HIGH ALTITUDE MEDICINE & BIOLOGY
Volume 24, Number 4, 2023

DOI: 10.1089/ham.2023.0068

Review

Termination of Cardiopulmonary Resuscitation in Mountain Rescue: A Scoping Review and ICAR MedCom 2023 Recommendations

Viktor Lugnet,[1–3] Miles McDonough,[1,4] Les Gordon,[1,5,6] Mercedes Galindez,[1,7,8]
Nicolas Mena Reyes,[1,9–11] Alison Sheets,[1,12,13] Ken Zafren,[1,14–16] and Peter Paal[1,17]

Abstract

Lugnet, Viktor, Miles McDonough, Les Gordon, Mercedes Galindez, Nicolas Mena Reyes, Alison Sheets, Ken Zafren, and Peter Paal. Termination of cardiopulmonary resuscitation in mountain rescue: a scoping review and ICAR MedCom 2023 recommendations. *High Alt Med Biol*. 24:274–286, 2023.

Background: In 2012, the International Commission for Mountain Emergency Medicine (ICAR MedCom) published recommendations for termination of cardiopulmonary resuscitation (CPR) in mountain rescue. New developments have necessitated an update. This is the 2023 update for termination of CPR in mountain rescue.

Methods: For this scoping review, we searched the PubMed and Cochrane libraries, updated the recommendations, and obtained consensus approval within the writing group and the ICAR MedCom.

Results: We screened a total of 9,102 articles, of which 120 articles met the inclusion criteria. We developed 17 recommendations graded according to the strength of recommendation and level of evidence.

Conclusions: Most of the recommendations from 2012 are still valid. We made minor changes regarding the safety of rescuers and responses to primary or traumatic cardiac arrest. The criteria for termination of CPR remain unchanged. The principal changes include updated recommendations for mechanical chest compression, point of care ultrasound (POCUS), extracorporeal life support (ECLS) for hypothermia, the effects of water temperature in drowning, and the use of burial times in avalanche rescue.

Keywords: cardiac arrest; cardiopulmonary resuscitation; emergency medicine; extracorporeal life support; hypothermia; mountain medicine; mountain rescue

[1]International Commission for Mountain Emergency Medicine (ICAR MedCom), Kloten, Switzerland.
[2]Department of Anesthesiology and Intensive Care, Östersund Hospital, Östersund, Sweden.
[3]Swedish Mountain Guides Association (SBO), Gällivare, Sweden.
[4]Department of Emergency Medicine, UCSF Fresno, Fresno, California, USA.
[5]Langdale Ambleside Mountain Rescue Team, Ambleside, United Kingdom.
[6]Department of Anaesthesia, University Hospitals of Morecambe Bay Trust, Lancaster, United Kingdom.
[7]Department of Internal Medicine, Hospital Zonal Ramón Carrillo, San Carlos de Bariloche, Argentina.
[8]Comisión de Auxilio Club Andino Bariloche, San Carlos de Bariloche, Argentina.
[9]Department of Emergency Medicine, Sótero del Río Hospital, Santiago de Chile, Chile.
[10]Grupo de Rescate Médico en Montaña (GREMM), Santiago, Chile.
[11]Emegency Medicine Section, Pontificia Universidad Católica de Chile, Santiago, Chile.
[12]Emergency Medicine, Boulder Community Health, Boulder, Colorado, USA.
[13]Wilderness Medicine Section, University of Colorado Health Sciences Center, Aurora, Colorado, USA.
[14]Himalayan Rescue Association, Kathmandu, Nepal.
[15]Department of Emergency Medicine, Stanford University Medical Center, Stanford, California, USA.
[16]Alaska Native Medical Center, Anchorage, Alaska, USA.
[17]Department of Anaesthesiology and Intensive Care Medicine, St. John of God Hospital, Paracelsus Medical University, Salzburg, Austria.

Introduction

A victim of cardiac arrest (CA) in the mountains is likely to die, even when emergency medical systems (EMS) and definitive in-hospital medical care are nearby. The chances of survival after CA are generally lower in the mountains compared with urban areas because of less dense networks of EMS and hospitals, delays in EMS arrival, and less access to defibrillation (Jung et al., 2018; Oshiro and Murakami, 2022; Soar et al., 2021; Strohle et al., 2019; Strohle et al., 2014).

Performing cardiopulmonary resuscitation (CPR) in the mountains may be more difficult than in urban areas (Egger et al., 2020; Rottenberg, 2014; Vogele et al., 2021; Wang et al., 2014). The challenges may be compounded by limited resources. No doctor or other qualified person may be on the scene to make the decision to withhold or terminate CPR. Criteria for termination of resuscitation (TOR) should be easy for rescue personnel to use and must be in accordance with regional and national rules and regulations. Mountain rescue presents risks to both rescuers and victims because of the hazards of terrain and weather. Performing CPR in a mountain environment may be technically challenging, exhausting, and hazardous. In many instances, treatment comes too late and only death can be diagnosed on site (Jung et al., 2018; Oshiro and Murakami, 2022; Schön et al., 2020).

Guidelines for TOR may reduce unnecessary medical interventions and overall risk to the rescuers. In a multicasualty incident, this may also allow allocation of medical resources to victims with the best chances of survival.

Our goal is to aid mountain rescuers in deciding when to start, withhold, or terminate CPR in mountain rescue. We have updated the recommendations of the International Commission for Mountain Emergency Medicine (ICAR MedCom): Termination of Cardiopulmonary Resuscitation in Mountain Rescue (Paal et al., 2012).

Methods

The ICAR MedCom established a working group for TOR at the 2019 International Commission of Alpine Rescue (ICAR) Congress. We followed the guidelines for Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018) (Supplementary Data S1). We performed literature searches in PubMed and the Cochrane Library using the same keywords as the 2012 publication for articles from February 12, 2012 (the end of the literature search period for the previous recommendations), through June 30, 2022. We confined searches to human studies, adults, and articles in English. We manually searched reference lists for additional references.

Three articles published after the end of the search period were included for special characteristics (Blasco Marino et al., 2023a; Ntoumani et al., 2023; Pasquier et al., 2023). The search terms (with the number of articles found in the PubMed and Cochrane libraries) were ''termination cardiopulmonary resuscitation'' (605; 126), ''primary cardiac arrest survival'' (3,117; 855), ''trauma cardiac arrest survival'' (1,227; 103), ''hypothermia cardiac arrest survival'' (1,387; 259), ''drowning cardiac arrest survival'' (92; 19), ''avalanche survival'' (78; 14), ''lightning survival'' (45; 2), ''electrocution survival'' (58; 1), ''burns cardiac arrest survival'' (69; 21), ''poisoning cardiac arrest survival'' (113; 16), ''auto resuscitation'' (96; 67), and ''resuscitation ethics survival'' (627; 100) (Supplementary Data S2). We reviewed 9,102 articles by title and 467 by abstract. We reviewed the full texts of 131 articles. There were 120 articles that met the inclusion criteria.

We revised the recommendations from the original publication (Table 1) (Paal et al., 2012) based on our review and graded them according to the guidelines of the American College of Chest Physicians (Guyatt et al., 2006) (Table 2). All statistical citations refer to original articles reporting statistical significance as $p < 0.05$.

Results

Nontraumatic cardiac arrest

An adult victim in nontraumatic CA (non-TCA) has a poor chance of survival in most circumstances. Long-term survival with good neurologic outcome, cerebral performance category (CPC) 1–2 at hospital discharge, may occur after witnessed CA if there is an effective chain of survival (Oberhammer et al., 2008; Strohle et al., 2019). In non-TCA, CPR should be initiated (Hopson et al., 2003; Olasveengen et al., 2021). Lay rescuers may be the first rescuers on the scene and may start CPR. Retrospective data on resuscitation by laypersons include a German study of 40,640 patients in CA. In 14,245 cases, resuscitation was performed by lay rescuers.

Predictors of favorable outcomes when resuscitation was performed by lay rescuers include shockable rhythm on EMS arrival (33% vs. 19%) and return of spontaneous circulation (ROSC) on scene (48% vs. 41%) (Gässler et al., 2020). Overall outcomes with CPC 1–2 at discharge were also significantly higher (12%) with lay resuscitation, compared with 6% without lay resuscitation.

Summary. Survival from non-TCA in remote areas is lower than in urban areas but is increased if bystanders attempt resuscitation.

Recommendation. Initiate CPR in a victim with a clinical condition suggestive of a nontraumatic cause of CA (1A).

Safety of the rescuers

Environmental hazards, such as inclement weather, steep terrain, avalanches, and falling seracs, are common in mountain rescue (Lunde and Tellefsen, 2019). The safety of

Table 1. Original Criteria for Termination of CPR from Paal et al. 2012

Criteria for termination of CPR
If all the following apply, terminate CPR: (1) Unwitnessed loss of vital signs. (2) No ROSC during 20 minutes of CPR. (3) No shock advised at any time by an AED or only asystole on the ECG.

AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; ECG, electrocardiogram; ROSC, return of spontaneous circulation.

