

# Termination of Cardiopulmonary Resuscitation in Mountain Rescue

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## Abstract

Paal, Peter, Mario Milani, Douglas Brown, Jeff Boyd, and John Ellerton. Termination of Cardiopulmonary Resuscitation in Mountain Rescue. *High Alt Med Biol.* 13, 200–208, 2012.—The aim was to establish scientifically supported recommendations for termination of cardiopulmonary resuscitation (CPR) in mountain rescue, which can be applied by physicians and nonphysicians. A literature search was performed; the results and recommendations were discussed among the authors, and finally approved by the International Commission for Mountain Emergency Medicine (ICAR MEDCOM) in October 2011. 4166 abstracts were reviewed; of these, 96 were relevant for this article and are included in this literature review. In mountain rescue, CPR may be withheld or terminated in a patient with absent vital signs when the risk is unacceptable to the rescuer, the rescuer is exhausted or in extreme environments where CPR is not possible or any of the following apply: decapitation; truncal transection; whole body incinerated, decomposed, or frozen solid; avalanche victim in asystole with obstructed airway and burial time >35 min. Also, CPR may be terminated when all of the following criteria apply: unwitnessed loss of vital signs, no return of spontaneous circulation during 20 min of CPR, no shock advised at any time by AED or only asystole on ECG, and no hypothermia or other special circumstances warranting extended CPR. In situations where transport is not possible, mitigation of special circumstances is not possible, and further resuscitation is futile, CPR should be terminated. Medical directors of rescue teams should interpret these recommendations in the context of local conditions and laws, and create team-specific training and protocols for determining when to withhold and terminate CPR in a patient with absent vital signs.

**Key words:** emergency medicine; death; first aid; mountain rescue; cardiopulmonary resuscitation

## Introduction

**D**URING RESCUE MISSIONS, mountain rescuers are regularly confronted with lifeless persons. For example, in Scotland, 57 fatal incidents in 622 emergency missions were reported, resulting in a fatality rate of 9% (Hearns, 2003). In many rescue missions, a mountain rescuer may be confronted with a lifeless casualty before a physician becomes available. In this circumstance, a decision may have to be made by a nonphysician whether to start and when to terminate cardiopulmonary resuscitation (CPR). These decisions may also

be difficult for physicians. A decision to resuscitate may imply risks for rescuers, as resuscitation attempts and extrication may have to be initiated and continued in dangerous terrain and under extreme climatic conditions (Paal et al., 2006). For example, two Swiss and four Italian rescuers died in January 2010 while trying to extricate avalanche victims because of second avalanches (Anonymous, 2010). In some emergency medical services (EMS), such as in Ontario, Canada (Morrison et al., 2009); Los Angeles, USA (Grudzen et al., 2010); and the United Kingdom (Lockey, 2002), nonphysicians may withhold or terminate CPR attempts using specific rules.

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Establishing death in the field may reduce unnecessary CPR, transport, and exposure to danger, while simultaneously directing limited medical resources to those who have a chance of survival (Brugger et al., 2005; Morrison et al., 2006; Elsensohn et al., 2009; Elsensohn et al., 2011; Tomazin et al., 2011). The aim of this review is to create decision guidelines for termination of CPR for nonphysicians and physicians involved in rescue missions in mountainous and other wilderness locations. These "Termination of CPR in Mountain Rescue" guidelines are principally aimed at reducing inappropriately prolonged CPR, and thus diminishing the risk to rescuers and the strain on limited medical resources, while identifying special circumstances where extended CPR may be warranted.

## Methods

In 2009 the International Commission for Mountain Emergency Medicine (ICAR MEDCOM) established a working group for this topic. A literature search was performed in Medline by an investigator (PP) and restricted to research in humans. Articles were sought with the keywords "termination cardiopulmonary resuscitation" (114 articles), "primary cardiac arrest survival" (1379 articles), "trauma cardiac arrest survival" (799 articles), "hypothermia cardiac arrest survival" (1041 articles), "drowning cardiac arrest survival" (70 articles), "avalanche survival" (78 articles), "lightning survival" (93 articles), "electrocution survival" (77 articles), "burns cardiac arrest survival" (56 articles), "poisoning cardiac arrest survival" (132 articles), "auto resuscitation" (90 articles), and "resuscitation ethics survival" (247 articles); 4166 pertinent articles were found, excluding duplicates; the last access date was February 11, 2012. Abstracts of all articles were filtered for relevance; for relevant abstracts the whole article was retrieved for further reading. Additionally, reference lists of retrieved articles were hand searched for additional articles. 96 relevant articles were included in this review. Evidence and recommendations were reviewed at ICAR MEDCOM meetings during the fall of 2009 in Zermatt, Switzerland, the spring of 2010 in Laterns, Austria, the fall of 2010 in Stary Smocovec, Slovakia, and the spring of 2011 in Longyearben, Svalbard, Norway. Consensus was obtained, and the final manuscript was approved by the ICAR MEDCOM at the fall meeting 2011 in Are, Sweden.

## General Aspects and Ethical Considerations

Resuscitation attempts in patients with sudden cardiac arrest are unsuccessful in 70%–98% of all in- and out-of-hospital cases and death will result (Lippert et al., 2010). Decisions regarding initiation and termination of CPR are challenging in individual cases (Lippert et al., 2010). Termination of CPR efforts may depend on several factors such as laws, policies and protocols, patient's age and medical history, mechanism and site of incident, and likelihood that resuscitation will be futile (Lockey, 2002; Farber et al., 2006; Rydvall et al., 2007; Rydvall et al., 2008; Grudzen et al., 2010; Millin et al., 2011). These factors may complement, but sometimes conflict with physician advice (Hall et al., 2004). In some situations where pre-hospital criteria for termination of CPR are inadequate, rescue personnel may need to use their judgement to determine whether CPR is reasonable or not (Ewy, 2006).

TABLE 1. CONDITIONS WHEN TO WITHHOLD OR TERMINATE CPR IN A PATIENT WITH ABSENT VITAL SIGNS (BOYD ET AL., 2010; MORRISON ET AL., 2010)

|   |    |
|---|----|
| 1. Unacceptable risk to rescuer or rescuer exhausted  | OR |
| 2. Decapitation, truncal transection, and incineration or decomposition of the whole body                                   | OR |
| 3. Whole body is frozen solid   | OR |
| 4. Avalanche victim in asystolic cardiac arrest with obstructed airway (e.g. packed with snow) and burial time > 35 minutes |    |

Death may be defined as the irreversible cessation of vital functions, including absence of circulation, spontaneous breathing, and whole-brain death when no confounding factors are present (Powner et al., 1996; Schlotzhauer et al., 2002). Nevertheless, diagnosing death's irreversibility in the field is not necessarily simple. A rescuer may declare a victim dead in the presence of some widely accepted conditions of death, or decide not to start CPR if the situation is unsafe (Table 1) (Boyd et al., 2010; Morrison et al., 2010a).

