POINT OF VIEW

Clinical management of accidental hypothermia

Manejo clínico de la hipotermia accidental

Robert Blasco Mariño[1,2], Iñigo Soteras Martínez[2-4]

Accidental hypothermia is defined as the unintentional lowering of core temperature below 35°C.[1] In Spain, the incidence of this environmental disorder is not quantified, but it is estimated to be low in comparison with other European countries. In the USA, approximately 1500 people/year die from accidental hypothermia while in Spain, in the last 18 years, about 19 people/year died (according to data from the National Institute of Statistics). However, mortality is not necessarily representative of incidence. A simplistic analysis might lead us to think that the logical reason for a supposedly lower incidence would be climatic aspects. However, published experience points to a multifactorial set of causes that may lead to under-diagnosis of hypothermia. There are different reasons that favor being in the presence of an entity that emergency teams are not very aware of,[2] especially outside specific natural environments such as the high mountains, and we would like to point them out.

The lack of knowledge of how this environmental disease affects the body and its pathophysiological similarity to other entities can lead to bias in the initial assessment of affected individuals, distorting diagnostic guidance, clinical judgment and decision making. Just as an athlete in the natural environment knows that hypothermia is an "enemy" and must take it into account; healthcare personnel involved in emergency care must learn to think about hypothermia, this being the only way to prevent, diagnose and initially treat a potentially serious disease.

Triage of accidental hypothermia cases can be complex even with multiple temperature measurement systems.[3] However, many thermometers are not validated for use in the natural environment and there is little knowledge of the limitations of different anatomical temperature measurement points. In the intubated patient, temperature measurement using a probe in the distal esophageal third is recommended, whereas, in the patient without airway protection, epitympanic temperature measurement using a thermistor probe, a very sensitive type of resistor whose values vary with temperature very markedly, is recommended. The pre-hospital approach is crucial in determining severity, as the risk of arrhythmias and cardiorespiratory arrest (CRA) is negatively correlated with core temperature. The main electrophysiological changes of the heart in hypothermia occur in cardiac repolarization, leading to QT lengthening and alteration of the arrhythmogenic threshold.[4] In 64% of cases of hypothermic CRA, ventricular fibrillation or pulseless ventricular tachycardia is identified as the initial rhythm, and up to one third of cases may present as asystole or pulseless electrical activity.

The scale used according to the Swiss model has been the most common clinical classification tool for accidental hypothermia. It makes it possible to quantify thermal severity when a thermometer is not available, based on physical examination (shivering, level of consciousness, etc.), although the correlation between the clinical findings and the patient's actual temperature is not always as expected. This classification may overestimate 18% and underestimate 21% of the assessments.[5] Recently this classification has been revised and a simplified assessment has been proposed that relates the clinical findings of the AVDN scale (A-Alert, V-Verbal, D-Pain, N-No response, Spanish acronyms) to the risk of CRA.[6] A temperature below 28ºC or a stage 3-4 of the revised classification are indication for transfer of the patient to a hospital with extracorporeal technology[7] (Table 1).

Cases of severe accidental hypothermia have been described in Spain,[8,9] although most of them have not been reported in the scientific literature even though they have generated great social repercussions. In 2020, the first case of accidental hypothermia with CRP and extracorporeal membrane resuscitation (ECMO) was published after almost 6 hours of circulatory arrest.[10,11] It is the first case in Spain of extracorporeal resuscitation by hypothermia and one of the longest successful neurological resuscitations published in the world literature. This case has been a training and care revulsive, both prehospital and in-hospital.

It has served to make it clear that rescue and resuscitation teams should have specific training in accidental hypothermia and that cases of hypothermia with CRA can occur in temperate climates such as ours and

Author Affiliations: [1]Service of Anesthesiology and Resuscitation, Hospital Universitario Vall d'Hebron, Barcelona, Spain. [2]Facultad de Medicina, Departamento de Ciencias Médicas, Universidad de Girona, Girona, Spain. [3]Emergency Department, Hospital Transfrontarer de la Cerdanya, Girona, Spain. [4]Servei d'Emergencies Mèdiques (SEM), Catalonia, Spain.
Authors' contribution: The authors have confirmed their authorship in the author responsibilities document, publication agreement and assignment of rights to EMERGENCIAS.
Corresponding author: Iñigo Soteras Martínez. Emergency Department. Hospital de la Cerdanya. Camí d'Ur, 31, 17520 Puigcerdà, Girona, Spain.
Email: inigosoteras1@gmail.com
Article information: Received: 24-9-2021. Accepted: 13-10-2021. Online: 18-11-2021.
Editor in Charge: Òscar Miró.

