

CONSENSUS STATEMENT

Consensus document on the management of patients with accidental hypothermia from the Spanish Society of Anesthesiology, Resuscitation and Pain Management (SEDAR), the Spanish Society of Intensive Care Medicine, Critical Care and Coronary Units (SEMICYUC), and the Spanish Society of Emergency Medicine (SEMES)

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Accidental hypothermia is an underdiagnosed condition with a significant impact on public health. With the aim of providing the basis for a comprehensive care framework, 12 panelists from 3 Spanish scientific societies (SEDAR, SEMES and SEMICYUC) developed this multidisciplinary consensus document. Through a systematic search and the final synthesis of 281 articles including 1,704,632 patients, 37 recommendations were developed through a 2-round Delphi process, distributed across 8 application domains based on the organization of a rescue chain: prehospital prevention, initial evaluation, management and transport, hospital detection, care of the polytraumatized patient, hospital rewarming, cardiac arrest, and resuscitation. Robust consensus among panelists (>75% agreement) and excellent internal consistency ($\omega = 0.913$) were achieved, providing a solid document that may serve as a basis for the implementation of standardized protocols.

Keywords: Accidental hypothermia. Cardiopulmonary resuscitation. Extracorporeal circulation. Cardiac arrest. First aid. Prehospital emergency care.

Documento de consenso sobre el manejo de pacientes con hipotermia accidental de la Sociedad Española de Anestesiología, Reanimación y Terapéutica del Dolor (SEDAR), la Sociedad Española de Medicina Intensiva, Crítica y Unidades Coronarias (SEMICYUC) y la Sociedad Española de Medicina de Urgencias y Emergencias (SEMES)

La hipotermia accidental es una condición infradiagnosticada con un impacto significativo en la salud pública. Con el objetivo de proporcionar las bases para un marco de atención integral, 12 panelistas de 3 sociedades científicas españolas (SEDAR, SEMES y SEMICYUC) han elaborado este documento de consenso multidisciplinar. Mediante una búsqueda sistemática y la síntesis final de 281 artículos que engloban 1.704.632 pacientes, se elaboraron 37 recomendaciones distribuidas en 8 ámbitos de aplicación mediante un proceso Delphi de dos rondas. Los ámbitos se definieron según la continuidad asistencial de una cadena de rescate: prevención prehospitalaria, evaluación inicial, manejo y traslado, detección hospitalaria, atención del paciente politraumatizado, recalentamiento hospitalario, parada cardiorrespiratoria y reanimación. Se alcanzó un consenso robusto entre los panelistas (> 75% de acuerdo) y una excelente consistencia interna ($\omega = 0,913$), lo que proporciona un documento sólido que puede servir de base para la implementación de protocolos estandarizados.

Palabras clave: Hipotermia accidental. Reanimación cardiopulmonar. Circulación extracorpórea. Parada cardiorrespiratoria. Primeros auxilios. Atención prehospitalaria de urgencias.

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Introduction

Accidental hypothermia (AH) is defined as an unintentional decrease in core temperature $< 35^{\circ}\text{C}$. It occurs when heat loss exceeds heat production and conservation, either because of exposure to low environmental temperatures (accidental or primary hypothermia) or because of secondary mechanisms that impair thermoregulation (e.g., trauma, intoxication, or severe illness).

AH may develop at any stage of prehospital or in-hospital care if heat-conservation measures are not implemented. Lack of clinical suspicion, a presentation similar to that of other conditions, insufficient training, and the absence of standardized protocols contribute to underdiagnosis, delaying diagnostic and therapeutic measures and adversely affecting prognosis. Implementation of systematic multidisciplinary guidelines may improve patient safety at all levels of care.

The primary endpoint of this consensus document is to provide evidence-based recommendations on the prevention, diagnosis, and treatment of patients with AH. Secondary endpoints include analyzing the specific characteristics of prehospital care and their impact on survival, characterizing the specific needs of trauma patients, and proposing management algorithms for severe cases and those with associated cardiac arrest (CA).

Methodology

The guidelines in this document were developed in accordance with the AGREE II (Appraisal of Guidelines for Research & Evaluation) instrument for guideline appraisal and good-practice recommendations.^{1,2} Identification and synthesis of the available evidence were performed through a scoping systematic review following the PRISMA guidelines for scoping reviews (PRISMA-ScR).³

Initially, a coordinating group of 4 clinical experts developed a methodological protocol that was evaluated and approved by the scientific committees of the Spanish Society of Anesthesiology, Resuscitation and Pain Therapy (SEDAR), the Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC), and the Spanish Society of Emergency Medicine (SEMES). The protocol was prospectively registered on the Open Science Framework (OSF) platform (<https://osf.io/jvsqz/files/osfstorage>; DOI: 10.17605/OSF.IO/JVSQZ), including a pilot data-extraction form. An expert panel comprising 12 panelists was subsequently established to ensure multidisciplinary balance, including 4 representatives from each society: 4 specialists in anesthesiology and resuscitation (SEDAR), 2 specialists in emergency medicine and 2 nurses (SEMES), and 4 specialists in intensive care medicine (SEMICYUC). Recruitment was performed through an open call disseminated by the participating societies, and selection was based on research experience and field of exper-

tise. The group had a mean of 14 years of clinical practice and a mean age of 42 years.

Data extraction

The search strategy was designed by an information specialist with expertise in systematic reviews and was implemented in PubMed, EMBASE and MEDLINE, Biblioteca Virtual de Salud (BVS), Web of Science (WoS), and Cochrane Library. ClinicalTrials.gov and the World Health Organization International Clinical Trials Registry Platform were also searched. The Peer Review of Electronic Search Strategies (PRESS) checklist was used to validate the search strategy, and a second information specialist performed an independent search. Studies reporting original data on AH in adults (> 18 years) published between 2004 and 2024 in English or Spanish were included. Clinical trials, systematic reviews, meta-analyses, cohort studies, case-control studies, and case series were accepted. Case reports without original data, guidelines, letters, and narrative reviews were excluded. Articles addressing induced or therapeutic hypothermia, drug-induced hypothermia, burns, immersion, or avalanches were also excluded.

Two authors (RB and ML) independently performed screening and data extraction using Rayyan (Rayyan Systems, Boston, MA, United States).⁴ Discrepancies were resolved by consensus. Articles considered to answer the PICO question were selected for full-text review. All data of interest were extracted into a preconfigured table using a spreadsheet (Microsoft Excel; Microsoft, Inc., Redmond, WA, USA), which was independently reviewed by both authors. The variables collected were title, name of principal investigator, nationality of principal investigator, article type, sample size, population, intervention, comparator, outcomes, findings of interest, declared conflicts of interest, whether the article answered the PICO question, and level of evidence according to the Oxford Centre for Evidence-Based Medicine (OCEBM) tool.⁵

Delphi process

The Delphi process was designed to identify areas of consensus regarding practical recommendations based on the literature. Recommendations were developed in 3 blocks (prehospital, in-hospital, and cardiac arrest [CA] and cardiopulmonary resuscitation [CPR]). A 2-round RAND/UCLA method was used.⁶ In round #1, 12/12 panelists voted on the recommendations using a 1–9 Likert scale in Google Forms. Acceptance was defined as $\geq 75\%$ of votes scoring ≥ 7 (1–3 disagreement, 4–6 neutral, 7–9 agreement). In round #2, 12/12 panelists participated in a virtual meeting to discuss recommendations with low scores. Reasons for inclusion or exclusion of each recommendation were documented. The recommendations were then voted on again using the same acceptance criteria. Results from each round were described using descriptive statistics

[mean and SD], and internal consistency was assessed using McDonald's omega coefficient. For each panelist, the mean absolute difference between their scores and the panel mean score for each recommendation was calculated and then averaged across all recommendations. A maximum interpanelist variability of 20% was established *a priori*. Values above this threshold would have prompted another voting round.