Historically, once CPR was started in a normothermic patient, many advocated that CPR should be performed for at least 20 minutes, and that CPR termination may be considered if asystole persists for longer than 20 minutes (Lockey, 2002; Baskett et al., 2005). More recently, clinical prediction rules for pre-hospital termination of basic life support (BLS) (Morrison et al., 2006; Ong et al., 2006) and advanced life support (ALS) (Morrison et al., 2009) for urban, nontraumatic, primary cardiac arrest have been validated. The BLS (Morrison et al., 2006) and ALS rules (Morrison et al., 2009) were re-validated for patients in urban centers by two separate research groups (Richman et al., 2008; Sasson et al., 2008). Recently, BLS and ALS rules (Morrison et al., 2006; Morrison et al., 2009) were also validated in patients with noncardiac causes of arrest, although patients with drowning or trauma were not included (Skrifvars et al., 2010). In the 2010 American Heart Association Resuscitation Guidelines, it is recommended that CPR should be continued until i) return of spontaneous circulation, ii) care is transferred to an ALS team, iii) rescuers are exhausted or CPR would jeopardize rescuers or others, or iv) reliable criteria of death are met, or v) criteria for termination of resuscitation are met (Morrison et al., 2010b).

These termination-of-resuscitation rules are promising, but they should be applied cautiously in mountain rescue since they have only been validated in urban areas. In mountainous and other wilderness areas the population, cardiac arrest circumstances, and survival may be different, creating the possibility for unexpected survivors (Gilbert et al., 2000; Oberhammer et al., 2008; Strapazzon et al., 2012). For example, mountain rescuers may encounter cardiac arrest caused by special circumstances such as avalanche, burns, drowning, hypothermia, poisoning or trauma, and these are discussed later in the article. Hence, any termination-of-resuscitation rule should be validated by mountain rescue services before widespread implementation.

With this caveat, we propose use of a modified BLS termination-of-resuscitation guideline to limit inappropriate CPR in mountain rescue. In a person with any unwitnessed loss of vital signs, all criteria have to be met to terminate CPR (Table 2). The termination of resuscitation in mountain rescue recommendations are more detailed than the urban ones, as they reflect CPR scenarios which may be associated with

TABLE 2. TO TERMINATE CPR IN A PERSON WITH UN-WITNESSED LOSS OF VITAL SIGNS ALL CRITERIA HAVE TO BE PRESENT (ADAPTED FROM (MORRISON ET AL., 2006; MORRISON ET AL., 2009))

- |   |     |
|---|-----|
| 1. No return of spontaneous circulation during 20 minutes of CPR                      | AND |
| 2. No shock advised at any time by AED, or only asystole observed by ECG              | AND |
| 3. No hypothermia <sup>1</sup> or other special circumstances warranting extended CPR |     |

AED denotes automated external defibrillator, CPR cardiopulmonary resuscitation, ECG electrocardiogram. <sup>1</sup> Clinical evidence of hypothermia, possibly confirmed by an esophageal temperature of less than 35°C if available.

higher rates of special circumstances (e.g., hypothermia and avalanches) than in an urban environment. We have incorporated these components in a structured algorithm (Fig. 1) and propose this evidence-based framework principally to reduce unnecessary prolonged CPR while, however, promoting CPR where appropriate. This algorithm would be very useful for the large proportion of mountain rescue responders who are trained at least to BLS level and are adequately equipped (Brugger et al., 2005; Elsensohn et al., 2006; Barcella et al., 2010; Hohliedier et al., 2010; McIntosh et al., 2010; Brugger et al., 2011).

Witnessed cardiac arrest, compared to unwitnessed arrest, has been shown to be significantly associated with greater return of spontaneous circulation in an urban pre-hospital study (OR 8.8; 95%CI=2.9–26.9) and therefore does not lend itself to a structured termination-of-resuscitation guideline