Table 1. Adaptation of the old Swiss Classification revised by Musi *et al.*[6] and the place of transfer

	Stage 1	Stage 2	Stage 3	Stage 4
Original Swiss Scale[5]	Conscious victim with tremor (35-32ºC)	Victim with altered level of consciousness without tremor (< 32-28ºC)	Victim was unconscious (< 28-24ºC)	Apparent death (< 24ºC)
Swiss Revised Scale[6]	"A"- Alert	"V"- Verbal	"D" Pain or "N" - No response WITH detectable signs of life	"N" - No response WITHOUT detectable signs of life*
Glasgow Coma Scale	15	14-9	< 9	3
Risk of cardiac arrest[6]	Low	Moderate	High	Hypothermic cardiac arrest
Transfer[7]	Nearest hospital or depending on other illnesses	Hospital with ICU, preferably with possibility to perform CPR	Hospital with eCPR capability	Hospital with eCPR capability

*Absence of signs of life (respiration or pulse) for at least one minute. ICU: intensive care unit; eCPR: extracorporeal cardiopulmonary resuscitation.

can be successfully resuscitated. At the prehospital level, for example, the Sistema d'Emergències Mèdiques (EMS) of Catalonia has developed an action guide for cases of severe hypothermia, which implements training on the importance of early detection and treatment of accidental hypothermia. At hospital level, the anesthesiology service of the Vall d'Hebron University Hospital in Barcelona has developed a multidisciplinary protocol for the treatment of cases of CRA due to accidental hypothermia requiring ECMO as a method of resuscitation and rewarming.

Deciding which hypothermic patients are candidates for initiation of cardiopulmonary resuscitation (CPR) can be complex. Potassium values have been used as a prognostic marker, but it can be dangerous to base prognosis and the decision whether to initiate CPR solely on isolated potassium values, since these have a certain degree of intrinsic biological variability and can vary up to 2 mmol/L depending on the point of extraction. On the other hand, clinical findings can be misleading in decision making, especially for untrained professionals. Thus, very adverse gasometric findings (pH < 6.8 and lactate > 15 mmol/L), an unobserved CRA, the first cardiac rhythm in asystole, chest compressions not initiated in the first 10 minutes of CRA or the performance of intermittent CPR are not absolute contraindications for the initiation of CPR maneuvers.[12] Only the presence of injuries incompatible with life, incompressible thorax or victims of an avalanche buried for more than 60 minutes with first rhythm in asystole and an airway occupied by snow are considered absolute contraindications. For this reason, the recently published European resuscitation guidelines[7] advise the use of prognostic scales to support the decision to initiate CPR or not. There are currently 2 scales based on prognostic variables in hypothermic patients [(ICE and HOPE (originally, a hyperlink to the scale's website was generated)].[13,14] Neither of the 2 is validated in polytrauma patients, although their use is recommended in the case of hypothermia due to avalanche, where associated polytrauma should always be suspected. The HOPE score values predict survival success until hospital discharge. With a HOPE < 10% and an ICE > 12, extracorporeal CPR (eCPR) would not be indicated. A patient with a favorable score on any scale and a transfer of less than 6 hours to a center with extracorporeal technology is indicated for rewarming and support by eCPR.

The key elements that influence the final prognosis of severe hypothermia are adequate planning and coordination of the rescue operation, prediction of potential problems, action according to elaborated protocols, including immediate and high quality CPR, cardiorespiratory support and rewarming with ECMO.[15] To this end, training in accidental hypothermia and the development of cross-cutting guidelines with each of the possible interveners are key to the development of a correct chain of survival that includes the particularities of the hypothermic patient. In this way, it will be possible to identify the possible victim of severe hypothermia, initiate life support measures, reduce the time of arrival at the destination hospital, implement effective treatment to improve survival and improve the final prognosis.