Table 2. ICAR MedCom Recommendations Regarding Termination of Cardiopulmonary Resuscitation in Mountain Rescue

No.	*Recommendation*	*Grade*
	Nontraumatic cardiac arrest	
1	Initiate CPR in a victim with a clinical condition suggestive of a nontraumatic cause of cardiac arrest.	1A
	Safety of rescuers	
2	If the environment is unsafe, transport the victim to a safe place before commencing resuscitation.	1A
	Termination of CPR	
3	Terminate resuscitation if all of the following criteria apply: unwitnessed loss of vital signs, no ROSC during 20 minutes of CPR, no shock advised at any time by an AED or only asystole on the ECG, and no hypothermia or other special circumstances (e.g., lightning, toxic agents) that warrant prolonged CPR. If no AED is available, terminate CPR after 20 minutes of unsuccessful CPR.	1A
	Use of AED	
4	Use an AED in a victim with a primary cardiac arrest.	1A
5	Use an AED in a victim with secondary cardiac arrest.	2A
	Mechanical chest compressions	
6	Use a mechanical chest compression device, if available, for prolonged CPR, during transport in a difficult terrain, or if there are too few rescue personnel on scene to provide high-quality manual CPR.	1A
	POCUS	
7	Use POCUS, if available, to help determine whether to terminate resuscitation.	1B
	Traumatic cardiac arrest	
8	Withhold resuscitation in a victim with nonsurvivable trauma such as decapitation, loss of brain tissue, truncal transection, incineration, or penetrating cardiac trauma.	1A
9	Terminate resuscitation if a victim of traumatic cardiac arrest has no vital signs after 10 minutes of CPR.	1B
10	Medical directors of mountain rescue teams should develop local protocols for traumatic cardiac arrest, matching urban guidelines to terminate CPR if transport time is >15 minutes.	1C
	Hypothermia	
11	Unless there are definite signs of death, start CPR in a hypothermic victim without vital signs and transport to a center capable of ECLS rewarming.	1A
	Drowning	
12	Withhold CPR in a drowning victim with a submersion time >30 minutes in water >6°C or >90 minutes in water <6°C.	2A
	Avalanche	
13	In an avalanche victim with burial duration >60 minutes, in asystole, with an obstructed airway, withhold or terminate CPR.	1A
14	Provide full resuscitative efforts for an avalanche victim with a core temperature <30°C with a patent airway and without lethal injuries and transport to an ECLS-capable center.	1C
	Lightning strike	
15	In a victim in cardiac arrest caused by a lightning strike, perform prolonged CPR if necessary. Prolonged ventilatory support may be necessary even after ROSC.	1B
	Burns	
16	In a victim with cardiac arrest caused by a burn injury, terminate CPR after 20 minutes without ROSC.	1C
	Poisoning	
17	In a victim with cardiac arrest from suspected poisoning or overdose, contact a poison control center before terminating CPR.	1C

(*continued*)

Table 2. (Continued)

Bold indicates Situations/Areas of research.
Grade refers to ''Grading strength of recommendations and quality of evidence in clinical guidelines'' (Guyatt et al. 2006).
ECLS, extracorporeal life support; ICAR MedCom, International Commission for Mountain Emergency Medicine; POCUS, point of care ultrasound.

the rescuers is the highest priority. The time to the start of high-quality CPR is a predictor of survival, but it may be necessary to delay starting CPR to extricate or transport a victim if there is an unacceptable risk to the rescuers (Boyd et al., 2010; Morrison et al., 2010).

Summary. Safety of the rescuer comes first.

Recommendation. If the environment is unsafe, transport the victim to a safe location before starting resuscitation (1A).

Termination of CPR

In mountain rescue, nonmedical personnel may have to make difficult decisions to terminate CPR. Rescue guidelines should be easy to follow and require limited expertise. Studies have investigated the validity of TOR guidelines, mainly in urban areas (Chiang et al., 2015; Diskin et al., 2014; Drennan et al., 2017; Fukuda et al., 2014; Goto et al., 2019; Grunau et al., 2017; Grunau et al., 2016; Kashiura et al., 2016; Morrison, 2019; Reynolds et al., 2016; Wah et al., 2017; Yates et al., 2018). There is broad support for the basic criteria for TOR (Table 1) (Morrison, 2019; Paal et al., 2012).

In one study of 11,368 patients with out-of-hospital cardiac arrest (OHCA), 905 (8%) survived with good neurologic outcomes (modified Rankin Scale 0–3) (Reynolds et al., 2016). In the group with good neurologic outcomes, 82% (739/905) had a witnessed CA, ROSC occurred after a median CPR time of 8 minutes (interquartile range 4–13), 5% (45/905) were in asystole and 4% (34/905) had no shock advised by an automated external defibrillator (AED). By contrast, in patients not achieving ROSC (7,345/11,368), the median CPR time was 23 minutes (interquartile range 17–30), 57% (4,190/7,345) were in asystole and 9% had no shock advised by an AED.

A pan-Asian study of 39,330 OHCA patients investigating the predictive value of initial cardiac rhythm and CPR duration found that 18% (938 of 5,356) of patients with initial shockable rhythms survived with good neurologic outcomes (CPC 1–2). The percentage decreased to 2% (517 of 33,974) in the group with initial nonshockable rhythms. Most survivors with good neurologic outcomes had their first defibrillation attempt within 20 minutes of EMS arrival. In a multivariate analysis, the odds ratio (OR) for good neurologic outcome improved with witnessed CA 1.8 (confidence interval [CI] 1.7–1.8) and with initial shockable rhythm 3.5 (CI 2.9–4.2). In the subgroup with an initial nonshockable rhythm, OR for good neurologic outcome improved with witnessed CA to 1.9 (CI 1.8–2.0) and with conversion to a shockable rhythm to 2.2 (CI 2.0–2.5) (Wah et al., 2017).

A study of minimum duration of resuscitation included 1,617 patients with OHCA, of whom 797 achieved ROSC. Shorter time to ROSC from start of CPR by a professional rescuer was independently associated with increased survival. The adjusted odds ratio (aOR) for survival decreased by 0.92 (95% CI 0.90–0.94) per additional minute of CPR. Favorable neurologic outcomes decreased by an OR of 0.91 (95% CI 0.89–0.94) per additional minute of CPR. The longest duration of CPR for all survivors was 29.8 minutes, but 18.4 minutes for survivors with good neurologic outcomes (CPC 1–2). Patients with initial shockable rhythms were more likely to have favorable neurologic outcomes than patients with nonshockable rhythms, 36% (130/360) versus 3% (36/1,253).

In the logistic regression analysis of survivors, favorable neurologic outcomes were associated with witnessed CA (aOR 1.9; 95% CI 1.1–3.4), CA witnessed by EMS (aOR 3.2; 95% CI 1.6–6.4), and initial shockable rhythm (aOR 7.5; CI 95% 4.6–12.3). Favorable neurological outcome was inversely correlated with time to initial ROSC (aOR 0.91; 95% CI 0.89–0.94), age (aOR 0.95; 95% CI 0.94–0.97), and time from dispatch to EMS arrival (aOR 0.92; 95% CI 0.85–0.99) (Grunau et al., 2016). The probability of survival fell below 1% at 48 minutes in the group with shockable rhythms and 15 minutes in the group with nonshockable rhythms. The median time to TOR was 36 minutes in the shockable and 26 minutes in the nonshockable group.

In a retrospective observational study of failure to achieve ROSC as the sole criterion for termination of CPR, 21,387 of 36,543 patients with OHCA were transported to hospital (Drennan et al., 2017). Of the 9,467 patients transported who had not achieved ROSC before transport, only 186 survived. In the group of survivors, the most common initial rhythms were ventricular fibrillation (VF) and pulseless ventricular tachycardia (63% in survivors vs. 25% in nonsurvivors). Asystole was less common (12% in survivors vs. 38% in nonsurvivors). The authors concluded that TOR should not be based solely on failure to achieve ROSC. In mountain rescue, special circumstances, such as accidental hypothermia or lightning injuries, may warrant prolonged resuscitation efforts (Lott et al., 2021).

Summary. Outcomes are best with witnessed arrests, initial shockable rhythms, first defibrillation attempt within 20 minutes, and ROSC within 10 minutes. Outcomes are worse with initial nonshockable rhythms, particularly if maintained throughout the arrest, and prolonged CPR.

Recommendation. Terminate resuscitation if all of the following criteria apply: unwitnessed loss of vital signs, no ROSC during 20 minutes of CPR, no shock advised at any time by an automated external defibrillator (AED) or only asystole on the electrocardiogram (ECG), and no hypothermia or other special circumstances (e.g., lightning, toxic agents) that warrant prolonged CPR. If no AED is available, terminate CPR after 20 minutes of unsuccessful CPR (1A).

Use of AEDs

The International Liaison Committee on Resuscitation (ILCOR) recommends implementation and use of public access AEDs (PADs) in mountain rescue (Brooks et al., 2022). Three studies related to mountain rescue support AED use (Mair et al., 2019; Strohle et al., 2019; Strohle et al., 2014).

Four studies from Japan reported increased ORs for good neurologic outcomes (CPC 1–2) in patients receiving shocks by PADs. In a study of 562 patients with OHCA of presumed cardiac etiology, aOR for good neurologic survival (CPC 1–2) with PADs compared with no PAD was 11 (95% CI 1.4–88.4) (Shibahashi et al., 2021). In a study of 28,019 patients, with witnessed shockable OHCA and bystander CPR, aOR for survival with PADs versus without PADs 1.3 (95% CI 1.1–1.5), and survival with good neurologic outcome was 1.5 (95% CI 1.2–1.7) with the use of PADs compared with without PADs (Nakashima et al., 2019). In a study of 20,970 witnessed OHCA events of presumed medical origin occurring in public locations from 2013 to 2015, the aOR for survival with PADs compared to without PADs was 2.3 (95% CI, 2.0–2.7) (Kobayashi et al., 2020).