For each recommendation, the available body of evidence was reviewed and synthesized, and one pivotal article was selected (the most informative or clinically relevant study). Risk of bias or methodological quality of the pivotal studies was systematically assessed using design-specific tools: Newcastle-Ottawa Scale (NOS) for observational studies,⁷ ROB 2 for clinical trials,⁸ AMSTAR-2 for systematic reviews,⁹ and PROBAST for prognostic models¹⁰ (supplementary data 1: <https://revistaemergencias.org/extra/5330-A.pdf>). Each recommendation was graded according to the American College of Chest Physicians (ACCP) system,¹¹ separating strength (1 = strong/recommendation, 2 = weak/suggestion) from quality of evidence (A, B, C). The final grade (1A–2C) integrated both dimensions and was assigned according to the benefit-risk/burden balance, feasibility, and consistency of findings. The rationale for the grade assigned to each recommendation is described in supplementary data 2 (<https://revistaemergencias.org/extra/5330-B.pdf>).

Results

A total of 14,867 records were identified, of which 281 met the inclusion criteria (Figure 1). The selected articles included a total of 1,704,632 patients. In Delphi round #1, the mean recommendation score was 8.15/9 (SD, 0.5), and no recommendation received < 75% agreement. Mean interpanelist variability was 4.2% (maximum 14%), with a McDonald's omega coefficient of 0.882, reflecting excellent internal consistency. In round #2, the mean score increased to 8.44/9 (SD, 0.3), with no recommendation < 75% agreement. Mean interpanelist variability dropped to 2.7% (maximum 9%), with a McDonald's omega of 0.913.

A total of 37 recommendations were developed and distributed across 8 areas of application (Table 1): (1–3) prevention and initial prehospital management, (4) transport and coordination of care, (5) in-hospital prevention and detection, (6) specific management of trauma victims, (7) in-hospital treatment strategies, and (8) care of patients with CA and resuscitation. Of the 37 recommendations, 18 (48.6%) were classified as grade 1 (strong) and 19 (51.4%) as grade 2 (weak). Regarding quality of evidence according to the ACCP system, no recommendation was graded A, 7 were graded B (18.9%), and 30 were graded C (81.1%) (supplementary data 2: <https://revistaemergencias.org/extra/5330-B.pdf>).

A summary of the most relevant findings in each area is provided in Table 2.

Area 1: Prehospital prevention and detection of accidental hypothermia

Rescue and prehospital care services often lack adequate equipment for the diagnosis and treatment of AH and, in many cases, also lack standardized management protocols.¹² Various thermal protection systems are available in the prehospital setting (Table 3). However, although thermal blankets and insulation materials are commonly used, few units have active warming devices or low-reading thermometers. As a result, scales that estimate temperature thresholds according to clinical findings are frequently used, with the consequent risk of overestimating or underestimating severity and failing to mobilize resources appropriately.

During the initial assessment of AH, it should be determined whether the patient's clothing is wet, because wet garments increase heat loss through evaporation and conduction and precipitate the development of AH. Studies using human models and mannequins have shown that removing wet clothing or encapsulating it within a vapor-barrier system reduces heat loss and improves skin temperature.¹³ Removing wet clothing accelerates rewarming compared with leaving it in place, although this entails brief exposure to the cold and should therefore only be performed when safe and feasible.¹⁴ Otherwise, a vapor barrier is an effective and preferable alternative.¹⁵

Area 2: Initial prehospital assessment

The currently internationally accepted scale for assessing patients with AH is the revised Swiss staging system.¹⁶ This scale uses the AVPU system (Alert, Voice, Pain, Unresponsive) to estimate the degree of AH in the absence of core temperature measurement. Its purpose is to correlate the clinical presentation of AH with the risk of CA, although its applicability has not been validated (Table 4). Patients with grade $\geq$ III hypothermia (response to pain [P] or unresponsive [U]) may have a risk of CA approaching 50%, even in the absence of precipitating causes.¹⁷ Nevertheless, up to 39% of classifications may be incorrect, highlighting the need to use overlapping ranges and to consider the AVPU scale useful but imperfect. Level of consciousness, systolic blood pressure, and respiratory rate are clinical signs directly correlated with decreasing temperature. A heart rate < 45 beats/min is a marker of CA risk.¹⁸

AH may cause characteristic electrocardiographic abnormalities such as J waves or Osborn J waves, bradyarrhythmias, interval prolongation, and an increased risk of atrial or ventricular fibrillation (Figure 2). None of these abnormalities is pathognomonic of AH, and although the J wave may have prognostic value, it does not independently predict mortality.¹⁹ These signs may constitute the first diagnostic clue in unconscious patients and help estimate severity. In moderate or severe AH, susceptibility to arrhythmias is high, even after minimal stimuli such as changes in position or pain.²⁰ Therefore, ECG and continuous monitoring should be

