

during Intrahospital Transportation of Critically Ill Patients. *Crit Care Res Pract.* 2017;2017:6847124, <http://dx.doi.org/10.1155/2017/6847124>.

Sara Ferreira Pagliarini^a, Pedro Henrique Rigotti Soares^{a,b}, Matheus Golenia dos Passos^a, Leonardo da Silva Marques^a, Wagner Nedel^{a,*}

^a Intensive Care Unit, Grupo Hospitalar Conceição, Porto Alegre, Brazil

^b Medicine School, Universidade do Vale do Rio dos Sinos, São Leopoldo, Brazil

Corresponding author.

E-mail address: wagnernedel@uol.com.br (W. Nedel).

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Before and after the first extracorporeal cardiopulmonary resuscitation due to accidental hypothermia in Spain



Antes y después de la primera reanimación cardiopulmonar extracorpórea por hipotermia accidental en España

Dear Editor:

On November 3, 2019, a 34-year-old woman in cardiac arrest (CA) due to accidental hypothermia was transferred to Hospital Universitario Vall d'Hebron, Barcelona, Catalonia, Spain. The patient was rescued in the Pyrenees with an initial esophageal temperature of 19.4 °C, initial rhythm of asystole, cyanosis in acral parts, and bilateral unresponsive mydriasis. The first venous blood gas revealed: pH levels of 6.8, potassium levels of 4.6, and lactate levels of 10.3. A HOPE score of 88% was calculated, which led to the indication of extracorporeal life support (ECLS) with venoarterial extracorporeal membrane oxygenation (VA-ECMO) via ipsilateral right femoro-femoral surgical cannulation. After gradual rewarming at a rate of 3 °C/h, spontaneous circulation was restored after defibrillation once the central temperature exceeded 30 °C. The patient progressed favorably, which eventually led to removing ECMO support 45 h later. The patient was eventually discharged 11 days later with a Cerebral Performance Category of 1.^{1,2}

To date, another case of CA due to accidental hypothermia resuscitated for 3 h had been published in *Medicina Intensiva* in Spain, but it was an in-hospital CA, and no previous experiences of extracorporeal cardiopulmonary resuscitation (ECPR) had ever been reported in these patients.³

The initially reported case represents the first successful resuscitation in Spain of an out-of-hospital CA patient due to accidental hypothermia and the longest resuscitation published nationally. Nearly 5 years after the accident, the patient is in excellent general condition. To evaluate functionality in activities of daily living, a Barthel test was performed which showed a score of 100/100. Additionally, a multidimensional quality of life test perceived by the person

was performed too (the World Health Organization Quality of Life scale abbreviated – WHOQOL-BREF). A psychologist reviewed the test, which revealed a total score of 125/130 (10/10, general area; 34/35, physical; 26/30, psychological; 15/15, social; 40/40, environmental). These data demonstrate that recovery after such a long resuscitation has been complete and reintegration into a normal life in all areas has been successful.

In Catalonia, Spain more than 19,000 rescues have been reported in the natural environment since 2010, with almost 50% being mountain rescues.⁴ In the past 2 decades, there have been other cases of CA due to accidental hypothermia. With the authorization of the ethics committee of hospital Arnau de Vilanova (CEIC-1308) and the analysis of the reports from the Mountain Intervention Unit of Mossos d'Esquadra and the Mountain Rescue Group of Bombers d'Andorra, all fatal accidents due to accidental hypothermia in the Pyrenees of Catalonia and Andorra from 2000 through 2024 have been compiled (Table 1). A total of 29 cases have been documented so far. Of these, 65.5% involved men, with a median age of 40 years (IQR, 35–48). A total of 48.2% of the cases occurred outside the winter season. The most practiced activity was ski mountaineering, followed by hiking, with most cases occurring in the Ripollés region (51.7%) and Val d'Aran (24.1%). No CPR measures were initiated in 69% of the victims, and only 4 victims (13.8%) were transferred to an ECMO center. Grouping data by number of reported accidents, a total of 17 accidents occurred (6 in winter, 5 in autumn, 4 in summer, and 2 in spring). These data indicate that 64.7% of the accidents occurred in non-winter seasons.

These results should warn us on the de-seasonalization of accidents due to accidental hypothermia and the need for careful evaluation of each case by personnel trained in hypothermia. Currently, hypothermia remains a poorly recognized entity with many biases in its assessment and management.⁵ Without the presence of environmental cold or a triggering environment (high mountains, drowning, or snowy terrain), hypothermia can be difficult to suspect. However, hypothermia exists in our environment, both in rural and urban settings, and failing to consider it can lead to underdiagnosis. In turn, the most severe cases could be dismissed for transfer to an ECLS center due to lack of knowledge or protocols.