In a study of 1,743 confirmed CA events of presumed medical origin before EMS arrival occurring in public locations, PADs were used in 336/1,743 cases. The aOR for a 1-month survival with CPC 1–2 with use of PADs compared with without PADs was 2.5 (95% CI 1.3–4.7) (Kishimori et al., 2020). ICAR MedCom recommends AEDs for mountain rescue teams and a high concentration of PADs in popular ski areas, busy mountain huts and restaurants, at mass-participation events, and in remote locations with high visitation without medical coverage (Elsensohn et al., 2006).

Summary. AEDs and PADs increase the chances of survival in victims with primary CA.

Recommendation. Use an AED in a victim with a primary CA (1A). Use an AED in a victim with secondary CA (2A).

Mechanical chest compressions

For victims in CA, high-quality CPR is critical for good neurologic outcomes. During prolonged CPR or technically demanding rescues, high-quality CPR may be hard to achieve (Olasveengen et al., 2021). High quality manual chest compressions are strenuous, leading to exhaustion and reduced quality of chest compressions (Egger et al., 2020; Rottenberg, 2014; Vogele et al., 2021; Wang et al., 2014). Mountain rescue operations often have limited resources and long transport times. It may take a high level of physical effort to reach the victim. In an experimental study involving 20 experienced mountain rescuers, the quality of chest compressions at baseline and after a rapid ascent to a mountain hut the mean depth of chest compressions decreased by 1 cm (95%

CI 0.5–1.3). The percentage of compressions of at least 5 cm depth decreased from 72% to 17% (Egger et al., 2020).

The 2021 European Resuscitation Council (ERC) guidelines (Lott et al., 2021; Soar et al., 2021) recommend against the routine use of mechanical chest compression but recognize that mechanical chest compression may be beneficial in difficult transport situations such as helicopter or ambulance rescue, particularly if prolonged CPR is necessary, and in terrestrial rescues when there are too few personnel on scene to maintain high-quality CPR (Lott et al., 2021; Soar et al., 2021). Teams should be trained in safe use and should keep hands-off times to a minimum.

Three systematic reviews found no increase in ROSC with mechanical chest compression. One systematic review and meta-analysis analyzed 5 randomized trials and cluster randomized trials with the LUCAS, LUCAS-2, and AutoPulse, involving a total of 12,206 patients. The OR for ROSC with mechanical chest compression compared with high-quality CPR without mechanical chest compression was 1 (95% CI 0.85–1.10) (Gates et al., 2015). Another meta-analysis on resuscitative effects of mechanical chest compression devices included 12 studies, 6 randomized controlled trials (RCTs) and 6 cohort studies, with a total of 98,826 patients, 23,871 in the mechanical chest compression group and 74,955 in the manual chest compression group. The meta-analysis showed that the OR for ROSC for both the cohort and the RCT studies was 1.1 (95% CI 0.9–1.4). No significant differences were seen when dividing the mechanical chest compression group into LUCAS/LUCAS-2 and AutoPulse subgroups (Zhu et al., 2019).

In a third systematic review and meta-analysis analyzing 4 RCTs and 2 non-RCTs with a total of 8,501 patients, comparing the LUCAS with manual compressions, the OR was 1 (0.9–1.1) (Liu et al., 2019). A Cochrane review (Wang and Brooks, 2018) found that clinical and statistical heterogeneities were too great for a pooled effect analysis.

One concern with mechanical chest compressions is the potential for greater risk of resuscitation-related injuries compared with manual chest compressions.

A systematic review and meta-analysis of resuscitation-related injuries comparing mechanical chest compressions with LUCAS and AutoPulse devices to manual CPR included 11 trials, 10 cohort studies and 1 RCT involving a total of 2,818 patients. Overall compression-induced injuries were increased for mechanical compressions (aOR, 1.3; 95% CI, 1.2–1.4) compared with manual compressions, but there was no significant difference between the two groups in the rates of life-threatening injuries (Gao et al., 2021).

Summary. Mechanical and manual chest compressions are equally effective in terms of survival and for victims to achieve ROSC. Mechanical chest compressions increases the risk of resuscitation-related injuries but does not decrease the survival rate among CA victims.

Recommendation. Use a mechanical chest compression device, if available, for prolonged CPR, during transport in difficult terrain or if there are too few rescue personnel on the scene to provide high-quality manual CPR (1A).

Point of care ultrasound

Point of care ultrasound (POCUS) including transthoracic echocardiography (TTE) may be valuable in predicting short- and long-term outcomes after CPR. Trials have been small and heterogeneous. POCUS can be used to assess for reversible and irreversible causes of CA in real time. A major disadvantage is the long learning curve (Reynolds et al., 2022; Soar et al., 2021). A systematic review of 15 studies with 1,695 patients reported that the absence of spontaneous cardiac movement predicts low survival (Tsou et al., 2017).

A systematic review of studies of TCA included 8 studies evaluating the absence of cardiac contractions with POCUS as a negative predictor of ROSC and survival to hospital discharge (Lalande et al., 2021). In 5 studies ($n = 82$), 57 patients presented without cardiac activity. All but one died. The patient without cardiac activity who achieved ROSC did not survive to hospital admission. Seven studies reported survival to hospital discharge in a total of 478 cases. Of the 369 patients without cardiac activity, none survived.

A small study evaluating the use of POCUS in 56 patients in a Dutch helicopter emergency medical service (HEMS) concluded that TTE during CPR is feasible in helicopter rescue (Ketelaars et al., 2018). Another study evaluated survival among 201 TCA patients in a military operation. The authors concluded that patients with organized cardiac activity, but without pulses, require aggressive hemorrhage control (Barnard et al., 2018).

The ERC recommends against using single findings such as a dilated right ventricle or low myocardial contractility as a basis for terminating CPR (Soar et al., 2021). A systematic review of 17 articles studying the diagnostic accuracy of POCUS in determining the cause of CA found that the overall quality of evidence was low for all outcomes because of risk of bias, inconsistency, and imprecision. The ERC concluded that POCUS tended to be more specific than sensitive when assessing for acute injuries and critical illness and could be used as a diagnostic adjunct in screening for reversible or suspected causes of CA (Reynolds et al., 2022). Cardiac activity may not be visible with POCUS in victims with weak vital signs (Ellis and Welch, 2016). POCUS should not be the sole method for diagnosing potential causes of CA.

Summary. POCUS can be used in CA to look for cardiac contractions and as a diagnostic adjunct to assess potential reversible causes.

Recommendation. Use POCUS, if available, to help determine whether to terminate resuscitation (1B).

Traumatic cardiac arrest

Traumatic cardiac arrest (TCA) has a high mortality rate, although good neurologic outcomes have been reported in survivors (Zwingmann et al., 2012). A systematic review and meta-analysis investigating factors associated with survival in TCA found low certainty evidence that cardiac motion on ultrasound (unadjusted OR [uOR] 16; 95% CI 4.5–54), shockable rhythm (uOR 2; 95% CI 1.6–2.8), and witnessed CA (uOR 1.6; 95% CI 1.4–2.0) were associated with ROSC. Cardiac motion on ultrasound (uOR 34; 95% CI 1.9–613), initial shockable rhythm (uOR 7.3; 95% CI 5.1–10.4), and witnessed CA (uOR 1.8; 95% CI 1.2–2.6) were also associated with survival to hospital discharge or survival to 30 days post-TCA (Tran et al., 2020).

A study from the US National Trauma Data Bank of 24,191 emergency department patients with chest trauma and no vital signs found 812 patients not declared dead on arrival; 246 survived. Survival was slightly more likely in penetrating trauma, (133/310) than in blunt trauma (113/502). Penetrating trauma was an independent factor associated with survival (OR 2.1, $p < 0.01$). Mean transport time was shorter in survivors than in nonsurvivors (63 minutes vs. 105 minutes), but shorter transport time was not independently associated with survival (OR 1.0, $p = 0.11$) (Khalifa et al., 2021).

An Australian study retrospectively compared the effects of a new trauma resuscitation protocol for paramedics with historical controls. Before the protocol was introduced, all cases of CA were treated with chest compressions, defibrillation, insertion of a laryngeal mask airway, and administration of epinephrine. During the study period, the protocol mandated correction of reversible causes of TCA with bilateral thoracostomies, cardiac ultrasound, and administration of blood products. There was no significant increase in ROSC (aOR 0.6, 95% CI 0.4–1) or survival to hospital discharge (aOR 1.3, 95% CI 0.5–3.2) (Alqudah et al., 2021).

There are few published studies of TCA in mountain rescue. Longer transport times may decrease survival (Sumann et al., 2020; Sumann et al., 2009). It is reasonable to withhold CPR in a victim of severe trauma without vital signs after >10 minutes of CPR (Byrne et al., 2015; Lott et al., 2021; Sherren et al., 2013). If POCUS is available, absence of spontaneous cardiac activity or carotid blood flow after reversible causes have been treated can reinforce this decision (Blasco Marino et al., 2023b; Soar et al., 2021).

Medical directors of mountain rescue teams should consider creating local protocols for TOR in TCA. The joint position statement from the National Association of EMS Physicians and the American College of Surgeons Committee on Trauma (NAEMSP-ACSCOT) (Millin et al., 2013) and the ERC guidelines (Lott et al., 2021) suggest terminating CPR if transport time is longer than 15 minutes.

Summary. In CA caused by hemorrhage, survival is not possible if transport time to definitive care is >15 minutes.