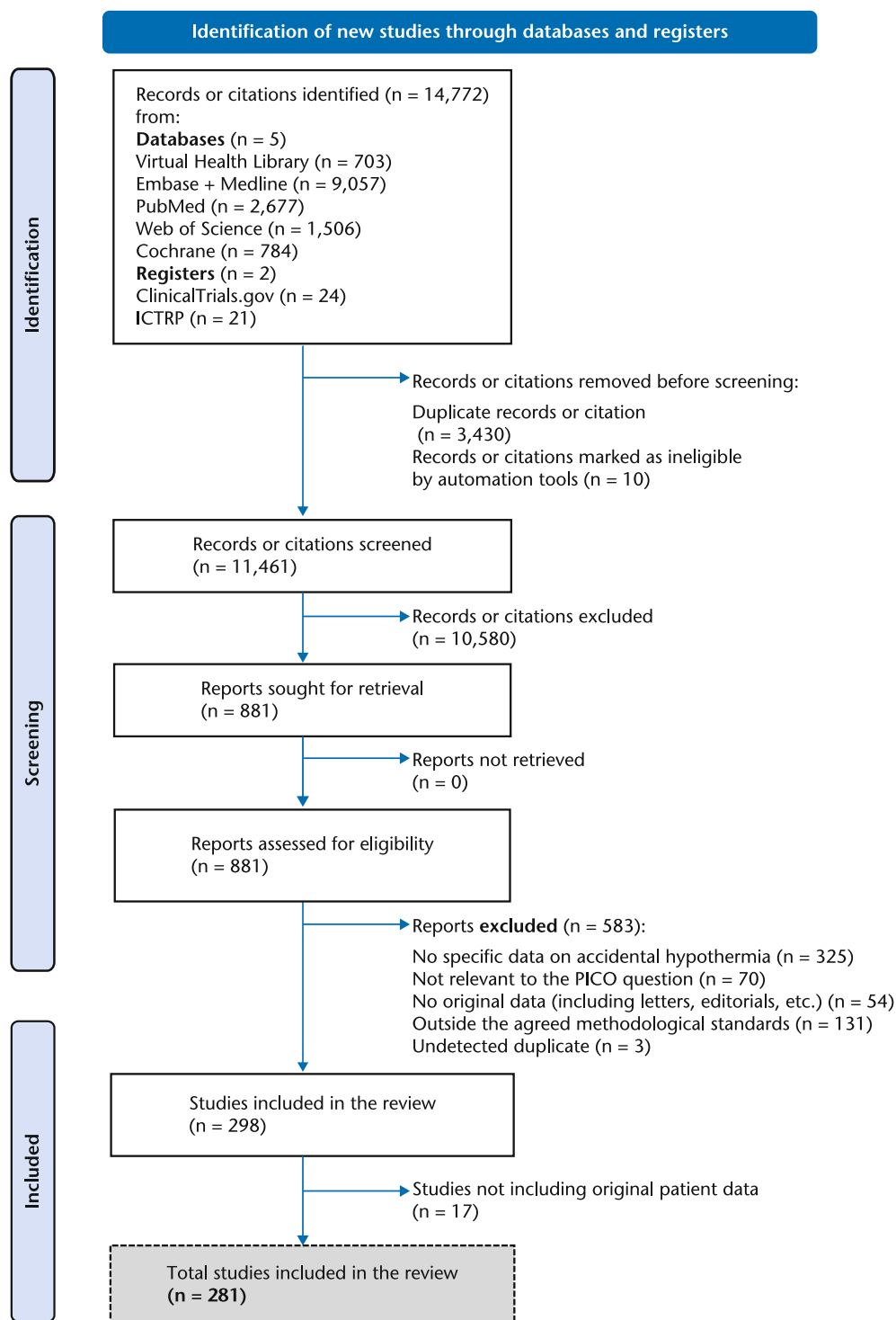


Figure 1. Flow diagram.

Study selection process for the scoping systematic review on accidental hypothermia.

initiated as soon as possible, provided that patient safety permits.

Area 3: Initial management of hypothermia victims

The initial priority of any intervention should be to

stop or minimize heat loss. Rewarming strategies available in the prehospital setting are limited by the capacity to transport thermal equipment. Active rewarming systems are superior to passive methods for preventing complications of AH. Resistive warming (electric blankets or direct conductive heat-transfer systems) is more effective than metallic blankets and, in trauma patients,

Table 1. Recommendations reached following multidisciplinary panel agreement

Area	Recommendation	Recommendation grade (ACCP)	Strength of recommendation
Prehospital prevention and detection	1. Adequate diagnostic and therapeutic resources are recommended in emergency medical services for the prevention, detection, and treatment of hypothermia.	1C	Strong
	2. Removal of wet clothing is suggested when safe and feasible, always minimizing exposure time. In very cold or windy environments, placing a vapor barrier over wet clothing may be preferable to undressing the patient.	2B	Weak
	3. Systematic temperature measurement and thermal protection are recommended in patients attended in prehospital settings.	1C	Strong
Initial prehospital assessment	4. Use of the AVPU scale is suggested to relate the degree of hypothermia to the risk of clinical deterioration, particularly in the absence of more accurate diagnostic tools.	2C	Weak
	5. When feasible and safe, ECG and continuous monitoring are suggested in all patients with grade II or higher accidental hypothermia, provided that this does not delay arrival at the referral center.	2C	Weak
	6. Attention to preventive, diagnostic, and therapeutic temperature control is recommended in all patients with severe trauma.	1C	Strong
Initial management of hypothermia victims	7. Basic or advanced cardiopulmonary resuscitation is recommended in all hypothermic patients without vital signs, even when the clinical circumstances appear unfavorable, except when criteria for withholding resuscitation are present.	1C	Strong
	8. Awareness of the risk of rescue collapse in hypothermic patients is recommended, particularly during mobilization or vagal maneuvers.	1C	Strong
	9. Active rewarming strategies, such as external active, resistive, or forced-air warming, are recommended in all patients attended in prehospital settings with findings suggestive of hypothermia, according to clinical needs and resource availability.	1B	Strong
	10. Use of a multilayer protection system combined with active warming is recommended to improve thermal outcomes during prolonged mountain transport.	1B	Strong
	11. Mechanical ventilation parameters should not be adjusted or guided solely on the basis of capnography data.	2C	Weak
Pre- and in-hospital transport and coordination	12. Patients with > grade III accidental hypothermia should be transferred to referral centers with extracorporeal life-support capability, optimizing transfer times and avoiding critical decisions during the early stages of management.	1C	Strong
	13. Development and implementation of coordinated regional plans for the management of accidental hypothermia are suggested, ensuring an integrated response among prehospital services, hospitals, and specialized centers.	2C	Weak
	14. Preventive strategies to reduce heat loss during prehospital transport are suggested, even in normothermic patients.	2C	Weak
	15. Implementation of standardized operating procedures for the care of all patients with hypothermia and continuing training strategies for health care personnel is suggested.	2C	Weak
In-hospital prevention and detection	16. Assessment of in-hospital prognosis in hypothermic patients using prognostic scores is suggested rather than basing prognosis on isolated laboratory values.	2C	Weak
	17. Prevention of hypothermia risk in vulnerable populations and exposed activities during winter periods is suggested.	2C	Weak
	18. A high index of suspicion for hypothermia and, therefore, temperature measurement during the initial emergency assessment are recommended in all patients aged > 65 years, individuals with altered consciousness, endocrine disorders, multiple comorbidities, signs of intoxication, or social isolation.	1C	Strong
	19. Monitoring of temperature using a core-temperature measurement device is recommended whenever possible, particularly in patients with signs of severe illness.	1C	Strong
	20. Awareness of the limitations and reliability of different temperature-measurement sites in clinical decision-making is suggested.	2C	Weak
	21. Implementation of multidisciplinary protocolization and quality-improvement programs is suggested to ensure temperature measurement in every patient presenting to an emergency department.	2C	Weak
	22. Prevention campaigns and strategies targeting vulnerable populations (older adults, people experiencing homelessness, and people who use intoxicating substances) are suggested, particularly during periods of cold weather.	2C	Weak

(Continued)

can increase core temperature by 0.8 °C/h, reduce pain and anxiety, and improve patient satisfaction.²¹ Forced-air warming provides greater thermal gain and comfort than blankets or halogen lamps.