Some specific cases—like the one initially presented in this article—demonstrate the possibility of surviving an out-of-hospital CA due to accidental hypothermia despite the presence of typical markers of poor prognosis in normoth-

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Table 1 Cases of accidental hypothermia* in the Pyrenees of Catalonia and Andorra from 2000 through 2024.

Victim	Age	Sex	Location	Region	Activity	Season	Accident date	Mechanism	CPR or ECLS attempt	Transfer to an ECMO-capable center	Survivor
1	51	M	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
2	37	M	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
3	35	M	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
4	37	M	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
5	48	F	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
6	28	F	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
7	37	F	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
8	46	M	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
9	38	M	Balandrau	Ripollès	Ski Mountaineering	Winter	30/12/2000	Accidental	No	No	No
10	44	M	Costabona	Ripollès	Ski Mountaineering	Winter	20/1/2001	Avalanche	No	No	No
11	40	M	Costabona	Ripollès	Ski Mountaineering	Winter	20/1/2001	Avalanche	No	No	No
12	44	M	Fontnegra	Ripollès	Ski Mountaineering	Winter	24/1/2002	Avalanche	No	No	No
13	37	M	Urús	Cerdanya	Unknown	Spring	11/4/2004	Accidental	No	No	No
14	50	F	Restanca	Val d'Aran	Ski Mountaineering	Winter	15/02/2005	Accidental	No	No	No
15	60	M	Aiguestortes	Val d'Aran	Ski Mountaineering	Winter	18/2/2005	Accidental	No	No	No
16	45	F	Puigmal	Ripollès	Hiking	Autumn	7/11/2009	Accidental	No	No	No
17	43	F	Puigmal	Ripollès	Hiking	Autumn	7/11/2009	Accidental	Yes, CPR	No	No
18	48	F	Cavalls de vent	Berguedà	Mountain Race	Autumn	29/9/2012	Accidental	Yes, CPR	No	No
19	35	M	Andorra	Andorra	Hiking	Winter	27/12/2012	Accidental	No	No	No
20	43	M	Cavalls de vent	Berguedà	Mountain Race	Spring	28/4/2015	Accidental	Yes, CPR	Yes (renal replacement therapy machine)	No
21	67	M	Pica d'estats	Pallars Sobirà	Hiking	Summer	21/08/2015	Accidental	No	No	No
22	28	M	Circ de Colomers	Val d'Aran	Hiking	Summer	12/9/2017	Accidental	Yes, CPR	No	No
23	20	M	Andorra	Andorra	Hiking	Autumn	29/10/2018	Accidental	Yes, CPR	No	No
24	34	F	Fontalba	Ripollès	Hiking	Autumn	4/11/2019	Accidental	Yes, ECLS	Yes (VA-ECMO)	Yes
25	38	M	Andorra	Andorra	Hiking	Summer	30/7/2020	Accidental	Yes, CPR	No	No
26	27	M	Aiguestortes	Val d'Aran	Hiking	Autumn	25/9/2020	Accidental	No	No	No
27	27	F	Aiguestortes	Val d'Aran	Hiking	Autumn	25/9/2020	Accidental	No	No	No
28	65	M	Aiguestortes	Val d'Aran	Hiking	Summer	14/9/2022	Accidental	Yes, ECLS	Yes (VA-ECMO)	No
29	69	F	Aiguestortes	Val d'Aran	Hiking	Summer	14/9/2022	Accidental	Yes, ECLS	Yes (VA-ECMO)	No

CPR, cardiopulmonary resuscitation; ECLS, extracorporeal life support; ECMO, extracorporeal membrane oxygenation; F, female; M, male; VA, venoarterial.

* Cause of death: hypothermia certified in a forensic report.