Recommendations. Withhold resuscitation in a victim with nonsurvivable trauma such as decapitation, loss of brain tissue, truncal transection, incineration, or penetrating cardiac trauma (1A).

Terminate resuscitation if a victim of TCA has no vital signs after 10 minutes of CPR (1B).

Medical directors of mountain rescue teams should develop local protocols for TCA, matching urban guidelines to terminate CPR if transport time is >15 minutes (1C).

Hypothermia

Accidental hypothermia is an unintentional drop of core temperature to <35°C. In mountain rescue, primary hypothermia is usually caused by cold, wet, and windy conditions. Secondary hypothermia is caused by an underlying medical condition or trauma. Factors such as young or advanced age, exhaustion, intoxication, and immobilization may contribute to secondary hypothermia (Paal et al., 2022). Hypothermia may cause CA at a core temperature <30°C (Frei et al, 2019). Hypothermic CA may occur in elderly or ill individuals at temperatures up to 32°C (Expert opinion).

Hypothermia is a reversible cause of CA. A study of 206 patients with witnessed hypothermic CA found only 5 with core temperatures >28°C (Frei et al., 2019). Decreased core temperatures are neuroprotective because of reduced cerebral metabolism (McCullough et al., 1999). Even patients in hypothermic CA presenting with asystole have reasonable chances of survival with good neurologic outcomes (Podsiadlo et al., 2021).

Extracorporeal life support (ECLS) rewarming is the most effective method of rewarming victims in hypothermic CA. The Hypothermia Outcome Prediction after ECLS (HOPE) score (www.hypothermiascore.org) can help to estimate survival probability with ECLS rewarming of a victim in hypothermic CA. A study from the International Hypothermia Registry found that preserved circulation, witnessed CA, and ROSC before rewarming are associated with greater survival (Walpoth et al., 2021). When possible, a victim in hypothermic CA should be transported to a hospital capable of ECLS rewarming (Lott et al., 2021; Swol et al., 2022).

Based on case studies and induced neuroprotective low-flow or no-flow hypothermic surgery, delayed and intermittent CPR has been suggested if high-quality CPR cannot be maintained or transportation not possible with continuous CPR (Gordon et al., 2015; Lott et al., 2021).

Summary. Unless rescuer safety is at risk, CPR should not be terminated on scene for hypothermic CA. If a mechanical CPR device is not available to continue chest compressions during transport, CPR can be intermittent.

Recommendation. Unless there are definite signs of death, start CPR in a hypothermic victim without vital signs and transport to a center capable of ECLS rewarming (1A).

Drowning

Immediate rescue is critical in drowning, because the likelihood of a good outcome decreases with longer submersion. Hypoxic injury is more likely after longer duration of submersion (head under water). An ILCOR scoping review found that resuscitation in water or on a boat is feasible for specialists (Bierens et al., 2021). CA in drowning is caused by hypoxia, initial resuscitation should include rescue breathing and use of oxygen, if available. Bystander CPR with rescue breaths is helpful and should be continued until an AED is applied. Extracorporeal membrane oxygenation (ECMO) is potentially effective for victims in CA or severe respiratory problems after drowning (Bierens et al., 2021). Only one study of resuscitation in the water, with real-life data, met the inclusion criteria (Szpilman and Soares, 2004). Ventilation while the victim was still in the water improved survival with good neurologic outcomes (Szpilman and Soares, 2004).

Based on mannikin studies, the authors of the scoping review concluded that ventilation is difficult to perform in deep water, requiring at least two rescuers or a flotation device (Lungwitz et al., 2015; Perkins, 2005; Winkler et al., 2013). Adjuncts such as supraglottic airways may help improve the quality of ventilation (Winkler et al., 2013).

The effects of water temperature on survival are an ongoing area of research. In mountain rescue, most victims drown in water colder than the human thermoneutral temperature ($\sim$34°C in lean adults), the temperature at which the human body neither gains nor loses heat at rest (Ntoumani et al., 2023). These victims may be hypothermic. One study found that survival is extremely unlikely after submersion for >30 minutes in water >6°C or submersion for >90 minutes in water <6°C (Tipton and Golden, 2011). A retrospective study of 1,094 open water drowning victims did not find that water temperatures <6°C were associated with better outcomes (Quan et al., 2014).

A retrospective multicenter study of 270 consecutively enrolled patients admitted to an intensive care unit (ICU) in western France did not study water temperatures but found worse outcomes of drowning victims during the cold months (Reizine et al., 2021). The chances of survival are poor in submersions longer than 30 minutes (Kieboom et al., 2015; Quan et al., 2014; Tipton and Golden, 2011). Although 1 study of drowning (Kieboom et al., 2015) did not find positive effects of prolonged resuscitative efforts, a case series of 14 people who were not drowned but immersed in water at 2°C found good neurologic outcomes in 7 severely hypothermic victims in CA with asystole, pulseless electrical activity (PEA), or VF as the first cardiac rhythm (Wanscher et al., 2012). Few mountain rescue teams are able to measure water temperatures.

When immersion occurs before submersion, there may be neuroprotective cooling of the brain. ECLS rewarming may increase survival chances even after long submersions and prolonged CPR. Rates of core temperature decrease vary widely among drowning victims. Hypothermic CA before submersion increases the likelihood of survival (Wanscher et al., 2012).

An ILCOR scoping review, with 7 observational studies including 1,846 patients in CA after drowning, found that shockable rhythms were not associated with increased survival (Bierens et al., 2021). A French study found that drowning victims in CA had higher 28-day mortality compared with drowning victims not in CA (adjusted hazard ratio 12; 95% CI 2.5–52) (Reizine et al., 2021). A Chinese study of 142 drowning victims reported 118 with good neurologic outcomes (CPC 1–2) and 24 with poor neurologic outcomes (CPC >2). CA was associated with worse outcomes ($p < 0.001$): Of the 118 patients with good neurologic outcomes, 28 were in CA, while 17 of the 24 with poor neurologic outcomes were in CA (Zhou et al., 2022).

When immersion may have occurred before submersion with significant cooling, or when a victim was trapped in a car or boat with a possible air pocket, ECLS is indicated for rewarming and resuscitation (Bierens et al., 2021; Lott et al., 2021; Modell et al., 2004). In victims of drowning with CA, the HOPE score can guide the decision whether to initiate ECLS rewarming in hospital (Kosinski et al., 2021; Perkins, 2005). In drowning victims, the presence of froth is associated with poor outcomes because froth makes oxygenation through the lungs nearly impossible (Armstrong and Erskine, 2018; Farrugia and Ludes, 2011; Reijnen et al., 2017).

Summary. Chances of survival are poor regardless of water temperature with submersion >30 minutes.

Recommendation. Withhold CPR in a drowning victim with a submersion time >30 minutes in water >6°C or >90 minutes in water <6°C (2A).

Avalanches

Avalanches are common in many mountain areas. Most fatalities in the developing world are in settlements and on roads (Oshiro et al., 2022). In Europe and North America, avalanches are most likely to affect people pursuing outdoor activities. From 1983 to 2015, there were 5,123 avalanche fatalities in Europe and North America (Van Tilburg et al., 2017). On average, there are 130 avalanche deaths annually in Europe, 24 in the United States, and 12 in Canada (Van Tilburg et al., 2017). Asphyxia accounts for approximately two-thirds of fatalities (Falk et al., 1994; Haegeli et al., 2011; Sheets et al., 2018).

The presence of a patent airway and an air pocket (a space in front of the airway) increases the likelihood of survival (Falk et al., 1994; Paal et al., 2013; Procter et al., 2016). In a study of buried avalanche victims extricated after 36 minutes in Switzerland and Canada, only 4/101 survived in Canada and 75/461 in Switzerland (Haegeli et al., 2011). A systematic review found 4 studies that examined the patterns of survival. The risk of asphyxiation starts immediately after critical burial (head and chest covered by snow) (Pasquier et al., 2023). If the airway is completely obstructed, the chance of survival decreases within minutes (Procter et al., 2016).

There were no survivors when the airway was obstructed and burial exceeded 35 minutes (Boyd et al., 2010). If the airway is not obstructed, survival depends on the size of the air pocket and the quality of the snow, affecting diffusion of oxygen and carbon dioxide into and out of the air pocket (Paal et al., 2013; Procter et al., 2016; Strapazzon et al., 2017).

Longer burial times increase the likelihood of hypothermia. Lean individuals who are lightly clad and wet from sweating cool the fastest (Mittermair et al., 2021). In experimental studies, warmly dressed downhill skiers cooled at a rate of $0.8°C \pm 0.9°C/h$ (McIntosh et al., 2015). A similar study showed more rapid cooling in hypercapnic subjects (1.3°C/h) than in normocapnic subjects (1.0°C/h) (Grissom et al., 2008). Hypercapnia occurs with rebreathing exhaled carbon dioxide in a closed air pocket, increasing work of breathing and causing vasodilation of peripheral arteries, accelerating cooling (Roubik et al., 2015; Strapazzon et al., 2017). In most buried victims, cooling rates are not sufficient to cause hypothermic CA before asphyxia occurs. In critically buried avalanche victims, CA is usually the result of asphyxia.

One study found 5 cases with cooling rates of 6–9.4°C/h (Mittermair et al., 2021). Because cooling rates are unknown, avalanche victims should be handled gently to prevent CA, even in burials <60 minutes (Mittermair et al., 2021).