During any manipulation of patients with AH, the risk of rescue collapse should be considered. This condition describes sudden cardiovascular decompensation caused by hypotension resulting from changes in circu-

latory redistribution and body pressure and may occur in both aquatic and terrestrial environments. It may be triggered during vertical mobilization or procedures that induce vagal reflexes (orotracheal intubation, venous cannulation, catheterization) in unstable patients with AH (systolic blood pressure < 90 mmHg, heart rate < 45 beats/min, or arrhythmias). Therefore, extreme caution and monitoring during manipulation are essen-

Table 1. Recommendations reached following multidisciplinary panel agreement (Continuation)

Area	Recommendation	Recommendation grade (ACCP)	Strength of recommendation
Specific considerations in trauma patients	23. Preventive in-hospital rewarming strategies are recommended in all trauma patients until temperature has been measured.	1C	Strong
	24. Temperature measurement is recommended as part of the initial primary assessment of all trauma patients, particularly in the presence of TBI or suspected severe injury (ISS > 16).	1C	Strong
	25. A body temperature < 36 °C is suggested to be treated as trauma-associated hypothermia, while the term accidental hypothermia should be reserved for a core temperature < 35 °C.	2B	Weak
	26. Temperature monitoring is recommended in all trauma patients requiring transfusion of blood products.	1C	Strong
	27. Hypothermia is suggested to be included as a physiological severity factor in all trauma assessment and triage scales.	2C	Weak
In-hospital management	28. Active in-hospital rewarming measures are suggested for all patients with hypothermia, based on local protocols.	2C	Weak
	29. Administration of warmed fluids only is suggested to prevent additional cooling. Warmed fluid therapy should not be used as the primary rewarming strategy because of its limited thermal effectiveness.	2C	Weak
	30. Active rewarming measures are suggested in all patients with moderate-to-severe hypothermia in whom ECMO will not be performed or is unavailable. In these patients, in the presence of hemodynamic instability (SBP < 90 mmHg) or impaired level of consciousness, a multilayer system should be used and other adjunctive active techniques considered.	2C	Weak
CA and resuscitation	31. VA-ECMO is recommended as the treatment of choice for CA due to accidental hypothermia, with CPB reserved as an alternative when ECMO is unavailable.	1C	Strong
	32. Continuous venovenous hemodiafiltration techniques are suggested in patients with hypothermia when ECMO is contraindicated or unavailable. If the necessary resources are not available, other active rewarming techniques should be initiated according to the capabilities of the center.	2C	Weak
	33. Consideration of VA-ECMO is recommended in patients with severe hypothermia and hemodynamic instability, individualizing its indication according to availability and experience.	1C	Strong
	34. Mechanical chest compression devices are suggested in hypothermic CA to ensure effective and continuous chest compressions during CPR and prolonged transport.	2C	Weak
	35. A rewarming rate of 2°C–5 °C/h is suggested during extracorporeal life support.	2C	Weak
	36. Futility decisions are suggested to be based on multivariable predictive models such as HOPE rather than on isolated clinical parameters.	2B	Weak
	37. Use of the HOPE score is recommended to identify patients with hypothermic CA who may benefit from ECMO.	1B	Strong

The strength of the recommendation was classified as Strong (Grade 1) when the panel considered that the expected benefits clearly outweighed the risks and burdens and that the recommendation was applicable to most patients or clinical scenarios. Recommendations with greater uncertainty or variability in feasibility or in the benefit-risk balance were classified as Grade 2. The ACCP grade combines strength (1–2) and quality of evidence (A–C). Quality (A–C) reflects the methodological robustness of the body of studies supporting the recommendation and should not be interpreted as a direct indicator of the clinical importance of the recommendation.

ECMO/VA-ECMO: extracorporeal membrane oxygenation (venoarterial); ISS: Injury Severity Score; CA: cardiac arrest; CPR: cardiopulmonary resuscitation; SBP: systolic blood pressure; CPB: cardiopulmonary bypass; TBI: traumatic brain injury.

tial whenever feasible and safe. Rescue collapse is associated with high mortality, potentially twice that observed in patients without this phenomenon.²⁰ In cases of AH-related CA, CPR may be effective even when the initial rhythm is asystole or the arrest was unwitnessed.¹⁸ CPR should be initiated unless clear criteria for withholding resuscitation are present (Figure 3), with consideration of delayed initiation or intermittent CPR (5 minutes of CPR followed by 5 minutes without CPR in patients with body temperature < 28 °C, and 5 minutes of CPR followed by 10 minutes without CPR in patients with temperature < 20 °C),²² if necessary.

During advanced monitoring, capnography does not adequately reflect ventilatory status in patients with severe pulmonary hypoperfusion-related AH. Arterial carbon dioxide-to-EtCO₂ gradients of up to 35 mmHg have been documented.²³ Consequently, EtCO₂ should not be used in isolation to guide mechanical ventilation

in the prehospital setting. Its interpretation should be contextualized according to body temperature and, whenever possible, integrated with arterial blood gas analysis.

Area 4: Prehospital/in-hospital transport and coordination

Prehospital transport promotes body heat loss even in normothermic patients. Trauma patients may experience significant decreases in temperature during air transport, increasing transfusion requirements and mortality.²⁴

In mountain accidents, AH requires specific organized and coordinated care because prehospital care times may be prolonged, increasing both the risk of AH and the need for advanced support.²⁵ Prolonged mountain transport causes heat losses that cannot be com-