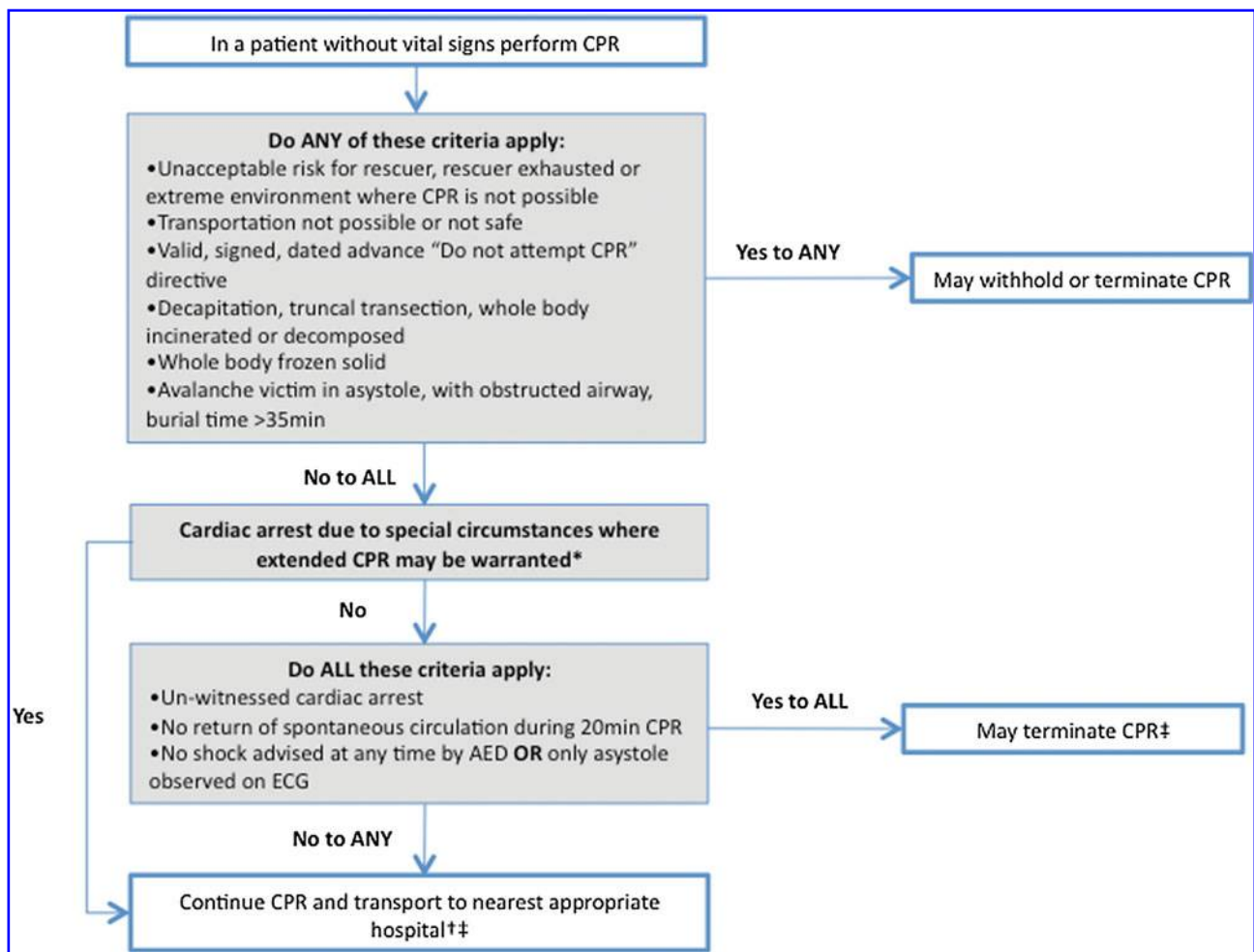


FIG. 1. Algorithm for termination of CPR in mountain rescue.

\*Other special circumstances include for instance drowning, lightning, and poisoning. In cardiac arrest due to special circumstances, such as these conditions, prolonged CPR may be associated with a good neurological outcome (see text for details) (Gilbert et al., 2000; Ibsen et al., 2002; Moser et al., 2005; Oberhammer et al., 2008). †When transport delays are excessive and special circumstances do not apply, it may be reasonable to terminate CPR after a 20 min period without ROSC provided that there has been no shock advised by AED or only asystole on ECG during the 20 min (this may apply to both witnessed and unwitnessed arrests without special circumstances). In special circumstances, where extended CPR is warranted, if transport to hospital is not possible then the rescuer will ideally mitigate the special circumstance prior to terminating CPR. In situations where transport is not possible, mitigation of special circumstances is not possible and further resuscitation is futile, CPR should be terminated.

‡Non-physicians should contact a suitably qualified physician if available.

(Verbeek et al., 2002). Therefore, with any witnessed cardiac arrest or, if one criterion is absent from the termination-of-resuscitation guideline (Table 2 and Fig. 1), CPR would best be continued unless a suitably qualified medical control provides a clinical assessment of the situation, patient, CPR, and transportation factors and determines that further CPR is futile. In contrast to the validated BLS rule, which stipulates that cardiac arrests witnessed by EMS be resuscitated (Morrison et al., 2006), this proposal for mountain rescue requires that CPR continues for arrests witnessed by bystanders also.

Prolonged CPR is not indicated when a patient is not expected to survive, consistent with the principle of medical futility (Morrison et al., 2010b; Soar et al., 2010), such as when rendered futile by patient condition as well as inadequate rescue resources or excessively long transports.

### Primary Cardiac Arrest

About 50% of all hiking fatalities in the mountains suffer a sudden primary cardiac arrest (Burtscher et al., 2000; Burtscher et al., 2007), and sedentary men >40 years of age are at greatest risk (Ponchia et al., 2006). Survival declines at an average of 3% per minute after collapse (Gold, 2010). Mountain rescue teams should consider carrying an automated external defibrillator (AED) to improve outcome from primary cardiac arrest (Elsensohn et al., 2006; Barcella et al., 2010).

### Environmental Limitations and Special Circumstances

In mountain rescue, outcomes from CPR may be worse than in an urban area due to limited personnel, equipment, environmental stresses, and longer extrication and transportation times. This trend towards worse outcome may be tempered by a somewhat healthier patient population compared with urban CPR studies. In addition, many instances of cardiac arrest occurring in the mountains may be classified as "cardiac arrest in special circumstances" (e.g., hypothermia), requiring modified criteria for termination of CPR (Soar et al., 2010; Vanden Hoek et al., 2010). For example, with hypothermia, drowning, lightning, and poisoning, prolonged CPR may be associated with a good outcome but in trauma or burns the prognosis very likely will be poor (Hopson et al., 2003; Mollberg et al., 2011).

### Trauma

In one study from the mountain rescue service of Scotland, trauma accounted for ~10% of all fatalities (Hearns, 2003). Trauma is also a frequent medical emergency in mountains in the United States (McIntosh et al., 2010; Rodway et al., 2011) and after avalanches (Hohlrieder et al., 2007) and crevasse accidents (Hohlrieder et al., 2010). Additionally, trauma in mountain areas is associated with a higher mortality rate when compared to urban areas because of longer transportation times associated with a higher risk of traumatic shock (Sumann et al., 2009). Severely traumatized patients should be assessed for lethal injuries, and if these injuries are absent, CPR should be commenced (Koster et al., 2010). In traumatic cardiac arrest, CPR in many cases is unsuccessful (Martin et al., 2002); however, when trauma is associated either with hypoxia, hypothermia, or electrical injury, survival rates increase (Pickens et al., 2005; Lockey et al., 2006; Willis et al., 2006). Cardiopulmonary resuscitation should be initiated in

patients with clinical conditions, suggesting a nontraumatic initial cause of cardiac arrest (Hopson et al., 2003). Some suggest continuing CPR for at least 20 minutes in blunt trauma (Moriwaki et al., 2011), although it is not clear how those recommendations pertain to pre-hospital traumatic cardiopulmonary arrest. In the end, mountain rescuers should consider that one set of current guidelines for resuscitation of out-of-hospital traumatic cardiopulmonary arrest (Hopson et al., 2003) recommend termination of CPR after 15 minutes of unsuccessful resuscitation, and these guidelines have been supported by one large retrospective review (Mollberg et al., 2011).

Medical directors of mountain rescue teams should consider creating local protocols for termination of CPR in traumatic cardiac arrest bearing in mind that current guidelines also consider terminating CPR if the transport time is greater than 15 minutes (Hopson et al., 2003).