Critically buried avalanche victims in CA rarely make full neurologic recoveries, even after resuscitation with ECLS (Metrailler-Mermoud et al., 2019). A systematic review of 39 avalanche victims with unwitnessed hypothermic CA treated with ECLS rewarming found no survivors (Podsiadlo et al., 2021). However, good neurological survival has been reported in victims receiving CPR after short burials (Moroder et al., 2015), because asphyxia-related CA or rescue collapse from hypothermia was treated effectively (Boue et al., 2014). Successful recovery with good neurologic outcome was reported with delayed ECLS rewarming after a burial time of 100 minutes with an epitympanic temperature of 22°C (Oberhammer et al., 2008).

A retrospective study of 140 avalanche victims buried longer than 60 minutes found a survival rate of 19% (27/140) (Eidenbenz et al., 2021). Airway patency was reported in only 36/140 cases (26%). The presence or absence of an air pocket was reported in only 65/140 cases (46%). A patent airway with an air pocket was associated with increased survival. Nonsurvivors were in CA. Among nonsurvivors, only 21/113 (19%) were transported to an ECLS-capable hospital. The number of patients who might have benefited from ECLS rewarming is unknown (Eidenbenz et al., 2021). The authors concluded that avalanche victims with burial times >60 minutes with a patent airway and no lethal injuries should receive full resuscitative measures.

Avalanche victims in CA should be transferred to hospitals capable of ECLS. In-hospital prediction of successful rewarming for hypothermic victims with CA can be based on the HOPE score (Pasquier et al., 2019). If this is not possible, resuscitation should only be attempted for victims with core temperatures ≤30°C and serum potassium ≤7 mmol/l (Brugger et al., 2019; Falk et al., 2020; Lott et al., 2021). In Monte Carlo simulations of burials with multiple victims and limited numbers of rescuers, providing CPR for 6 minutes rather than at least 20 minutes allowed earlier extrication of victims who were still buried and at risk of asphyxiation (Genswein et al., 2022).

Summary. The keys to survival are airway patency and an air pocket. In avalanche victims, CA is usually caused by asphyxia. Longer burial times increase the likelihood of hypothermia. The rate of cooling is faster in hypercapnic victims.

Recommendations. In an avalanche victim with burial duration >60 minutes, in asystole, with an obstructed airway, withhold or terminate CPR (1A).

Provide full resuscitative efforts for an avalanche victim with a core temperature <30°C with a patent airway and without lethal injuries and transport to an ECLS-capable center (1C).

Lightning

Lightning discharges occur about 50 times per second worldwide, but only 20% result in ground strikes (Jensen et al., 2022). Regions with frequent thunderstorms have more lightning events. During thunderstorms, people should avoid ridgelines and peaks (Davis et al., 2014). The risk of lightning injuries is greatest in the afternoon.

Injury can occur by direct strike, contact strike, indirect strike, side flash, ground current, initiation of an upward streamer from the body, and explosive barotrauma (Blumenthal, 2021). The most common mechanisms of injury are ground current (50%–55%) and side flash (30%–35%) (Cooper and Holle, 2010). Injury from ground current occurs when current from lightning travels through the ground to the victim. Injury from a side flash occurs when lightning strikes a tall object near the victim and part of the current strikes the victim.

When the situation is unclear and lightning strike is possible, victims who may have been struck should be assessed for Lichtenberg figures, fernlike patterns on the skin that are pathognomonic for lightning injury. The victim's equipment and clothing may be melted or torn. Sudden death after a lightning strike can be caused by simultaneous cardiac and respiratory arrest (Taussig, 1969).

Based on animal studies, cardiac automaticity with ROSC occurs before resolution of medullary respiratory center paralysis and resumption of spontaneous respirations (Davis et al., 2014). Prolonged artificial ventilation may be required to prevent hypoxic CA (Zafren et al., 2005).

Summary. In subjects who may have been struck by lightning, the circumstances of CA should be examined thoroughly. Prolonged ventilatory support may be lifesaving.

Recommendations. In a victim in CA caused by a lightning strike, perform prolonged CPR if necessary. Prolonged ventilatory support may be necessary even after ROSC (1B).

Burns

Burns can be caused by heat from a liquid or solid, inhalation, chemicals, electricity (including lightning), sunlight, and radiation. Burns are classified by the depth of the injury. The extent of a burn injury is estimated as the percentage of the total body surface area (TBSA) with deep burns. With inhalation injuries, the upper airway and lungs are injured by heat or irritants, especially in closed spaces with limited ventilation. Inhalation injuries can cause respiratory complications, including respiratory failure (ISBI Practice Guidelines Committee et al., 2016; Kearns et al., 2016).

Predictive models for in-hospital mortality caused by burn injuries usually include age, extent of burn in percentage of TBSA, and factors related to the inhalation injury (Halgas et al., 2018). There are no RCTs of interventions for victims in CA with severe burns. Victims with inhalation injury and with high predicted mortality may benefit from ECMO. ECMO should not be used routinely (Chiu et al., 2022). In mountain rescue, it is difficult to estimate the extent of a burn and to assess burn depth. TBSA burned cannot be estimated accurately on site.

Summary. A victim with CA caused by a burn injury is unlikely to survive with a good neurologic outcome.

Recommendation. In a victim with CA caused by a burn injury, terminate CPR after 20 minutes without ROSC (1C).

Poisoning

Poisoning is a rare cause of CA in mountain rescue (Gummin et al., 2021) that may be reversible. CA from poisoning may be caused by arrythmias, hypoxemia, hypotension, hypertension, or hypovolemia (Lott et al., 2021). Cardiorespiratory arrest from opioids is a major public health problem worldwide. ILCOR recommendations for poisoning include standard advanced life support and empiric use of naloxone to reverse opioid poisoning (Soar et al., 2020). In CA caused by poisoning, prolonged resuscitation may be necessary to allow metabolism or excretion of the toxin (Lott et al., 2021). ECMO may provide a bridge to recovery (de Lange et al., 2013). If toxic exposure is the suspected cause of CA, the toxin should be identified as early as possible. Contacting a poison control center can be helpful. There may be an antidote.

Summary. Poisoning is a rare but potentially reversible cause of CA.

Recommendation. In a victim with CA from suspected poisoning or overdose, contact a poison control center before terminating CPR (1C).

Limitations

Most of the studies we included were not conducted in mountain areas. We have extrapolated recommendations from urban areas to mountain environments. The levels of supporting evidence are generally low. We have not made specific recommendations for children.

Conclusions

Most of the recommendations from 2012 are still valid. The principal changes include updates in mechanical compressions, POCUS, ECLS criteria, relevance of water temperature to resuscitation in drowning, and criteria for burial time in avalanche rescue. Use of modified TOR guidelines to limit inappropriate CPR in mountain rescue is still valid. Terminate CPR when all the following apply: unwitnessed loss of vital signs, no ROSC during 20 minutes of CPR, no shock advised at any time by AED or only asystole on ECG, and absence of hypothermia or other special circumstances that warrant extended CPR.

Acknowledgments

The content of this article, including the recommendations, was presented to and accepted by the ICAR MedCom in Montreux, Switzerland, on October 14, 2022. We thank the participants and ICAR delegates for their valuable input.

Author Disclosure Statement

The authors declare no conflicts of interest regarding the content of this article.

Funding Information

No funding was received for this work.

Supplementary Material

Supplementary Data S1
Supplementary Data S2

References

Alqudah Z, Nehme Z, Williams B, et al. Survival outcomes in emergency medical services witnessed traumatic out-of-hospital cardiac arrest after the introduction of a trauma-based resuscitation protocol. Resuscitation 2021;168:65–74; doi: 10.1016/j.resuscitation.2021.09.011

Armstrong EJ, Erskine KL. Investigation of drowning deaths: A practical review. Acad Forensic Pathol 2018;8(1):8–43; doi: 10.23907/2018.002

Barnard EBG, Hunt PAF, Lewis PEH, et al. The outcome of patients in traumatic cardiac arrest presenting to deployed military medical treatment facilities: Data from the UK Joint Theatre Trauma Registry. J R Army Med Corps 2018;164(3): 150–154; doi: 10.1136/jramc-2017-000818

Bierens J, Abelairas-Gomez C, Barcala Furelos R, et al. Resuscitation and emergency care in drowning: A scoping review. Resuscitation 2021;162:205–217; doi: 10.1016/j.resuscitation.2021.01.033

Blasco Marino R, Martinez Martinez M, Soteras Martinez I, et al. During cardiopulmonary resuscitation in an arrested hypothermic patient with a potentially stiff chest, carotid ultrasound may confirm orthograde blood flow. High Alt Med Biol 2023a;24(1):81–82; doi: 10.1089/ham.2022.0135

Blasco Mariño R, Roy S, Martin Orejas M, et al. Ample room for cognitive bias in diagnosing accidental hypothermia. Diagnosis (Berl) 2023b;10(3):322–324; doi: 10.1515/dx-2023-0005

Blumenthal R. Injuries and deaths from lightning. J Clin Pathol 2021;74(5):279–284; doi: 10.1136/jclinpath-2020-206492

Boue Y, Payen JF, Brun J, et al. Survival after avalanche-induced cardiac arrest. Resuscitation 2014;85(9):1192–1196; doi: 10.1016/j.resuscitation.2014.06.015

Boyd J, Brugger H, Shuster M. Prognostic factors in avalanche resuscitation: A systematic review. Resuscitation 2010;81(6): 645–652; doi: 10.1016/j.resuscitation.2010.01.037