Table 2. Summary of evidence by area

Recommendation area	No. of patients	No. of studies	Quantitative findings of interest for the area
Prehospital prevention and detection of hypothermia	601	10	– Rescue-related factors: Environmental and clinical factors such as ambient temperature, wet clothing, and impaired level of consciousness determine the presence of AH. OR, 2.08; 95% CI, 1.8–4.0 for wet patients; OR, 0.93; 95% CI, 0.91–0.96 for ambient temperature; and OR, 0.87; 95% CI, 0.81–0.92 for level of consciousness (GCS). ⁶⁴
Initial prehospital assessment	27,577	10	– Mechanism of injury: Asphyxia is a negative prognostic determinant. Survival is significantly higher in nonasphyxial than in asphyxial hypothermic CA (OR, 5.36; 95% CI, 2.80–10.27). ⁵⁵
Initial management of hypothermia victims	771	10	– Airway management: Prehospital orotracheal intubation was identified as a predictor of AH and was associated with a significantly higher risk of temperature decline (OR, 7.36; 95% CI, 4.43–12.21). ⁶⁵ – Rescue collapse: Patients experiencing collapse during rescue had a higher mortality rate than those who remained hemodynamically stable (49% vs 24%; RR, 2.0; 95% CI, 1.1–3.62). ²⁰ – Prognostic factors: Overall survival in hypothermic CA was 27%, with a favorable neurological outcome in 83% of survivors. The presence of electrical activity was associated with a better prognosis than fibrillation or asystole (OR, 6.73; 95%CI, 1.6–18.68), as was CPR duration (OR, 0.99; 95% CI, 0.98–0.99). ⁵⁵
Prehospital and in-hospital transport and coordination	1,995	7	– Air transport: Transition from normothermia to hypothermia is a risk factor that doubles mortality in air-transported patients (OR, 2.08; 95% CI, 1.20–3.63). ⁶⁶
In-hospital prevention and detection	22,294	50	– Length of stay: Hospitalization of frail patients with hypothermia increases mortality (OR, 2.11; 95% CI, 1.09–4.10). ³⁶ – Mechanism of injury: Occurrence of the injury mechanism indoors increases mortality (OR, 3.20; 95% CI, 1.58–6.46). ⁶⁷ – Temperature measurement: Absence of hospital temperature measurement increases mortality in the emergency department (OR, 2.86; 95% CI, 1.64–4.99) and in the operating room (OR, 4.66; 95%CI, 2.50–8.69). ³¹ – Dependency: Hypothermic patients dependent in BADL have higher in-hospital mortality (OR, 2.31; 95% CI, 1.15–4.63). ³⁶ – Age: Age is positively associated with in-hospital mortality in patients diagnosed with hypothermia (OR, 2.91; 95% CI, 1.41–6.02). ³⁷
Specific considerations in trauma patients	1,644,503	41	– Patients with multiple trauma: Meta-analysis of mortality associated with hypothermia (OR, 5.18; 95% CI, 2.61–10.28) and in the subgroup of patients with TBI (OR, 2.38; 95% CI, 1.53–3.69). ⁴³ Cohort studies showed consistent mortality findings.
In-hospital management	1,929	59	– Rewarming methods: Unstable patients have higher mortality when rewarmed using noninvasive methods (41% vs 20.5%; RR, 2.0; OR, 2.7; 95% CI, 0.99–7.37). ⁶¹
Cardiac arrest and cardiopulmonary resuscitation	4,962	82	– Indication for ECMO in AH-related CA: VA-ECMO reduces in-hospital mortality vs conventional CPR without extracorporeal rewarming (65% vs 84%; 95%CI, –21% to –5.1%) and improves survival with a favorable level of consciousness (21% vs 10%; 95%CI, 1.9%–15%). ⁵⁴ – ECMO vs CPB rewarming: VA-ECMO as an extracorporeal rewarming system improved the probability of survival compared with CPB (RR, 7.6; 95% CI, 1.14–50.8). ⁴⁹ – Extracorporeal rewarming rate: An excessively rapid rewarming rate was associated with a 1.9% decrease in survival probability for each 1 °C/h increase. Cutoff between favorable and unfavorable neurological prognosis: rewarming ≤ 5 °C/h. ⁵⁸ – ECMO in patients with severe hypothermia without CA: The risk of death among patients rewarmed using less invasive measures was twice that of those rewarmed with ECMO (41% vs 20.5%; RR, 2.0; OR, 2.7; 95% CI, 0.99–7.37). ⁶¹

For each area, the total number of patients and studies included in the scoping review is presented, together with examples of clinically relevant effect estimates (OR, RR, or absolute differences) extracted from the most informative studies in that area. Estimates are reported as originally published (crude or adjusted, depending on the study) and do not represent pooled estimates, as no meta-analysis was performed.

OR: odds ratio; RR: relative risk; 95% CI: 95% confidence interval; GCS: Glasgow Coma Scale; AH: accidental hypothermia; CA: cardiac arrest; ECMO/VA-ECMO: extracorporeal membrane oxygenation (venoarterial); CPB: cardiopulmonary bypass; CPR: cardiopulmonary resuscitation; TBI: traumatic brain injury; BADL: basic activities of daily living.

compensated for by isolated active systems, particularly in victims unable to shiver or with impaired consciousness. The combination of a multilayer insulation system and active rewarming is essential to maintain an adequate thermal balance.²⁶ Because unstable patients with AH may require prolonged transfer, mechanical chest-compression devices are recommended to ensure the quality and consistency of compressions in the event of CA or risk of CA during transport.²⁷ In addition, mechanical chest-compression devices free rescuers from having to perform manual compressions, which can be particularly difficult in some prehospital environments and may complicate transport.

Management of hypothermic patients requires a structured and coordinated approach. The absence of

specific protocols is associated with underreporting, diagnostic delay, and higher mortality rates.²⁸ Implementation of standardized operating procedures and specialized teams improves early recognition, survival with extracorporeal resuscitation, transport, and patient safety.¹⁸ Continuous training optimizes the use of algorithms, reduces variability in care, and reinforces safety, enabling rescue times to be optimized and premature critical decisions to be avoided. This supports the development of integrated regional plans among prehospital services, hospitals, and referral centers. In patients with moderate or severe AH, hemodynamic instability, or CA, immediate transfer to AH referral centers with an extracorporeal membrane oxygenation (ECMO) program is recommended.

Table 3. Rewarming systems in accidental hypothermia

System	Invasiveness	Prehospital availability	In-hospital availability
Passive	No	High	Mostly low because uncommon
– Consider removal of wet clothing			
– Aluminized blanket			
– Wool blankets			
– Sheets or bubble wrap			
– Multilayer systems			
Active			
External			
– Forced-air warming	No	Low	High
– Warmed oxygen	Minimal	Low	High
– Resistive electric blankets	No	Moderate	Moderate
– Heat packs	No	Moderate (ambulance)	Low
– Environmental warming	No	Moderate (ambulance)	High
Minimally invasive internal			
– Warmed intravenous fluids	Yes	Moderate	High
Invasive internal			
– Active internal rewarming with endovascular temperature control	Yes	None	Moderate (depending on center)
– Active internal rewarming with an esophageal heat-transfer device	Yes	None	Low
– Cavity lavage	Yes	None	High
Extracorporeal			
– ECMO	Yes	Very low	Moderate (depending on center)
– CPB	Yes	None	Moderate (depending on center)
– Continuous renal replacement therapies	Yes	None	Moderate (depending on center)

Classification of rewarming strategies according to system type (passive/active), route of application (external, minimally invasive internal, invasive internal, and extracorporeal), and invasiveness. Availability in prehospital and in-hospital settings is presented as a qualitative estimate (high/moderate/low/none) based on usual resource availability and variability across settings and should not be interpreted as a universal standard or as an indicator of comparative effectiveness.

ECMO: extracorporeal membrane oxygenation; CPB: cardiopulmonary bypass.

Area 5: In-hospital prevention and detection

AH is an underdiagnosed clinical condition in hospital emergency departments.^{29,30} The absence of systematic temperature measurement during the initial phases of care is associated with delays in initiating rewarming measures and increased mortality.^{29,31} Early temperature assessment is essential for identifying patients at risk and guiding early interventions.

Estimation of temperature by clinical examination alone is not recommended in the hospital setting because it may lead to diagnostic errors. Definitive diag-

nosis and classification of AH severity can only be performed by measuring core temperature, which should continue to be monitored until normothermia is achieved. Standardization of core-temperature measurement in emergency departments is essential for all patients with suspected or confirmed AH. Although core methods are the reference standard because of their accuracy, their invasive nature limits routine use. In more severe cases or in patients undergoing orotracheal intubation, esophageal or bladder temperature monitoring is recommended.³² In patients without a protected airway, epitympanic thermistor probes are recommended. The choice of temperature-monitoring method should be adapted to local protocols, the care setting, and the patient's clinical condition, while always considering the inherent limitations of each technique.

