrantes T, et al. Prehospital interventions to prevent hypothermia in trauma patients: a scoping review. Aust J Adv Nurs [Internet]. 2020 Jul;37(3):29–36. Available from: https://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=144426199&lang=pt-pt&site=ehost-live

(14) Peters MDJ, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, et al. Updated methodological guidance for the conduct of scoping reviews. JBI Evid Synth. 2020 Oct;18(10):2119–26.

(15) Stroop R, Schöne C, Grau T. Incidence and strategies for preventing sustained hypothermia of crash victims during prolonged vehicle extrication. Injury [Internet]. 2019 Feb;50(2):308–17. Available

from: https://search.ebscohost.com/login.aspx?direct=true&db=ccm&AN=134928113&lang=pt-pt&site=ehost-live

(16) Meléndez-Lugo JJ, Caicedo Y, Guzmán-Rodríguez M, Serna JJ, Ordoñez J, Angamarca E, et al. Prehospital Damage Control: The Management of Volume, Temperature… and Bleeding! Colomb medica (Cali, Colomb. 2020 Dec;51(4):e4024486.

(17) Lapostolle F, Garrigue B, Richard O, Weisslinger L, Chollet C, Lagadec S, et al. Prevention of hypothermia in trauma victims - the HYPOTRAUM 2 study. J Adv Nurs. 2021 Jun;77(6):2908–15.

(18) Lavado P. Trauma – Uma viagem do Pré-hospitalar à abordagem no serviço de Urgência. Lifesav Sci. 2021;1–11.

(19) Van Veelen MJ, Brodmann Maeder M. Hypothermia in Trauma. Int J Environ Res Public Health. 2021 Aug;18(16).

(20) Mota MAL, Santos MR, Santos EJF, Henriques C, Matos A, Cunha M. Trauma Prehospital Hypothermia Prevention and Treatment: An Observational Study. J Trauma Nurs. 2021;28(3):194–202.

(21) Stevens RA, Pierce B, Tilley L. Airway and Hypothermia Prevention: and Treatment via STEAM The System for Thermogenic Emergency Airway Management. J Spec Oper Med a peer Rev J SOF Med Prof. 2022 Dec;22(4):72–6.

(22) Zafren K, Mechem C. UpToDate. 2023. p. 55 Hipotermia acidental em adultos.

(23) Mydske S, Thomassen Ø. Is prehospital use of active external warming dangerous for patients with accidental hypothermia: A systematic review. Scand J Trauma Resusc Emerg Med. 2020;28(1):1–8.

(24) Podsiadło P, Nogalski A, Kosiński S, Sanak T, Sałapa K, Gałązkowski R, et al. Is an emergency department a safer place for hypothermic victims than an ambulance? A comparison of the knowledge of medical personnel concerning hypothermia. Wiad Lek. 2019;72(2):209–15.

(25) Rossaint R, Afshari A, Bouillon B, Cerny V, Cimpoesu D, Curry N, et al. The European guideline on management of major bleeding and coagulopathy following trauma: sixth edition. Crit Care [Internet]. 2023;19(10):1138–44. Available from: https://doi.org/10.1186/s13054-023-04327-7