Brooks SC, Clegg GR, Bray J, et al. Optimizing outcomes after out-of-hospital cardiac arrest with innovative approaches to public-access defibrillation: A scientific statement from the International Liaison Committee on Resuscitation. Resuscitation 2022;172:204–228; doi: 10.1016/j.resuscitation.2021.11.032

Brugger H, Bouzat P, Pasquier M, et al. Cut-off values of serum potassium and core temperature at hospital admission for extracorporeal rewarming of avalanche victims in cardiac arrest: A retrospective multi-centre study. Resuscitation 2019; 139:222–229; doi: 10.1016/j.resuscitation.2019.04.025

Byrne JP, Xiong W, Gomez D, et al. Redefining "dead on arrival": Identifying the unsalvageable patient for the purpose of performance improvement. J Trauma Acute Care Surg 2015;79(5):850–857; doi: 10.1097/TA.0000000000000843

Chiang WC, Ko PC, Chang AM, et al. Predictive performance of universal termination of resuscitation rules in an Asian community: Are they accurate enough? Emerg Med J 2015; 32(4):318–323; doi: 10.1136/emermed-2013-203289

Chiu YJ, Huang YC, Chen TW, et al. A systematic review and meta-analysis of extracorporeal membrane oxygenation in patients with burns. Plast Reconstr Surg 2022;149(6):1181e–1190e; doi: 10.1097/PRS.0000000000009149

Cooper MA, Holle RL. Mechanisms of lightning injury should affect lightning safety messages. 2010. Available from: https://www.researchgate.net/profile/Mary-Ann-Cooper/publication/277719387_Mechanisms_of_lightning_injury_should_affect_lightning_safety_messages/links/5571e2f308aeb6d8c0159f41/Mechanisms-of-lightning-injury-should-affect-lightning-safety-messages.pdf [Last accessed: August 24, 2023].

Davis C, Engeln A, Johnson EL, et al. Wilderness Medical Society practice guidelines for the prevention and treatment of lightning injuries: 2014 update. Wilderness Environ Med 2014;25(4 Suppl):S86–S95; doi: 10.1016/j.wem.2014.08.011

de Lange DW, Sikma MA, Meulenbelt J. Extracorporeal membrane oxygenation in the treatment of poisoned patients. Clin Toxicol (Phila) 2013;51(5):385–393; doi: 10.3109/15563650.2013.800876

Diskin FJ, Camp-Rogers T, Peberdy MA, et al. External validation of termination of resuscitation guidelines in the setting of intra-arrest cold saline, mechanical CPR, and comprehensive post resuscitation care. Resuscitation 2014;85(7): 910–914; doi: 10.1016/j.resuscitation.2014.02.028

Drennan IR, Case E, Verbeek PR, et al. A comparison of the universal TOR Guideline to the absence of prehospital ROSC and duration of resuscitation in predicting futility from out-of-hospital cardiac arrest. Resuscitation 2017;111:96–102; doi: 10.1016/j.resuscitation.2016.11.021

Egger A, Niederer M, Tscherny K, et al. Influence of physical strain at high altitude on the quality of cardiopulmonary re-

suscitation. Scand J Trauma Resusc Emerg Med 2020;28(1): 19; doi: 10.1186/s13049-020-0717-0
Eidenbenz D, Techel F, Kottmann A, et al. Survival probability in avalanche victims with long burial (>/=60min): A retrospective study. Resuscitation 2021;166:93–100; doi: 10.1016/j.resuscitation.2021.05.030
Ellis MM, Welch RD. Severe hypothermia and cardiac arrest successfully treated without external mechanical circulatory support. Am J Emerg Med 2016;34(9):1913.e5–1913.e6; doi: 10.1016/j.ajem.2016.02.021
Elsensohn F, Agazzi G, Syme D, et al. The use of automated external defibrillators and public access defibrillators in the mountains: Official guidelines of the International Commission for Mountain Emergency Medicine ICAR-MEDCOM. Wilderness Environ Med 2006;17(1):64–66; doi: 10.1580/1080-6032(2006)17[64:tuoaed]2.0.co;2
Falk M, Brugger H, Adler-Kastner L. Avalanche survival chances. Nature 1994;368(6466):21; doi: 10.1038/368021a0
Falk M, Brugger H, Bouzat P, et al. Data and methods to calculate cut-off values for serum potassium and core temperature at hospital admission for extracorporeal rewarming of avalanche victims in cardiac arrest. Data Brief 2020;28: 104913; doi: 10.1016/j.dib.2019.104913
Farrugia A, Ludes B. Diagnostic of drowning in forensic medicine. In: Forensic Medicine—From Old Problems to New Challenges. (Vieira DN.) Chapter 3. InTech. 2011; doi: 10.5772/661. Available from: https://www.intechopen.com/chapters/19161 [Last accessed: March 30, 2023].
Frei C, Darocha T, Debaty G, et al. Clinical characteristics and outcomes of witnessed hypothermic cardiac arrest: A systematic review on rescue collapse. Resuscitation 2019;137: 41–48; doi: 10.1016/j.resuscitation.2019.02.001
Fukuda T, Ohashi N, Matsubara T, et al. Applicability of the prehospital termination of resuscitation rule in an area dense with hospitals in Tokyo: A single-center, retrospective, observational study: Is the pre hospital TOR rule applicable in Tokyo? Am J Emerg Med 2014;32(2):144–149; doi: 10.1016/j.ajem.2013.10.032
Gao Y, Sun T, Yuan D, et al. Safety of mechanical and manual chest compressions in cardiac arrest patients: A systematic review and meta-analysis. Resuscitation 2021;169:124–135; doi: 10.1016/j.resuscitation.2021.10.028
Gässler H, Helm M, Hossfeld B, et al. Survival following lay resuscitation. Dtsch Arztebl Int 2020;117(51–52):871–877; doi: 10.3238/arztebl.2020.0871
Gates S, Quinn T, Deakin CD, et al. Mechanical chest compression for out of hospital cardiac arrest: Systematic review and meta-analysis. Resuscitation 2015;94:91–97; doi: 10.1016/j.resuscitation.2015.07.002
Genswein M, Macias D, McIntosh S, et al. AvaLife—A new multi-disciplinary approach supported by accident and field test data to optimize survival chances in rescue and first aid of avalanche patients. Int J Environ Res Public Health 2022; 19(9):5257; doi: 10.3390/ijerph19095257
Gordon L, Paal P, Ellerton JA, et al. Delayed and intermittent CPR for severe accidental hypothermia. Resuscitation 2015; 90:46–49; doi: 10.1016/j.resuscitation.2015.02.017
Goto Y, Funada A, Maeda T, et al. Field termination-of-resuscitation rule for refractory out-of-hospital cardiac arrests in Japan. J Cardiol 2019;73(3):240–246; doi: 10.1016/j.jjcc.2018.12.002
Grissom CK, McAlpine JC, Harmston CH, et al. Hypercapnia effect on core cooling and shivering threshold during snow burial. Aviat Space Environ Med 2008;79(8):735–742; doi: 10.3357/asem.2261.2008
Grunau B, Reynolds JC, Scheuermeyer FX, et al. Comparing the prognosis of those with initial shockable and non-shockable rhythms with increasing durations of CPR: Informing minimum durations of resuscitation. Resuscitation 2016;101:50–56; doi: 10.1016/j.resuscitation.2016.01.021
Grunau B, Taylor J, Scheuermeyer FX, et al. External validation of the universal termination of resuscitation rule for out-of-hospital cardiac arrest in British Columbia. Ann Emerg Med 2017;70(3):374.e1–381.e1; doi: 10.1016/j.annemergmed.2017.01.030
Gummin DD, Mowry JB, Beuhler MC, et al. 2020 Annual report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 38th Annual report. Clin Toxicol (Phila) 2021;59(12):1282–1501; doi: 10.1080/15563650.2021.1989785
Guyatt G, Gutterman D, Baumann MH, et al. Grading strength of recommendations and quality of evidence in clinical guidelines: Report from an American College of Chest Physicians Task Force. Chest 2006;129(1):174–181; doi: 10.1378/chest.129.1.174
Haegeli P, Falk M, Brugger H, et al. Comparison of avalanche survival patterns in Canada and Switzerland. CMAJ 2011; 183(7):789–795; doi: 10.1503/cmaj.101435
Halgas B, Bay C, Foster K. A comparison of injury scoring systems in predicting burn mortality. Ann Burns Fire Disasters 2018;31(2):89–93.
Hopson LR, Hirsh E, Delgado J, et al. Guidelines for withholding or termination of resuscitation in prehospital traumatic cardiopulmonary arrest: Joint position statement of the National Association of EMS Physicians and the American College of Surgeons Committee on Trauma. J Am Coll Surg 2003;196(1):106–112; doi: 10.1016/s1072-7515(02)01668-x
ISBI Practice Guidelines Committee; Steering Subcommittee; Advisory Subcommittee. ISBI practice guidelines for burn care. Burns 2016;42(5):953–1021; doi: 10.1016/j.burns.2016.05.013
Jensen JD, Thurman J, Vincent AL. Lightning Injuries. StatPearls: Treasure Island, FL; 2022.
Jung E, Park JH, Kong SY, et al. Cardiac arrest while exercising on mountains in national or provincial parks: A national observational study from 2012 to 2015. Am J Emerg Med 2018;36(8):1350–1355; doi: 10.1016/j.ajem.2017.12.040
Kashiura M, Hamabe Y, Akashi A, et al. Applying the termination of resuscitation rules to out-of-hospital cardiac arrests of both cardiac and non-cardiac etiologies: A prospective cohort study. Crit Care 2016;20:49; doi: 10.1186/s13054-016-1226-4
Kearns RD, Conlon KM, Matherly AF, et al. Guidelines for burn care under austere conditions: Introduction to burn disaster, airway and ventilator management, and fluid resuscitation. J Burn Care Res 2016;37(5):e427–e439; doi: 10.1097/BCR.0000000000000304
Ketelaars R, Beekers C, Van Geffen GJ, et al. Prehospital echocardiography during resuscitation impacts treatment in a physician-staffed helicopter emergency medical service: An observational study. Prehosp Emerg Care 2018;22(4):406–413; doi: 10.1080/10903127.2017.1416208
Khalifa A, Avraham JB, Kramer KZ, et al. Surviving traumatic cardiac arrest: Identification of factors associated with survival. Am J Emerg Med 2021;43:83–87; doi: 10.1016/j.ajem.2021.01.020
Kieboom JK, Verkade HJ, Burgerhof JG, et al. Outcome after resuscitation beyond 30 minutes in drowned children with cardiac arrest and hypothermia: Dutch nationwide retrospective cohort study. BMJ 2015;350:h418; doi: 10.1136/bmj.h418