AH is a preventable condition with a significant public health impact, particularly affecting vulnerable groups such as older adults, people experiencing homelessness, patients with multiple comorbidities, trauma victims, and individuals intoxicated by alcohol or drugs.³³⁻³⁷ In these groups, early diagnosis is essential to prevent complications and reduce morbidity and mortality.³⁸ Moreover, it is priority to promote clinical awareness and public health measures aimed at prevention and early detection of AH. In Spain, the Ministry of Health's "National Plan for Preventive Measures against Low Temperatures" (2024-2025) recognizes cold as an environmental health risk that should not be underestimated and emphasizes the need to establish and devel-

Table 4. Assessment of hypothermia severity according to clinical findings

Severity	Hypothermia grade	AVPU scale	Compatible clinical findings	Estimated temperature (°C)
Mild	I	Alert	Conscious	35–32 °C
Moderate	II	Verbal	Altered level of consciousness	32–28 °C
Severe	III	Pain or unresponsive (with vital signs)	Unconscious with vital signs	< 28 °C
Very severe/ Critical– CRA	IV	Unresponsive (without vital signs)	Absence of vital signs confirmed for 1 minute	Variable, generally < 28 °C

AVPU corresponds to the values of the revised Swiss staging system.¹⁶ This estimate should be interpreted with caution in the presence of severe comorbidities or factors that may interfere with assessment (substance use, trauma, severe illness, or psychiatric disorders). CA: cardiac arrest.

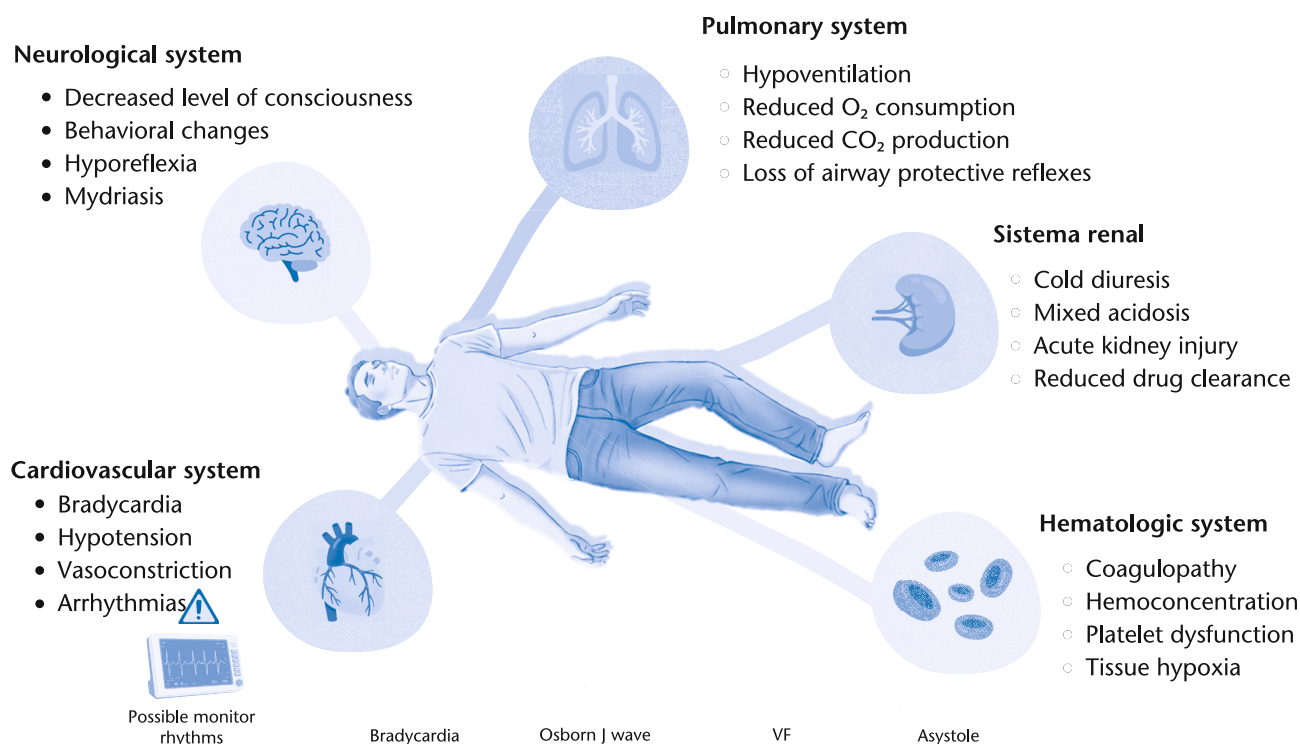


Figure 2. Common clinical findings in patients with accidental hypothermia.

op specific preventive plans to mitigate the effects of low temperatures.³⁵ To this end, it establishes recommendations to reduce the health effects of cold, coordination measures with the relevant State Administration institutions, and actions to be implemented with the Autonomous Communities or Local Administration.

Area 6: Specific management of patients with multiple trauma

AH, together with acidosis and coagulopathy, constitutes the so-called “lethal triad,” a condition associated with 15% mortality during the first 6 hours, increasing to 48% when overall data are considered.³⁹ Although AH is defined by a temperature threshold of 35 °C, in trauma patients a body temperature < 36 °C should prompt preventive initiation of thermal protection and treatment measures.⁴⁰ AH is common in severe trauma.⁴¹ Factors such as low environmental temperature, level of consciousness, and wet clothing double the risk. Prevention, early diagnosis, and thermal protection should therefore be priorities during initial care. AH should consequently be considered a physiological marker of severity in triage scales, enabling early identification of at-risk patients and optimization of decision-making in highly complex, high-pressure settings.⁴²

Body temperature measurement should be standardized as part of the primary assessment of all trauma patients.⁴³ It is particularly important in patients with traumatic brain injury (TBI) or suspected severe injury (ISS > 16), in whom thermal abnormalities are associat-

ed with neurological dysfunction, coagulopathy, and increased mortality.⁴³ Nevertheless, absence or delay in temperature measurement, which may occasionally occur because life-saving procedures take priority, should not delay the initiation of preventive rewarming measures. Patients with hemorrhagic shock are at high risk of AH because of blood loss, hypoperfusion, and environmental exposure, factors that contribute to coagulopathy and increase mortality.⁴⁴ This risk is further increased by transfusion of unwarmed blood products, a cause of iatrogenic hypothermia that may worsen hemostatic dysfunction.⁴⁵ In this context, continuous temperature monitoring is essential for early detection of temperature decreases and immediate initiation of active rewarming strategies, thereby optimizing resuscitation and improving clinical outcomes.

Area 7: In-hospital management strategies

In-hospital rewarming techniques are safe and effective interventions for managing the different degrees of AH (Table 3). In severe cases characterized by hemodynamic instability, impaired consciousness, or CA, extracorporeal rewarming with ECMO is the treatment of choice.⁴⁶ However, when this modality is unavailable or is not considered indicated, combining different conventional active rewarming techniques with a multilayer thermal insulation system may provide an alternative.