Conflict of Interests Disclosure: None reported

Funding/Support: The authors declare that they have no financial support for this article.

Ethical responsibilities: All authors have confirmed the maintenance of confidentiality and respect for patient rights in the document of author responsibilities, publication agreement and assignment of rights to EMERGENCIAS.

Article not commissioned by the Editorial Committee and with external peer review.

References

1 Paal P, Gordon L, Strapazzon G, Brodmann Maeder M, Putzer G, Walpoth B, et al. Accidental hypothermia-an update : The content of this review is endorsed by the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). Scand J Trauma Resusc Emerg Med. 2016;24:111.
2 Kosiński S, Darocha T, Gałązkowski R, Drwiła R. Accidental hypothermia in Poland – estimation of prevalence, diagnostic methods and treatment. Scand J Trauma Resusc Emerg Med. 2015;23:13.
3 Strapazzon G, Procter E, Paal P, Brugger H. Pre-hospital core temperature measurement in accidental and therapeutic hypothermia. High Alt Med Biol. 2014;15:104-11.
4 Dietrichs ES, Tveita T, Smith G. Hypothermia and cardiac electrophysiology: a systematic review of clinical and experimental data. Cardiovasc Res. 2019;115:501-9.
5 Deslarzes T, Rousson V, Yersin B, Durrer B, Pasquier M. An evaluation of the Swiss staging model for hypothermia using case reports from the literature. Scand J Trauma Resusc Emerg Med. 2016;24:16.
6 Musi ME, Sheets A, Zafren K, Brugger H, Paal P, Hölzl N, et al. Clinical staging of accidental hypothermia: The Revised Swiss System: Recommendation of the International Commission for Mountain Emergency Medicine (ICAR MedCom). Resuscitation. 2021;162:182-7.

7 Lott C, Truhlář A, Alfonzo A, Barelli A, González-Salvado V, Hinkelbein J, et al. European Resuscitation Council Guidelines 2021: Cardiac arrest in special circumstances. Resuscitation. 2021;161:152-219.
8 Avellanas ML, Laplaza J, Cegonino J, Montón JM, Serón C. Hipotermia accidental en los accidentes de montana. Importancia de la rapidez en el rescate y traslado. Med Intensiva. 1991;15:147-53.
9 Kot P, Botella J. Parada cardiaca por hipotermia accidental y resucitación cardiopulmonar prolongada. Med Intensiva. 2010;34:567-70.
10 Mariño RB, Argudo E, Ribas M, Robledo XR, Martínez IS, Strapazzon G, et al. Anesthetic Management of Successful Extracorporeal Resuscitation After Six Hours of Cardiac Arrest Due to Severe Accidental Hypothermia. J Cardiothorac Vasc Anesth. 2020;S1053-0770(20)31193-9.
11 Riera J, Argudo E, Ruiz-Rodríguez JC, Rodríguez-Lecoq R, Ferrer R. Full neurological recovery 6 h after cardiac arrest due to accidental hypothermia. Lancet. 2020;395(10236):e89.
12 Michels G, Wengenmayer T, Hagl C, Dohmen C, Böttiger BW, Bauersachs J, et al. Recommendations for extracorporeal cardiopulmonary resuscitation (eCPR): consensus statement of DGIIN, DGK, DGTHG, DGfK, DGNI, DGAI, DIVI and GRC. Clin Res Cardiol. 2019;108:455-64.
13 Saczkowski RS, Brown DJA, Abu-Laban RB, Fradet G, Schulze CJ, Kuzak ND. Prediction and risk stratification of survival in accidental hypothermia requiring extracorporeal life support: An individual patient data meta-analysis. Resuscitation. 2018;127:51-7.
14 Pasquier M, Hugli O, Paal P, Darocha T, Blancher M, Husby P, et al. Hypothermia outcome prediction after extracorporeal life support for hypothermic cardiac arrest patients: The HOPE score. Resuscitation. 2018;126:58-64.
15 Avellanas Chavala ML, Ayala Gallardo M, Soteras Martínez Í, Subirats Bayego E. Gestión de la hipotermia accidental: revisión narrativa. Med Intensiva. 2019;43:556-68.