Kishimori T, Kiguchi T, Kiyohara K, et al. Public-access automated external defibrillator pad application and favorable neurological outcome after out-of-hospital cardiac arrest in public locations: A prospective population-based propensity score-matched study. Int J Cardiol 2020;299:140–146; doi: 10.1016/j.ijcard.2019.07.061

Kobayashi D, Sado J, Kiyohara K, et al. Public location and survival from out-of-hospital cardiac arrest in the public-access defibrillation era in Japan. J Cardiol 2020;75(1):97–104; doi: 10.1016/j.jjcc.2019.06.005

Kosinski S, Darocha T, Mendrala K, et al. Estimation of the survival probabilities in hypothermic cardiac arrest patients with drowning: The HOPE score as a tool to help selecting patients for extracorporeal rewarming. Resuscitation 2021;162:453–454; doi: 10.1016/j.resuscitation.2021.02.043

Lalande E, Burwash-Brennan T, Burns K, et al. Is point-of-care ultrasound a reliable predictor of outcome during traumatic cardiac arrest? A systematic review and meta-analysis from the SHoC investigators. Resuscitation 2021;167:128–136; doi: 10.1016/j.resuscitation.2021.08.027

Liu M, Shuai Z, Ai J, et al. Mechanical chest compression with LUCAS device does not improve clinical outcome in out-of-hospital cardiac arrest patients: A systematic review and meta-analysis. Medicine (Baltimore) 2019;98(44):e17550; doi: 10.1097/MD.0000000000017550

Lott C, Truhlar A, Alfonzo A, et al. European Resuscitation Council Guidelines 2021: Cardiac arrest in special circumstances. Resuscitation 2021;161:152–219; doi: 10.1016/j.resuscitation.2021.02.011

Lunde A, Tellefsen C. Patient and rescuer safety: Recommendations for dispatch and prioritization of rescue resources based on a retrospective study of Norwegian avalanche incidents 1996–2017. Scand J Trauma Resusc Emerg Med 2019;27(1):5; doi: 10.1186/s13049-019-0585-7

Lungwitz YP, Nussbaum BL, Paulat K, et al. A novel rescue-tube device for in-water resuscitation. Aerosp Med Hum Perform 2015;86(4):379–385; doi: 10.3357/AMHP.4133.2015

Mair P, Gasteiger L, Mair B, et al. Successful defibrillation of four hypothermic patients with witnessed cardiac arrest. High Alt Med Biol 2019;20(1):71–77; doi: 10.1089/ham.2018.0084

McCullough JN, Zhang N, Reich DL, et al. Cerebral metabolic suppression during hypothermic circulatory arrest in humans. Ann Thorac Surg 1999;67(6):1895–1899; discussion 1919–1921; doi: 10.1016/s0003-4975(99)00441-5

McIntosh SE, Crouch AK, Dorais A, et al. Effect of head and face insulation on cooling rate during snow burial. Wilderness Environ Med 2015;26(1):21–28; doi: 10.1016/j.wem.2014.07.003

Metrailler-Mermoud J, Hugli O, Carron PN, et al. Avalanche victims in cardiac arrest are unlikely to survive despite adherence to medical guidelines. Resuscitation 2019;141:35–43; doi: 10.1016/j.resuscitation.2019.05.037

Millin MG, Galvagno SM, Khandker SR, et al. Withholding and termination of resuscitation of adult cardiopulmonary arrest secondary to trauma: Resource document to the joint NAEMSP-ACSCOT position statements. J Trauma Acute Care Surg 2013;75(3):459–467; doi: 10.1097/TA.0b013e31829cfaea

Mittermair C, Foidl E, Wallner B, et al. Extreme cooling rates in avalanche victims: Case report and narrative review. High Alt Med Biol 2021;22(2):235–240; doi: 10.1089/ham.2020.0222

Modell JH, Idris AH, Pineda JA, et al. Survival after prolonged submersion in freshwater in Florida. Chest 2004;125(5):1948–1951; doi: 10.1378/chest.125.5.1948

Moroder L, Mair B, Brugger H, et al. Outcome of avalanche victims with out-of-hospital cardiac arrest. Resuscitation 2015;89:114–118; doi: 10.1016/j.resuscitation.2015.01.019

Morrison LJ. Prehospital termination of resuscitation rule. Curr Opin Crit Care 2019;25(3):199–203; doi: 10.1097/MCC.0000000000000614

Morrison LJ, Deakin CD, Morley PT, et al. Part 8: Advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Circulation 2010;122(16 Suppl 2):S345–S421; doi: 10.1161/CIRCULATIONAHA.110.971051

Nakashima T, Noguchi T, Tahara Y, et al. Public-access defibrillation and neurological outcomes in patients with out-of-hospital cardiac arrest in Japan: A population-based cohort study. Lancet 2019;394(10216):2255–2262; doi: 10.1016/S0140-6736(19)32488-2

Ntoumani M, Dugue B, Rivas E, et al. Thermoregulation and thermal sensation during whole-body water immersion at different water temperatures in healthy individuals: A scoping review. J Therm Biol 2023;112:103430; doi: 10.1016/j.jtherbio.2022.103430

Oberhammer R, Beikircher W, Hormann C, et al. Full recovery of an avalanche victim with profound hypothermia and prolonged cardiac arrest treated by extracorporeal re-warming. Resuscitation 2008;76(3):474–480; doi: 10.1016/j.resuscitation.2007.09.004

Olasveengen TM, Semeraro F, Ristagno G, et al. European Resuscitation Council Guidelines 2021: Basic life support. Resuscitation 2021;161:98–114; doi: 10.1016/j.resuscitation.2021.02.009

Oshiro K, Murakami T. Causes of death and characteristics of non-survivors rescued during recreational mountain activities in Japan between 2011 and 2015: A retrospective analysis. BMJ Open 2022;12(2):e053935; doi: 10.1136/bmjopen-2021-053935

Oshiro K, Tanioka Y, Schweizer J, et al. Prevention of hypothermia in the aftermath of natural disasters in areas at risk of avalanches, earthquakes, tsunamis and floods. Int J Environ Res Public Health 2022;19(3):1098; doi: 10.3390/ijerph19031098

Paal P, Milani M, Brown D, et al. Termination of cardiopulmonary resuscitation in mountain rescue. High Alt Med Biol 2012;13(3):200–208; doi: 10.1089/ham.2011.1096

Paal P, Pasquier M, Darocha T, et al. Accidental hypothermia: 2021 Update. Int J Environ Res Public Health 2022;19(1):501; doi: 10.3390/ijerph19010501

Paal P, Strapazzon G, Braun P, et al. Factors affecting survival from avalanche burial—A randomised prospective porcine pilot study. Resuscitation 2013;84(2):239–243; doi: 10.1016/j.resuscitation.2012.06.019

Pasquier M, Rousson V, Darocha T, et al. Hypothermia outcome prediction after extracorporeal life support for hypothermic cardiac arrest patients: An external validation of the HOPE score. Resuscitation 2019;139:321–328; doi: 10.1016/j.resuscitation.2019.03.017

Pasquier M, Strapazzon G, Kottmann A, et al. On-site treatment of avalanche victims: Scoping review and 2023 recommendations of the International Commission for Mountain Emergency Medicine (ICAR MedCom). Resuscitation 2023;184:109708; doi: 10.1016/j.resuscitation.2023.109708

Perkins GD. In-water resuscitation: A pilot evaluation. Resuscitation 2005;65(3):321–324; doi: 10.1016/j.resuscitation.2004.12.002

Podsiadlo P, Darocha T, Svendsen OS, et al. Outcomes of patients suffering unwitnessed hypothermic cardiac arrest rewarmed with extracorporeal life support: A systematic review. Artif Organs 2021;45(3):222–229; doi: 10.1111/aor.13818

Procter E, Strapazzon G, Dal Cappello T, et al. Burial duration, depth and air pocket explain avalanche survival patterns in Austria and Switzerland. Resuscitation 2016;105(173–176; doi: 10.1016/j.resuscitation.2016.06.001

Quan L, Mack CD, Schiff MA. Association of water temperature and submersion duration and drowning outcome. Resuscitation 2014;85(6):790–794; doi: 10.1016/j.resuscitation.2014.02.024