### Hypothermia

Isolated hypothermia accounted for 4% of mountain deaths in one study from Scotland (Hearns, 2003). Diagnosis should be based on clinical and environmental presentation, classified according to the Swiss Classification (Durrer et al., 2003; Paal et al., 2006) and confirmed with core temperature measurement when available (Putzer et al., 2010). Even in cases of prolonged cardiopulmonary arrest, survival without neurological deficit may be possible if the patient was sufficiently cold before the onset of cardiac arrest (Gilbert et al., 2000; Oberhammer et al., 2008). In deeply hypothermic patients, survival with a good neurological outcome has been reported after as much as 6 hours and 30 minutes of CPR (Lexow, 1991). Patients have also been successfully resuscitated when part of their body is frozen (Moser et al., 2005). If, however, the whole body is frozen, the patient can be considered dead (Lloyd, 1996). For hypothermic patients in cardiac arrest or with cardiac instability, improved survival has been demonstrated with extracorporeal rewarming (ECR) (Walpoth et al., 1997; Gilbert et al., 2000; Ruttman et al., 2007). In the absence of alternate causes of death, all nonfrozen, hypothermic patients without vital signs should be considered for CPR (Soar et al., 2010), and ideally transport should be to a center capable of ECR. In cases where time to ECR will be greater than 3 hours and 10 minutes (Husby 1990), no evidence exists to help choose between shorter transport to center without ECR or longer transport to an ECR center. Cardiopulmonary resuscitation should be continued until the patient is in the hospital and rewarmed to normothermia (Larach, 1995). Mechanical chest compression devices may be helpful with prolonged CPR (Lim et al., 2010).

### Drowning

Worldwide every year, 150,000 die of drowning, making it the second leading cause of unintentional death (WHO, 2002a; Layon et al., 2009). Hypothermia, following cold water submersion, may be neuroprotective, thus survival even after prolonged submersion is possible (Harries, 2003). Several case reports have documented good outcomes in children receiving CPR (Ibsen et al., 2002), especially in those with cold water immersion (i.e., head out of the water) before submersion (i.e., head below the water); the documented record stands at 66 minutes submersion without neurological deficit (Bolte et al., 1988; Ibsen et al., 2002). Factors that are predictive for survival

include witnessed short-lasting submersion and early resuscitation (Youn et al., 2009).

In many cases, drowning may be the result of another primary event, for instance arrhythmia, intoxication, seizure, stroke, or trauma (Modell, 1993). Thus, besides drowning, it is important to consider other potential reasons for cardiac arrest when making the decision to terminate CPR (Layon et al., 2009). A review has stated that if the water temperature is  $>6^{\circ}\text{C}$ , survival is extremely unlikely if the patient is submerged for  $>30$  minutes; if the water is  $<6^{\circ}\text{C}$ , survival is extremely unlikely after  $>90$  minutes of submersion (Tipton et al., 2011). Despite concerns over producing guidelines using minimal data, there is some support for using the above noted temperature and timing of submersion for termination of resuscitation decisions. The issue is further complicated because the time of immersion is usually known, but the time of submersion often is not. For these reasons it may be premature to use water temperature and timing to guide decisions regarding search and rescue effort or resuscitation (Perkins, 2011).

### Avalanche

In North America and Europe, avalanches account for an average of  $\sim 150$  deaths per year (Brugger et al., 2001; Brugger et al., 2011). In a complete burial (at least the head and chest covered by snow) with an obstructed airway (e.g., packed with snow, no air pocket), asphyxia leads to death within 35 minutes. In the absence of life-threatening trauma, a buried patient with a patent airway will develop hypothermia, hypoxia, and hypercapnia, the so-called triple H-syndrome (Brugger et al., 2003). Hypoxia is the most common cause of death, followed by trauma (McIntosh et al., 2007). Trauma mortality was reported to be 24% overall in a study of 204 avalanche fatalities, although this rate varied considerably between activity groups (Boyd et al., 2009). Two other studies from different regions, of 56 and 36 fatalities, respectively, have demonstrated lower rates of trauma mortality (McIntosh et al., 2007; Hohlrieder et al., 2007). Hypothermia may be neuroprotective and survival with a good neurological outcome after prolonged burial and even cardiac arrest is possible (Oberhammer et al., 2008; Putzer et al., 2010).

In the absence of trauma incompatible with life, all avalanche patients buried for less than 35 minutes should be resuscitated according to current BLS and ALS guidelines (Berg et al., 2010; Deakin et al., 2010; Koster et al., 2010; Morrison et al., 2010a; Neumar et al., 2010). With burial time exceeding 35 minutes, absent vital signs and a patent airway, CPR should be performed and the patient should be transported to an ECR center as per the hypothermia guideline noted above. With burial time exceeding 35 minutes, asystolic cardiac arrest and an obstructed airway, CPR may be terminated (Brugger et al., 2001; Boyd et al., 2010; Vanden Hoek et al., 2010).

### Lightning

In the United States of America,  $\sim 100$  persons a year die from lightning (Koumbourlis, 2002). Lightning has a mortality rate 5 to 10 times higher than other forms of electrical injuries. For example, in the Italian mountains 0.2% of persons rescued were hit by lightning and the mortality rate was 24% (CNSAS, 2002–2008). Unconscious patients with linear or feathering burns should be considered as lightning victims (Zafren et al.,

2005). Explosive force may result in blunt trauma (Cherington, 1995), and burns or trauma may be life-threatening (Cooper, 1980; Koumbourlis, 2002; Ritenour et al., 2008), requiring rapid evacuation. A patient with a lightning injury should be assessed and, if indicated, CPR performed for at least 20 minutes (Zafren et al., 2005; Nelson et al., 2007). Death from lightning may result from primary respiratory arrest, followed by hypoxia and secondary cardiac arrest (Zafren et al., 2005). Thus, rescuers should be aware that with lightning, some patients may be nonbreathing but may have cardiac activity and thus only require artificial ventilation. Lengthy periods of ventilation may be required before spontaneous respiration returns. In cases of persistent cardiac arrest despite 20 minutes of CPR, terminating CPR should be in accordance with Tables 1 and 2 and Figure 1.

### Burns

Worldwide, fire-related burns are responsible for over 300,000 deaths annually (WHO, 2002b). A significant portion of these deaths are related to open flame cooking that is common in many mountain communities. Case reports have shown good outcomes in burn patients who required short durations of in-hospital CPR (Jeschke et al., 2000). Unfortunately, out-of-hospital cardiac arrest in burn patients is unlikely to result in survival to discharge or meaningful neurologic function. However, withholding or terminating CPR should be in accordance with Tables 1 and 2 and Figure 1.