Among nonextracorporeal rewarming techniques, no specific method has demonstrated significant superiority in terms of survival, safety, or rewarming rate. Therefore, techniques should be selected according to

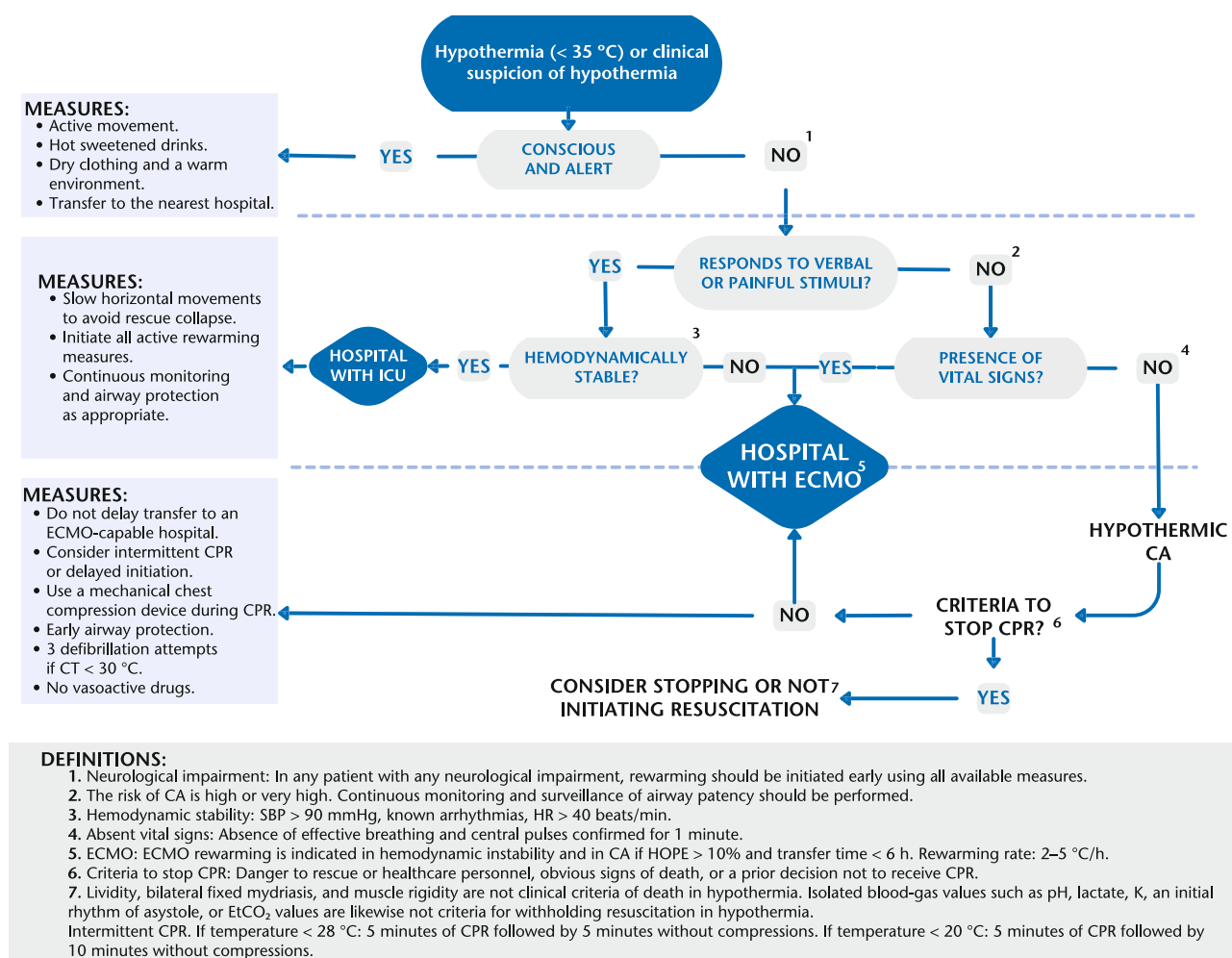


Figure 3. Algorithm for the clinical management of patients with accidental hypothermia.

ECMO: extracorporeal membrane oxygenation; CA: cardiac arrest; CPR: cardiopulmonary resuscitation; CT: core temperature; ICU: intensive care unit; HR: heart rate; K: potassium; EtCO₂: end-tidal CO₂; SBP: systolic blood pressure.

the patient's clinical condition and available resources, prioritizing early initiation, combined use of different modalities, and continuity throughout the chain of care, with close monitoring being essential to prevent complications (Figure 4). Active internal rewarming using endovascular temperature-control systems and active internal rewarming with heat-transfer devices are effective and less invasive than extracorporeal rewarming. These systems are recommended in patients without CA and without access to ECMO, although device selection depends on the equipment available at each center.⁴⁷ During active rewarming, the afterdrop phenomenon should be monitored. This is a paradoxical drop in core temperature caused by peripheral vasodilation and the return of cold blood from the extremities to the central circulation and may precipitate hemodynamic instability.⁴⁸

In patients with AH or at risk of developing it, warmed fluids (38°–42 °C) are recommended when fluid therapy is required to limit additional iatrogenic cooling. Warmed fluids should not be used as the primary method of rewarming in AH because of their limited

thermal yield (0.25 °C after 1 L of warmed crystalloids) and the possibility of adverse effects.

Area 8: Cardiac arrest and cardiopulmonary resuscitation

In cases of CA, extracorporeal resuscitation using venoarterial (VA) ECMO is the treatment of choice because it both restores circulation and allows progressive rewarming. ECMO cannulation provides benefits in terms of survival and neurological outcome compared with cardiopulmonary bypass (CPB).^{49,50} In addition, it is a more applicable and accessible technique and is associated with a lower complication rate.

The decision to initiate, discontinue, or continue CPR in patients with AH-related CA can be difficult and may depend on experience and training in AH. In the hospital setting, potassium has traditionally been used as a threshold to decide whether resuscitation should continue (> 12 mmol/L), although potassium values may vary simply according to the site of blood sampling and may be influenced by contextual factors