Reijnen G, Buster MC, Vos PJE, et al. External foam and the post-mortem period in freshwater drowning; results from a retrospective study in Amsterdam, the Netherlands. J Forensic Leg Med 2017;52:1–4; doi: 10.1016/j.jflm.2017.07.013

Reizine F, Delbove A, Dos Santos A, et al. Clinical spectrum and risk factors for mortality among seawater and freshwater critically ill drowning patients: A French multicenter study. Crit Care 2021;25(1):372; doi: 10.1186/s13054-021-03792-2

Reynolds JC, Grunau BE, Rittenberger JC, et al. Association between duration of resuscitation and favorable outcome after out-of-hospital cardiac arrest: Implications for prolonging or terminating resuscitation. Circulation 2016;134(25):2084–2094; doi: 10.1161/CIRCULATIONAHA.116.023309

Reynolds JC, Nicholson T, O'Neil B, et al. Diagnostic test accuracy of point-of-care ultrasound during cardiopulmonary resuscitation to indicate the etiology of cardiac arrest: A systematic review. Resuscitation 2022;172:54–63; doi: 10.1016/j.resuscitation.2022.01.006

Rottenberg EM. Effective CPR at high altitudes likely requires oxygen-supplemented continuous abdominal compressions. Am J Emerg Med 2014;32(12):1545–1546; doi: 10.1016/j.ajem.2014.09.022

Roubik K, Sieger L, Sykora K. Work of breathing into snow in the presence versus absence of an artificial air pocket affects hypoxia and hypercapnia of a victim covered with avalanche snow: A randomized double blind crossover study. PLoS One 2015;10(12):e0144332; doi: 10.1371/journal.pone.0144332

Schön CA, Gordon L, Holzl N, et al. Determination of death in mountain rescue: Recommendations of the International Commission for Mountain Emergency Medicine (ICAR MedCom). Wilderness Environ Med 2020;31(4):506–520; doi: 10.1016/j.wem.2020.06.013

Sheets A, Wang D, Logan S, et al. Causes of death among avalanche fatalities in Colorado: A 21-year review. Wilderness Environ Med 2018;29(3):325–329; doi: 10.1016/j.wem.2018.04.002

Sherren PB, Reid C, Habig K, et al. Algorithm for the resuscitation of traumatic cardiac arrest patients in a physician-staffed helicopter emergency medical service. Crit Care 2013;17(2):308; doi: 10.1186/cc12504

Shibahashi K, Sakurai S, Kobayashi M, et al. Effectiveness of public-access automated external defibrillators at Tokyo railroad stations. Resuscitation 2021;164:4–11; doi: 10.1016/j.resuscitation.2021.04.032

Soar J, Berg KM, Andersen LW, et al. Adult advanced life support: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation 2020;156:A80–A119; doi: 10.1016/j.resuscitation.2020.09.012

Soar J, Bottiger BW, Carli P, et al. European Resuscitation Council Guidelines 2021: Adult advanced life support. Resuscitation 2021;161:115–151; doi: 10.1016/j.resuscitation.2021.02.010

Strapazzon G, Paal P, Schweizer J, et al. Effects of snow properties on humans breathing into an artificial air pocket—An experimental field study. Sci Rep 2017;7(1):17675; doi: 10.1038/s41598-017-17960-4

Strohle M, Paal P, Strapazzon G, et al. Defibrillation in rural areas. Am J Emerg Med 2014;32(11):1408–1412; doi: 10.1016/j.ajem.2014.08.046

Strohle M, Vogele A, Neuhauser P, et al. Sudden cardiac arrest and cardiopulmonary resuscitation with automated external defibrillator in the Austrian mountains: A retrospective study. High Alt Med Biol 2019;20(4):392–398; doi: 10.1089/ham.2018.0134

Sumann G, Moens D, Brink B, et al. Multiple trauma management in mountain environments—A scoping review: Evidence based guidelines of the International Commission for Mountain Emergency Medicine (ICAR MedCom). Intended for physicians and other advanced life support personnel. Scand J Trauma Resusc Emerg Med 2020;28(1):117; doi: 10.1186/s13049-020-00790-1

Sumann G, Paal P, Mair P, et al. Fluid management in traumatic shock: A practical approach for mountain rescue. Official recommendations of the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). High Alt Med Biol 2009;10(1):71–75; doi: 10.1089/ham.2008.1067

Swol J, Darocha T, Paal P, et al. Extracorporeal life support in accidental hypothermia with cardiac arrest—A narrative review. ASAIO J 2022;68(2):153–162; doi: 10.1097/MAT.0000000000001518

Szpilman D, Soares M. In-water resuscitation—Is it worthwhile? Resuscitation 2004;63(1):25–31; doi: 10.1016/j.resuscitation.2004.03.017

Taussig HB. ''Death'' from lightning and the possibility of living again. Am Sci 1969;57(3):306–316.

Tipton MJ, Golden FS. A proposed decision-making guide for the search, rescue and resuscitation of submersion (head under) victims based on expert opinion. Resuscitation 2011;82(7):819–824; doi: 10.1016/j.resuscitation.2011.02.021

Tran A, Fernando SM, Rochwerg B, et al. Pre-arrest and intra-arrest prognostic factors associated with survival following traumatic out-of-hospital cardiac arrest—A systematic review and meta-analysis. Resuscitation 2020;153:119–135; doi: 10.1016/j.resuscitation.2020.05.052

Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. Ann Intern Med 2018;169(7):467–473; doi: 10.7326/M18-0850

Tsou PY, Kurbedin J, Chen YS, et al. Accuracy of point-of-care focused echocardiography in predicting outcome of resuscitation in cardiac arrest patients: A systematic review and meta-analysis. Resuscitation 2017;114:92–99; doi: 10.1016/j.resuscitation.2017.02.021

Van Tilburg C, Grissom CK, Zafren K, et al. Wilderness Medical Society practice guidelines for prevention and management of avalanche and nonavalanche snow burial accidents. Wilderness Environ Med 2017;28(1):23–42; doi: 10.1016/j.wem.2016.10.004

Vogele A, van Veelen MJ, Dal Cappello T, et al. Effect of acute exposure to altitude on the quality of chest compression-only cardiopulmonary resuscitation in helicopter emergency medical services personnel: A randomized, controlled, single-blind crossover trial. J Am Heart Assoc 2021;10(23):e021090; doi: 10.1161/JAHA.121.021090

Wah W, Wai KL, Pek PP, et al. Conversion to shockable rhythms during resuscitation and survival for out-of hospital cardiac arrest. Am J Emerg Med 2017;35(2):206–213; doi: 10.1016/j.ajem.2016.10.042

Walpoth BH, Maeder MB, Courvoisier DS, et al. Hypothermic cardiac arrest—Retrospective cohort study from the International Hypothermia Registry. Resuscitation 2021;167:58–65; doi: 10.1016/j.resuscitation.2021.08.016

Wang JC, Tsai SH, Chen YL, et al. The physiological effects and quality of chest compressions during CPR at sea level and high altitude. Am J Emerg Med 2014;32(10):1183–1188; doi: 10.1016/j.ajem.2014.07.007

Wang PL, Brooks SC. Mechanical versus manual chest compressions for cardiac arrest. Cochrane Database Syst Rev 2018;8:CD007260; doi: 10.1002/14651858.CD007260.pub4

Wanscher M, Agersnap L, Ravn J, et al. Outcome of accidental hypothermia with or without circulatory arrest: Experience from the Danish Praesto Fjord boating accident. Resuscitation 2012;83(9):1078–1084; doi: 10.1016/j.resuscitation.2012.05.009

Winkler BE, Eff AM, Ehrmann U, et al. Effectiveness and safety of in-water resuscitation performed by lifeguards and laypersons: A crossover manikin study. Prehosp Emerg Care 2013;17(3):409–415; doi: 10.3109/10903127.2013.792892

Yates EJ, Schmidbauer S, Smyth AM, et al. Out-of-hospital cardiac arrest termination of resuscitation with ongoing CPR: An observational study. Resuscitation 2018;130:21–27; doi: 10.1016/j.resuscitation.2018.06.021

Zafren K, Durrer B, Herry JP, et al. Lightning injuries: Prevention and on-site treatment in mountains and remote areas. Official guidelines of the International Commission for Mountain Emergency Medicine and the Medical Commission of the International Mountaineering and Climbing Federation (ICAR and UIAA MEDCOM). Resuscitation 2005;65(3):369–372; doi: 10.1016/j.resuscitation.2004.12.014

Zhou P, Xu H, Li B, et al. Neurological outcomes in adult drowning patients in China. Ann Saudi Med 2022;42(2):127–138; doi: 10.5144/0256-4947.2022.127

Zhu N, Chen Q, Jiang Z, et al. A meta-analysis of the resuscitative effects of mechanical and manual chest compression in out-of-hospital cardiac arrest patients. Crit Care 2019;23(1):100; doi: 10.1186/s13054-019-2389-6

Zwingmann J, Mehlhorn AT, Hammer T, et al. Survival and neurologic outcome after traumatic out-of-hospital cardiopulmonary arrest in a pediatric and adult population: A systematic review. Crit Care 2012;16(4):R117; doi: 10.1186/cc11410

Address correspondence to:
Viktor Lugnet, MD
Department of Anesthesiology and Intensive Care
Östersunds Sjukhus
831 83 Östersund
Sweden

E-mail: viktor.lugnet@gmail.com

Received June 6, 2023;
accepted in final form July 9, 2023.