### Poisoning

Poisoning in the mountains may result from causes such as alcohol, carbon monoxide, herbicides, plant ingestion, or envenomation (Hampson et al., 2001; Boyd et al., 2007). When managing a potentially contaminated patient, special personal protective measures are of utmost importance to protect the rescuer from toxic exposure until the patient has been adequately decontaminated. Case reports exist of patients with cardiac toxins surviving to good outcome after prolonged (i.e.,  $>20$  min) CPR (Durward et al., 2003). Therefore, be prepared to continue CPR for a prolonged period, particularly in young patients, as poison may be metabolized during life support measures (Soar et al., 2010). In poisoned patients, consultation with a poison control center should be considered before discontinuing CPR.

### Further Considerations

#### *Dangerous terrain necessitating delayed assessment*

In some instances, assessing the victim on site is too dangerous (Samuel, 2008). In such circumstances, consider first evacuating and then assessing the patient when the environment is deemed safe. Declaring a victim dead on site without a complete assessment may be premature (Adhiyaman et al., 2007; Krarup et al., 2010; Braun et al., 2011).

#### *Prolonged transport scenarios*

If the risk of performing CPR is acceptable but a rescuer is in doubt about the likely outcome of a patient, then CPR should be performed continuously until arrival at an appropriate hospital, care is transferred to a higher level provider, or instruction to terminate CPR is given by a suitably qualified medical control. Mechanical chest compression devices can

maintain good quality CPR and may assist in difficult evacuations or long transports (Nolan et al., 2010), although a systematic review found insufficient evidence of benefit or harm to recommend their widespread use (Brooks et al., 2011).

### Legal issues

Medical leaders of rescue teams should interpret these guidelines in the context of their own local conditions and create team-specific training and guidelines for determining when to withhold and when to terminate CPR. The appropriate type of physician oversight will also vary and may include onsite, online (telephone or radio), and/or offline (protocols or guidelines along with training and quality assurance programs). Separate from the decision to start or stop CPR is the need for informing the responsible authorities (e.g., police) and the certification of death in accordance with laws and EMS protocols (Bailey et al., 2000; Richman et al., 2008; Stratton et al., 2008; Morrison et al., 2009; Ruygrok et al., 2009). Customized CPR protocols and standard operating procedures may help assisting EMS in making the difficult decision to withhold and terminate CPR in mountainous and other wilderness environments.

### Limitations

These recommendations are based in part on studies performed in urban areas and, due to paucity of pre-hospital data, some in-hospital studies. These recommendations should be applied cautiously and reviewed prospectively, as there may be unexpected survivors in mountain populations. These recommendations should not preclude performing or terminating CPR in individual circumstances. Also, these recommendations specifically do not address pediatric patients.

### Conclusions

In mountain rescue, CPR may be withheld or terminated in a patient with absent vital signs when the risk is unacceptable to the rescuer, the rescuer is exhausted, or in extreme environments where CPR is not possible or any of the following apply: decapitation; truncal transection; whole body incinerated, decomposed or frozen solid; avalanche victim in asystolic cardiac arrest with obstructed airway and burial time >35 minutes. Also, CPR may be terminated when all of the following criteria apply: unwitnessed loss of vital signs, no return of spontaneous circulation during 20 min of CPR; no shock advised at any time by AED or only asystole confirmed on ECG, and no hypothermia or other special circumstances warranting extended CPR. In special circumstances where extended CPR is warranted, if transport to hospital is not possible, then the rescuer will ideally mitigate the special circumstance prior to terminating CPR. In situations where transport is not possible, mitigation of special circumstances is not possible and further resuscitation is futile, CPR should be terminated. Medical directors of rescue teams should interpret these recommendations in the context of their local conditions and create team-specific training and protocols for determining when to withhold and terminate CPR in a patient with absent vital signs. This process is separate from the possible need for medical certification of death in accordance

with regional and national laws and compliance with requirements of investigatory legal agencies.

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### References

- Adhiyaman V, Adhiyaman S, and Sundaram R. (2007). The Lazarus phenomenon. *J R Soc Med* 100:552–557.
- Anonymous. 2010. Avalanches Kill 7 in Northern Italy. In: *New York Times*.
- Bailey ED, Wydro GC, and Cone DC. (2000). Termination of resuscitation in the pre-hospital setting for adult patients suffering nontraumatic cardiac arrest. National Association of EMS Physicians Standards and Clinical Practice Committee. *Prehosp Emerg Care* 4:190–195.
- Barcella L, Agazzi G, Malgrati D, Sileo F, Calderoli A, Rottoli E, Valoti O, and Parigi GB. (2010). First aid and public access defibrillation in mountain huts: The Mountain Huts Initiative of the Bergamo section of the Club Alpino Italiano. *Wilderness Environ Med* 21:379–381.
- Baskett PJ, Steen PA, and Bossaert L. (2005). European Resuscitation Council guidelines for resuscitation 2005. Section 8. The ethics of resuscitation and end-of-life decisions. *Resuscitation* 67:S171–180.
- Berg RA, Hemphill R, Abella BS, Aufderheide TP, Cave DM, Hazinski MF, Lerner EB, Rea TD, Sayre MR, and Swor RA. (2010). Part 5: Adult basic life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 122:S685–705.
- Bolte RG, Black PG, Bowers RS, Thorne JK, and Corneli HM. (1988). The use of extracorporeal rewarming in a child submerged for 66 minutes. *JAMA* 260:377–379.
- Boyd J, Brugger H, and Shuster M. (2010). Prognostic factors in avalanche resuscitation: A systematic review. *Resuscitation* 81:645–652.