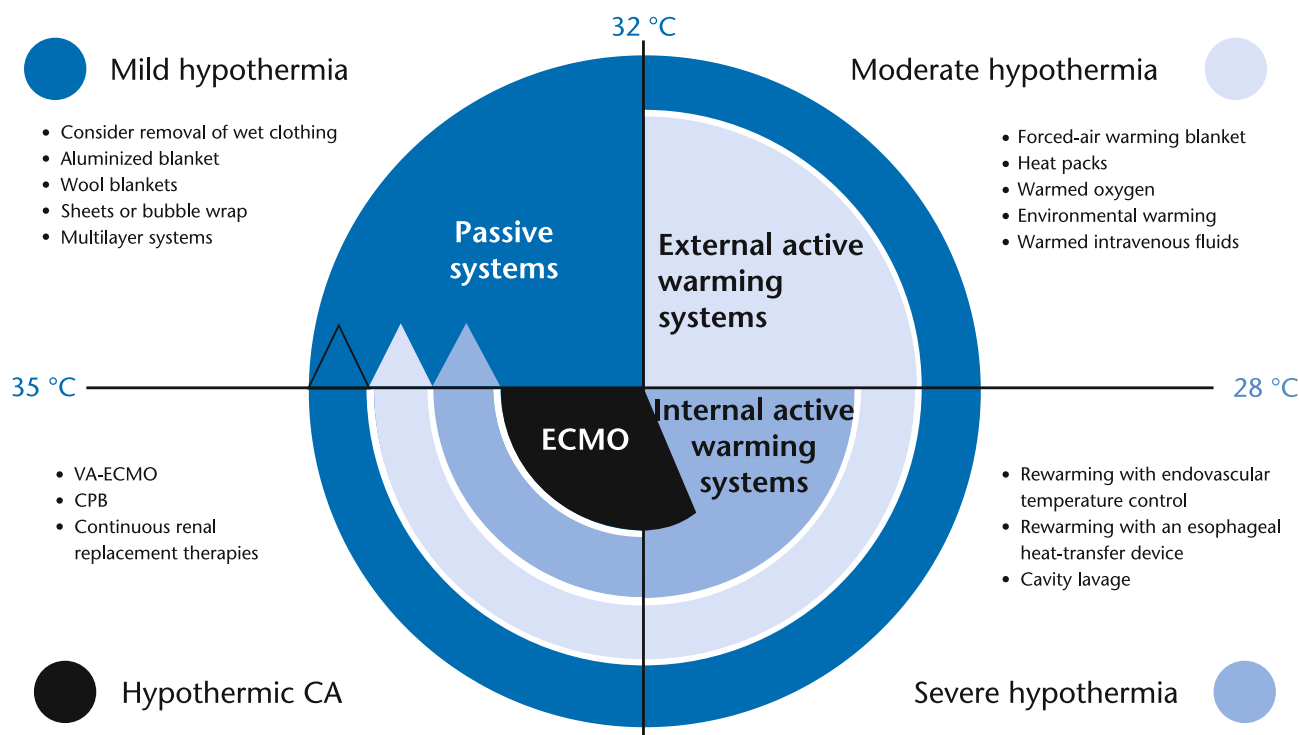


Figure 4. Rewarming systems according to hypothermia severity.

Rewarming systems are not strictly specific to each degree of hypothermia and may vary according to the patient's clinical condition and the resources available at each center. Increasing invasiveness of the systems should be proportional to the patient's clinical context, assessing in each case whether the patient is a candidate for escalation to the next level of treatment. ECMO-type systems may be considered in some patients with hemodynamic instability. Passive systems may be used in any setting, although their thermal effectiveness in the absence of autoregulation is very low. Close temperature monitoring is recommended to assess the effectiveness of the measures. Adapted from, Cold card assessment and care of cold-exposed patients.⁶³

CA: cardiac arrest; CPB: cardiopulmonary bypass; VA-ECMO: venoarterial extracorporeal membrane oxygenation; heat packs, external active rewarming systems available for prehospital use.

such as concomitant trauma, pre-existing renal failure, or drug use.⁵¹ Therefore, isolated assessment of blood-gas parameters such as pH, potassium, base excess, or bicarbonate should not be used as the basis for terminating CPR in patients with AH.⁵² Similarly, usual clinical signs of death such as fixed dilated pupils, lividity, or apparent *rigor mortis* should not be considered unequivocal reasons to discontinue CPR in AH (Figure 3). In patients with AH-related CA, the priority should be transfer to an ECMO-capable center, preferably one with experience in AH. The decision to continue CPR with extracorporeal support should be based on multivariable prognostic models. Currently, HOPE (<https://www.hypothermiascore.org/>) is the preferred score for determining which patients with AH-related CA may benefit from ECMO (indicated when estimated survival is > 10%).⁵² This multidimensional approach has greater predictive ability than isolated potassium values. This recommendation does not imply that potassium should be ignored as a marker of futility. If the HOPE score cannot be calculated, very high potassium values ($K > 12$ mmol/L) may be considered an orientative criterion of CPR futility, always with caution and in conjunction with the clinical and situational context.

During CPR, no more than 3 defibrillation attempts should be administered until temperature > 30 °C. Administration of a maximum of 1 mg of adrenaline < 30 °C may be considered if rapid access to extracorporeal resuscitation is unavailable. At a core temperature of 30°–35 °C, drug-administration intervals should be increased to every 6–10 minutes.¹⁸ Survival outcomes after AH-related CA are favorable, even after unwitnessed CA.^{54,55} These survival rates are closely linked to the use of extracorporeal techniques as the treatment of choice. Successful survival after AH-related CA using ECMO support has been reported in Spain.^{56,57} Survival rate after extracorporeal resuscitation with ECMO may reach 37%, with 84% of survivors having a favorable neurological outcome (CPC 1–2).⁵³ In unwitnessed CA, survival after extracorporeal resuscitation may reach 27%, with 83% of survivors achieving a favorable neurological outcome.⁵⁵ Rewarming rates < 2 °C/h and > 5 °C/h have been associated with poorer survival outcomes; therefore, rewarming should be performed within this range whenever possible.⁵⁸⁻⁶⁰

Unstable patients with AH are at high risk of CA. In this group, on an individualized basis and depending on experience and availability of the technique, ECMO rewarming may be considered as an alternative associ-

ated with improved survival compared with other active rewarming systems (Figure 4).⁶¹ When ECMO is unavailable or transfer time to an ECMO center > 6 hours, active rewarming should be initiated at the nearest hospital.¹⁸ This threshold is based on a pragmatic expert-opinion approach that does not distinguish between witnessed and unwitnessed CA and should not be regarded as an absolute cutoff. In such cases, hemodialysis or continuous venovenous hemofiltration is recommended as an alternative rewarming strategy in severe hypothermia without circulatory collapse.⁶²

Limitations

This document is based on a scoping systematic review and a Delphi process; therefore, no formal quantitative synthesis (meta-analysis) or effect estimates of the evaluated information were performed. The selected articles show substantial heterogeneity, limiting direct comparison of results and the precision of the recommendations. Publication bias cannot be excluded, although the search strategy was broad. Despite assessment of risk of bias in key studies, the results may be affected by residual confounding and other limitations inherent to nonrandomized designs. The ACCP system was selected instead of GRADE because it allows strength (1/2) and quality of evidence (A–C) to be assessed separately and incorporates the benefit-risk balance and feasibility. Some recommendations, supported mainly by observational studies, may appear stronger if both dimensions are not assessed together. The breadth of the clinical question may affect the applicability of certain recommendations and limit their generalizability in some settings.

Conclusions

AH is a preventable and treatable condition with multiple etiologies that may occur in a range of clinical settings. Its management should be based on standardized diagnostic, treatment, and referral measures appropriate to each patient. Comprehensive coordination throughout the entire chain of care is therefore essential to optimize clinical outcomes. Identification of at-risk subgroups, continuous training, and educational strategies aimed at all involved professionals are key elements that may improve patient prognosis and ensure quality of care. In cases of CA, establishing transfer pathways to ECMO referral centers allows a comprehensive response and maximizes the chances of survival.

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