RESCUE CHAIN FOR VICTIMS OF ACCIDENTAL HYPOTHERMIA

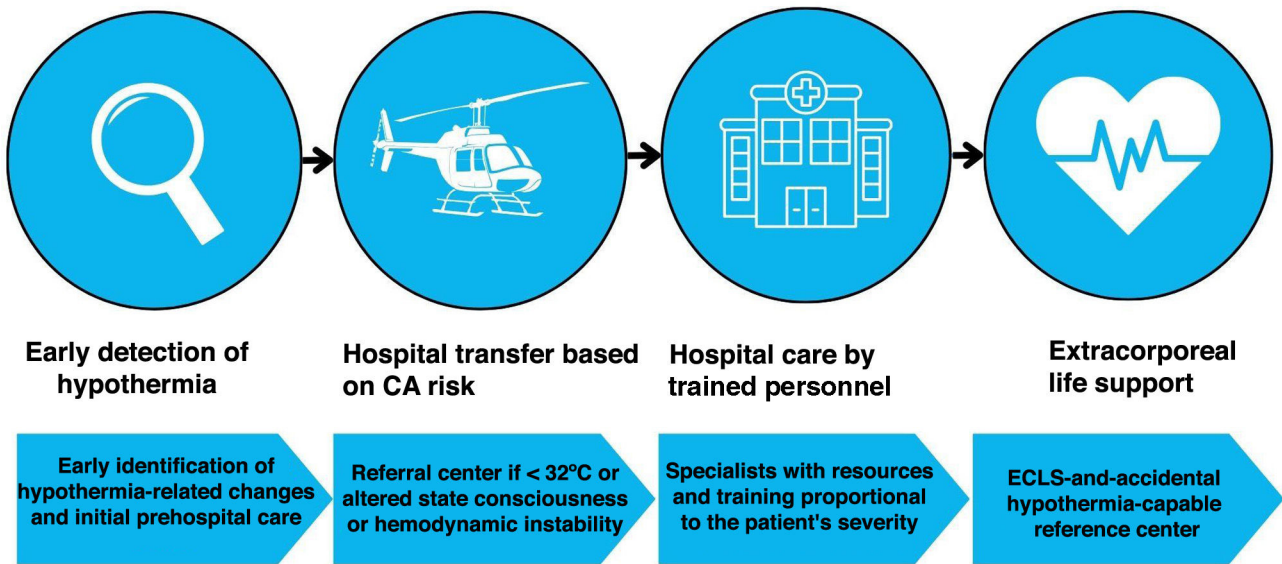


Figure 1 Rescue chain for victims of accidental hypothermia. ECLS, extracorporeal life support.

ermia (asystole, acidosis, lactate, end-tidal carbon dioxide, CA duration, unresponsive mydriasis). Out of all the cases that were not resuscitated, it is impossible to know if their prognosis would have changed or if CPR should have been initiated. However, same as it happens with very specific conditions for which there care and referral circuits remain available such as stroke, acute myocardial infarction, burns, or acute spinal injury, victims of accidental hypothermia should be taken care of through standardized circuits in centers with resources and experience proportional to the risk of CA.

Therefore, a feasible solution would be to implement a specific rescue chain ranging from prehospital services trained in detection, triage, and initial management to, if necessary, transfer to a reference hospital center capable of managing cases of accidental hypothermia with an altered state of consciousness, hemodynamic instability, or temperature $\leq 30^{\circ}\text{C}$ in adults and $\leq 32^{\circ}\text{C}$ in elderly patients with comorbidities (Fig. 1).^{6–8} A reference center should be equipped with trained and experienced health care personnel in the management of these cases and, also, with specific treatment protocols and circuits, including ECLS, to shorten transfer times by not having to decide which center to refer to while offering the highest possible quality of care.^{9,10}

The approach to this problem can go beyond hospital strategies, providing the first responder with the necessary basics to act and alert. Prevention strategies (providing the victim or responders with the skills needed to resolve the problem when it arises through strategies like informational pamphlets at key points, training courses, information on social networks), prevention campaigns (informational panels, accessible weather information, or preventive advertising campaigns), and intervention strategies (to avoid recurrence of cases, such as improving signals, expanding and securing telephone coverage areas,

or improving the traceability of hikers between shelters) can improve the safety of any victim.

Accidental hypothermia is a poorly recognized entity requiring specific management. A total of 86.2% of the victims of all accidents compiled were not transferred to an ECLS-capable center. One out of 3 patients who were put on ECMO survived with excellent functional capacity. The creation of specific circuits associated with reference hypothermia centers should facilitate triage decisions and ensure the proportionality of resources applicable to the risk of CA in any hypothermia victim.

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Authors' contributions

Robert Blasco was involved in the conceptualization, research, and drafting of the original manuscript, review, and editing.

Eduard Argudo was involved in the conceptualization, drafting, review, and editing of the manuscript.

Iñigo Soteras was involved in the conceptualization, drafting, review, and editing of the manuscript.

Conflicts of interest

None declared. The authors also declare that they have the CEIC approval and the patient's explicit informed consent for the publication of the case.

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Robert Blasco Mariño^{a,b}, Eduard Argudo^{c,d,*}, Iñigo Soteras Martínez^{e,f}

^a Servicio de Anestesiología y Reanimación, Hospital Universitario Vall d'Hebron, Barcelona, Spain

^b Facultad de Medicina, Departamento de Ciencias Médicas. Universidad de Girona, Girona, Spain

^c Servicio de Medicina Intensiva, Hospital Universitario Vall d'Hebron, Barcelona, Spain

^d Grupo de Investigación en Shock, Disfunción Orgánica y Reanimación (SODIR), Vall d'Hebron Institut de Recerca, Barcelona, Spain

^e Sistema d'Emergències Mèdiques (SEM), Spain

^f Servicio de Urgencias, Hospital Transfronterer de la Cerdanya, Girona, Spain

Corresponding author.

E-mail address: eduard.argudo@vallhebron.cat (E. Argudo).

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