- Boyd JJ, Agazzi G, Svajda D, Morgan AJ, Ferrandis S, and Norris RL. (2007). Venomous snakebite in mountainous terrain: Prevention and management. *Wilderness Environ Med* 18:190–202.
- Braun P, Herff H, and Paal P. (2011). The Lazarus phenomenon—False positive death certifications and auto-resuscitation cases covered in lay press. *Resuscitation* 82:1363–1364.
- Brooks SC, Bigham BL, and Morrison LJ. (2011). Mechanical versus manual chest compressions for cardiac arrest. *Cochrane Database Syst Rev*:CD007260.
- Brugger H, Durrer B, Adler-Kastner L, Falk M, and Tschirky F. (2001). Field management of avalanche victims. *Resuscitation* 51:7–15.
- Brugger H, Elsensohn F, Syme D, Sumann G, and Falk M. (2005). A survey of emergency medical services in mountain areas of Europe and North America: Official recommendations of the International Commission for Mountain Emergency Medicine (ICAR Medcom). *High Alt Med Biol* 6:226–237.
- Brugger H, Paal P, and Boyd J. (2011). Pre-hospital resuscitation of the buried avalanche victim. *High Alt Med Biol* 12:199–205.
- Brugger H, Sumann G, Meister R, Adler-Kastner L, Mair P, Gunga HC, Schobersberger W, and Falk M. (2003). Hypoxia and hypercapnia during respiration into an artificial air pocket in snow: Implications for avalanche survival. *Resuscitation* 58:81–88.
- Burtscher M, Pachinger O, Mittleman MA, and Ulmer H. (2000). Prior myocardial infarction is the major risk factor associated with sudden cardiac death during downhill skiing. *Int J Sports Med* 21:613–615.
- Burtscher M, Pachinger O, Schocke MF, and Ulmer H. (2007). Risk factor profile for sudden cardiac death during mountain hiking. *Int J Sports Med* 28:621–624.
- Cherington M. (1995). Lightning injuries. *Ann Emerg Med* 25:517–519.
- CNSAS. (2002–2008). [Corpo Nazionale Soccorso Alpino e Speleologico (CNSAS), Annual Reports 2002–2008].
- Cooper MA. (1980). Lightning injuries: Prognostic signs for death. *Ann Emerg Med* 9:134–138.
- Deakin CD, Nolan JP, Soar J, Sunde K, Koster RW, Smith GB, and Perkins GD. (2010). European Resuscitation Council Guidelines for Resuscitation 2010 Section 4. Adult advanced life support. *Resuscitation* 81:1305–1352.
- Durrer B, Brugger H, and Syme D. (2003). The medical on-site treatment of hypothermia: ICAR-MEDCOM recommendation. *High Alt Med Biol* 4:99–103.
- Durward A, Guerguerian AM, Lefebvre M, and Shemie SD. (2003). Massive diltiazem overdose treated with extracorporeal membrane oxygenation. *Pediatr Crit Care Med* 4:372–376.
- Elsensohn F, Agazzi G, Syme D, Swangard M, Facchetti G, and Brugger H. (2006). 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* 17:64–66.
- Elsensohn F, Niederklapfer T, Ellerton J, Swangard M, Brugger H, and Paal P. (2009). Current status of medical training in mountain rescue in America and Europe. *High Alt Med Biol* 10:195–200.
- Elsensohn F, Soteras I, Resiten O, Ellerton J, Brugger H, and Paal P. (2011). Equipment of medical backpacks in mountain rescue. *High Alt Med Biol* 12:343–347.
- Ewy GA. (2006). Cardiac resuscitation—When is enough enough? *N Engl J Med* 355:510–512.
- Farber NJ, Simpson P, Salam T, Collier VU, Weiner J, and Boyer EG. (2006). Physicians' decisions to withhold and withdraw life-sustaining treatment. *Arch Intern Med* 166:560–564.
- Gilbert M, Busund R, Skagseth A, Nilsen PA., and Solbo JP. (2000). Resuscitation from accidental hypothermia of 13.7 degrees C with circulatory arrest. *Lancet* 355:375–376.
- Grudzen CR, Hoffman JR, Koenig WJ, Boscardin J, Lorenz KA, and Asch SM. (2010). The LA story: What happened after a new policy allowing paramedics to forgo resuscitation attempts in pre-hospital cardiac arrest. *Resuscitation* 81:685–690.
- Hall WL, 2nd, Myers JH, Pepe PE, Larkin GL, Sirbaugh PE, and Perse DE. (2004). The perspective of paramedics about on-scene termination of resuscitation efforts for pediatric patients. *Resuscitation* 60:175–187.
- Hampson NB and Zmaeff JL. (2001). Outcome of patients experiencing cardiac arrest with carbon monoxide poisoning treated with hyperbaric oxygen. *Ann Emerg Med* 38:36–41.
- Harries M. (2003). Near drowning. *BMJ* 327:1336–1338.
- Hearns S. (2003). The Scottish mountain rescue casualty study. *Emerg Med J* 20:281–284.
- Hohliedner M, Brugger H, Schubert HM, Pavlic M, Ellerton J, and Mair P. (2007). Pattern and severity of injury in avalanche victims. *High Alt Med Biol* 8:56–61.
- Hohliedner M, Kroesslhuber F, Voelckel W, Lutz M, and Mair P. (2010). Experience with helicopter rescue missions for crevasse accidents. *High Alt Med Biol* 11:375–379.
- Hopson LR, Hirsh E, Delgado J, Domeier RM, McSwain NE, and Krohmer J. (2003). Guidelines for withholding or termination of resuscitation in pre-hospital 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* 196:106–112.
- Ibsen LM and Koch T. (2002). Submersion and asphyxial injury. *Crit Care Med* 30:S402–408.
- Jeschke MG, Herndon DN, and Barrow R. E. (2000). Long-term outcomes of burned children after in-hospital cardiac arrest. *Crit Care Med* 28:517–520.
- Koster RW, Baubin MA, Bossaert LL, Caballero A, Cassan P, Castren M, Granja C, Handley AJ, Monsieurs KG, Perkins GD, Raffay V, and Sandroni C. (2010). European Resuscitation Council Guidelines for Resuscitation 2010 Section 2. Adult basic life support and use of automated external defibrillators. *Resuscitation* 81:1277–1292.
- Koumbourlis AC. (2002). Electrical injuries. *Crit Care Med* 30:S424–430.
- Krurup NH, Kaltoft A, and Lenler-Petersen P. (2010). Risen from the dead: A case of the Lazarus phenomenon with considerations on the termination of treatment following cardiac arrest in a pre-hospital setting. *Resuscitation* 81:1598–1599.
- Larach MG. (1995). Accidental hypothermia. *Lancet* 345:493–498.
- Layon AJ and Modell JH. (2009). Drowning: Update 2009. *Anesthesiology* 110:1390–1401.
- Lim SH, Shuster M, Deakin CD, Kleinman ME, Koster RW, Morrison LJ, Nolan JP, and Sayre MR. (2010). Part 7: CPR techniques and devices: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 81 Suppl 1:e86–92.
- Lippert FK, Raffay V, Georgiou M, Steen PA, and Bossaert L. (2010). European Resuscitation Council Guidelines for Resuscitation 2010 Section 10. The ethics of resuscitation and end-of-life decisions. *Resuscitation* 81:1445–1451.
- Lloyd EL. (1996). Accidental hypothermia. *Resuscitation* 32:111–124.

- Lockey AS. (2002). Recognition of death and termination of cardiac resuscitation attempts by UK ambulance personnel. *Emerg Med J* 19:345–347.
- Lockey D, Crewdson K, and Davies G. (2006). Traumatic cardiac arrest: Who are the survivors? *Ann Emerg Med* 48:240–244.
- Martin SK, Shatney CH, Sherck JP, Ho CC, Homan SJ, Neff J, and Moore EE. (2002). Blunt trauma patients with pre-hospital pulseless electrical activity (PEA): Poor ending assured. *J Trauma* 53:876–880; discussion 880–871.
- McIntosh SE, Brillhart A, Dow J, and Grissom CK. (2010). Search and rescue activity on Denali, 1990 to 2008. *Wilderness Environ Med* 21:103–108.
- McIntosh SE, Grissom CK, Olivares CR, Kim HS, and Tremper B. (2007). Cause of death in avalanche fatalities. *Wilderness Environ Med* 18:293–297.
- Millin MG, Khandker SR, and Malki A. (2011). Termination of resuscitation of nontraumatic cardiopulmonary arrest: Resource document for the National Association of EMS Physicians position statement. *Prehosp Emerg Care* 15:547–554.
- Modell JH. (1993). Drowning. *N Engl J Med* 328:253–256.
- Mollberg NM, Wise SR, Berman K, Chowdhry S, Holevar M, Sullivan R, and Vafa A. (2011). The consequences of non-compliance with guidelines for withholding or terminating resuscitation in traumatic cardiac arrest patients. *J Trauma* 71:997–1002.
- Moriwaki Y, Sugiyama M, Yamamoto T, Tahara Y, Toyoda H, Kosuge T, Harunari N, Iwashita M, Arata S, and Suzuki N. (2011). Outcomes from pre-hospital cardiac arrest in blunt trauma patients. *World J Surg* 35:34–42.
- Morrison LJ, Deakin CD, Morley PT, Callaway CW, Kerber RE, Kronick SL, Lavonas EJ, Link MS, Neumar RW, Otto CW, Parr M, Shuster M, Sunde K, Peberdy MA, Tang W, Hoek TL, Bottiger BW, Drajer S, Lim SH, and Nolan JP. (2010a). Part 8: Advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Circulation* 122:S345–421.
- Morrison LJ, Kierzek G, Diekema DS, Sayre MR, Silvers SM, Idris AH, and Mancini ME. (2010b). Part 3: Ethics: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 122:S665–675.
- Morrison LJ, Verbeek PR, Zhan C, Kiss A, and Allan KS. (2009). Validation of a universal pre-hospital termination of resuscitation clinical prediction rule for advanced and basic life support providers. *Resuscitation* 80:324–328.
- Morrison LJ, Visentin LM, Kiss A, Theriault R, Eby D, Vermeulen M, Sherbino J, and Verbeek PR. (2006). Validation of a rule for termination of resuscitation in out-of-hospital cardiac arrest. *N Engl J Med* 355:478–487.
- Moser B, Voelckel W, Gardetto A, Sumann G, and Wenzel V. (2005). One night in a snowbank: A case report of severe hypothermia and cardiac arrest. *Resuscitation* 65:365–368.
- Nelson KL, Mills W, Jr., Umbel S, Crosson JE, Shaffner DH, and Hunt EA. (2007). Lightning, sudden cardiac death, simulation and an automated external defibrillator: The perfect storm. *Resuscitation* 74:567–571.
- Neumar RW, Otto CW, Link MS, Kronick SL, Shuster M, Callaway CW, Kudenchuk PJ, Ornato JP, McNally B, Silvers SM, Passman RS, White RD, Hess EP, Tang W, Davis D, Sinz E, and Morrison LJ. (2010). Part 8: Adult advanced cardiovascular life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 122:S729–767.
- Nolan JP, Hazinski MF, Billi JE, Boettiger BW, Bossaert L, de Caen AR, Deakin CD, Drajer S, Eigel B, Hickey RW, Jacobs I, Kleinman ME, Kloeck W, Koster RW, Lim SH, Mancini ME, Montgomery WH, Morley PT, Morrison LJ, Nadkarni VM, O'Connor RE, Okada K, Perlman JM, Sayre MR, Shuster M, Soar J, Sunde K, Travers AH, Wyllie J, and Zideman D. (2010). Part 1: Executive summary: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Resuscitation* 81:e1–25.
- Oberhammer R, Beikircher W, Hormann C, Lorenz I, Pycha R, Adler-Kastner L, and Brugger H. (2008). Full recovery of an avalanche victim with profound hypothermia and prolonged cardiac arrest treated by extracorporeal re-warming. *Resuscitation* 76:474–480.
- Ong ME, Jaffey J, Stiell I, and Nesbitt L. (2006). Comparison of termination-of-resuscitation guidelines for basic life support: Defibrillator providers in out-of-hospital cardiac arrest. *Ann Emerg Med* 47:337–343.
- Paal P, Beikircher W, and Brugger H. (2006). [Avalanche emergencies. Review of the current situation]. *Anaesthetist* 55:314–324.
- Perkins GD. (2011). Rescue and resuscitation or body retrieval: The dilemmas of search and rescue efforts in drowning incidents. *Resuscitation* 82:799–800.
- Pickens JJ, Copass MK, and Bulger EM. (2005). Trauma patients receiving CPR: Predictors of survival. *J Trauma* 58:951–958.
- Ponchia A, Biasin R, Tempesta T, Thiene M, and Volta SD. (2006). Cardiovascular risk during physical activity in the mountains. *J Cardiovasc Med (Hagerstown)* 7:129–135.
- Powner DJ, Ackerman BM, and Grenvik A. (1996). Medical diagnosis of death in adults: Historical contributions to current controversies. *Lancet* 348:1219–1223.
- Putzer G, Schmid S, Braun P, Brugger H, and Paal P. (2010). Cooling of six centigrades in an hour during avalanche burial. *Resuscitation* 81:1043–1044.
- Richman PB, Vadeboncoeur TF, Chikani V, Clark L, and Bobrow BJ. (2008). Independent evaluation of an out-of-hospital termination of resuscitation (TOR) clinical decision rule. *Acad Emerg Med* 15:517–521.
- Ritenour AE, Morton MJ, McManus JG, Barillo DJ, and Cancio LC. (2008). Lightning injury: A review. *Burns* 34:585–594.
- Rodway GW, McIntosh SE, and Dow J. (2011). Mountain search and rescue on Denali: A short history from the 1980s to the present. *High Alt Med Biol* 12:277–283.
- Ruttman E, Weissenbacher A, Ulmer H, Muller L, Hofer D, Kilo J, Rabl W, Schwarz B, Laufer G, Antretter H, and Mair P. (2007). Prolonged extracorporeal membrane oxygenation-assisted support provides improved survival in hypothermic patients with cardiocirculatory arrest. *J Thorac Cardiovasc Surg* 134:594–600.
- Ruygrok ML, Bynny RL, and Haukoos JS. (2009). Validation of 3 termination of resuscitation criteria for good neurologic survival after out-of-hospital cardiac arrest. *Ann Emerg Med* 54:239–247.
- Rydvall A, Bergenheim T, and Lynoe N. (2007). Decision making in a life-threatening cerebral condition: A comparative study of the ethical reasoning of intensive care unit physicians and neurosurgeons. *Acta Anaesthesiol Scand* 51:1338–1343.
- Rydvall A and Lynoe N. (2008). Withholding and withdrawing life-sustaining treatment: A comparative study of the ethical reasoning of physicians and the general public. *Crit Care* 12:R13.
- Samuel H. 2008. Mont Blanc avalanche—Dozens more could have died. *Daily Telegraph*. <http://www.telegraph.co.uk/news/worldnews/europe/france/2619922/Mont-Blanc-avalanche-Dozens-more-could-have-died.html>



- Sasson C, Hegg AJ, Macy M, Park A, Kellermann A, and McNally B. (2008). Pre-hospital termination of resuscitation in cases of refractory out-of-hospital cardiac arrest. *JAMA* 300:1432–1438.
- Schlottzhauer AV and Liang BA. (2002). Definitions and implications of death. *Hematol Oncol Clin North Am* 16:1397–1413.
- Skrifvars MB, Vayrynen T, Kuisma M, Castren M, Parr MJ, Silfverstople J, Svensson L, Jonsson L, and Herlitz J. (2010). Comparison of Helsinki and European Resuscitation Council “do not attempt to resuscitate” guidelines, and a termination of resuscitation clinical prediction rule for out-of-hospital cardiac arrest patients found in asystole or pulseless electrical activity. *Resuscitation* 81:679–684.
- Soar J, Perkins GD, Abbas G, Alfonso A, Barelli A, Bierens JJ, Brugger H, Deakin CD, Dunning J, Georgiou M, Handley AJ, Lockey DJ, Paal P, Sandroni C, Thies KC, Zideman DA, and Nolan JP. (2010). European Resuscitation Council Guidelines for Resuscitation 2010: Section 8. Cardiac arrest in special circumstances: Electrolyte abnormalities, poisoning, drowning, accidental hypothermia, hyperthermia, asthma, anaphylaxis, cardiac surgery, trauma, pregnancy, electrocution. *Resuscitation* 81:1400–1433.
- Strapazzon G, Beikircher W, Procter E, and Brugger H. (2012). Electrical heart activity recorded during prolonged avalanche burial. *Circulation* 125:646–647.
- Stratton SJ and Rashi P. (2008). Out-of-hospital unwitnessed cardiopulmonary collapse and no-bystander CPR: A practical addition to resuscitation termination guidelines. *J Emerg Med* 35:175–179.
- Sumann G, Paal P, Mair P, Ellerton J, Dahlberg T, Zen-Ruffinen G, Zafren K, and Brugger H. (2009). 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* 10:71–75.
- Tipton MJ and Golden FS. (2011). A proposed decision-making guide for the search, rescue and resuscitation of submersion (head under) victims based on expert opinion. *Resuscitation* 82:819–824.
- Tomazin I, Ellerton J, Reisten O, Soteras I, and Avbelj M. (2011). Medical standards for mountain rescue operations using helicopters: Official consensus recommendations of the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). *High Alt Med Biol* 12:335–341.
- Vanden Hoek TL, Morrison LJ, Shuster M, Donnino M, Sinz E, Lavonas EJ, Jeejeebhoy FM, and Gabrielli A. (2010). Part 12: Cardiac arrest in special situations: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 122:S829–861.
- Verbeek PR, Vermeulen MJ, Ali FH, Messenger DW, Summers J, and Morrison LJ. (2002). Derivation of a termination-of-resuscitation guideline for emergency medical technicians using automated external defibrillators. *Acad Emerg Med* 9:671–678.
- Walpoth BH, Walpoth-Aslan BN, Mattle HP, Radanov BP, Schroth G, Schaeffler L, Fischer AP, von Segesser L, and Althaus U. (1997). Outcome of survivors of accidental deep hypothermia and circulatory arrest treated with extracorporeal blood warming. *N Engl J Med* 337:1500–1505.
- WHO. 2002a. World Health Organization. Drowning factsheet. In: World Health Organization.
- WHO. 2002b. World Health Organization. Enemies of health, allies of poverty. Page 8. In: World Health Organization.
- Willis CD, Cameron PA, Bernard SA, and Fitzgerald M. (2006). Cardiopulmonary resuscitation after traumatic cardiac arrest is not always futile. *Injury* 37:448–454.
- Youn CS, Choi SP, Yim HW, and Park KN. (2009). Out-of-hospital cardiac arrest due to drowning: An Utstein Style report of 10 years of experience from St. Mary’s Hospital. *Resuscitation* 80:778–783.
- Zafren K, Durrer B, Herry JP, and Brugger H. (2005). 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* 65:369–372.

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### Appendix 1: Definitions

- Decapitation: the severing of the head from the remainder of the patient’s body
- Truncal transection: the body is completely cut across below the shoulders and above the hips through major organs and vessels
- Incineration: >90% of body surface area 3° burn as exhibited by ash
- Decomposition or putrefaction: the skin is bloated or ruptured, with or without soft tissue sloughed off, or there is the odor of decaying flesh
- Adult: patient age 18 or over
- Normothermic patient: the normal human body temperature of a resting adult body is  $36.8 \pm 0.7^\circ\text{C}$  ( $98.2 \pm 1.3^\circ\text{F}$ )
- Hypothermic patient: any internal body temperature below  $35^\circ\text{C}$  ( $95.0^\circ\text{F}$ )