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Fluid Management in Traumatic Shock: A Practical Approach for Mountain Rescue

OFFICIAL RECOMMENDATION OF THE INTERNATIONAL COMMISSION FOR MOUNTAIN EMERGENCY MEDICINE (ICAR MEDCOM)

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This article reflects the consensus of opinion of the International Commission for Mountain Emergency Medicine, which has full responsibility for the content.

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Official Recommendations of the International Commission for Mountain Emergency Medicine (ICAR MEDCOM)

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Abstract

Sumann, Günther, Peter Paal, Peter Mair, John Ellerton, Tore Dahlberg, Gregoire Zen-Ruffinen, Ken Zafren, and Hermann Brugger. Fluid management in traumatic shock: a practical approach for mountain rescue. *High Alt. Med. Biol*. 10:71–75, 2009.—The management of severe injuries leading to traumatic shock in mountains and remote areas is a great challenge for emergency physicians and rescuers. Traumatic brain injury may further aggravate outcome. A mountain rescue mission may face severe limitations from the terrain and required rescue technique. The mission may be characterized by a prolonged prehospital care time, where urban traumatic shock protocols may not apply. Yet optimal treatment is of utmost importance. The aim of this study is to establish scientifically supported recommendations for fluid management that are feasible for the physician or paramedic attending such an emergency. A nonsystematic literature search was performed; the results and recommendations were discussed among the authors and accepted by the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). Diagnostic and therapeutic strategies are discussed, as well as limitations on therapy in mountain rescue. An algorithm for fluid resuscitation, derived from the recommendations, is presented in Fig. 1. Focused on the key criterion of traumatic brain injury, different levels of blood pressure are presented as a goal of therapy, and the practical means for achieving these are given.

Key words: fluid therapy; hemorrhage; mountain rescue; shock; trauma

Introduction

Between 60% and 80% of the casualties evacuated from European mountainous regions by organized mountain rescue teams suffer from traumatic injuries. Of these, 4% to 8% have sustained major trauma, with traumatic brain injury (TBI) being common (Burtscher and Jenny, 1987; Benedetto et al., 1991; Hearns, 2003).

In mountain rescue, to achieve short response times (comparable to those in urban settings) and advanced life support at the scene of the incident, the rescue team normally relies on the availability of a helicopter emergency medical system (HEMS) (Marsigny et al., 1999; Tomazin and Kovacs, 2003; Hohlrieder et al., 2004; Brugger et al., 2005). Cold temperatures, high winds, snowfall, and the exposed and potentially dangerous environment often limit the therapeutic

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interventions that normally form part of standard prehospital management of shock (Durrer, 1993). Moreover, terrestrial mountain rescue operations, where the casualty is evacuated by stretcher, are frequently characterized by a prolonged prehospital time and a hostile environment; these severely limit surveillance of the casualty and make any medical intervention difficult.

Despite the limitations, practitioners working in the field need guidance on how to deal with traumatic shock patients. The aim of this study is to establish scientifically supported, practical recommendations for fluid management suitable for emergencies in the mountains and remote areas, a task made even more challenging by a number of controversies surrounding the management of traumatic shock.

Methods

A nonsystematic literature search in the Medline database was performed, and publications relevant to mountain rescue between 1980 and 2007 were reviewed and selected. The results were discussed among the authors, and draft recommendations were presented at the International Commission for Mountain Emergency Medicine (ICAR MEDCOM) meetings at Gemmi Pass, Switzerland, and Kranjska Gora, Slovenia, in 2006. Consensus between mountain rescue experts was achieved in two further meetings at Patterdale, England, and Pontresina, Switzerland, in 2007. The paper was finally approved in October 2007.

Results

Different philosophies of prehospital fluid resuscitation are practiced in patients with traumatic shock; none of these concepts has convincing clinical data to support it beyond any scientific doubt. In addition, most of the knowledge and recommendations are derived from experimental animal studies. Aggressive fluid management, although still standard in many emergency medical systems, failed to improve survival in most clinical studies (Kaweski et al., 1990; Bickell et al., 1994; Deakin, 1994). A Cochrane review on fluid management in traumatic shock (Kwan et al., 2003) concluded that there is "continuing uncertainty about the best fluid administration strategy in bleeding trauma patients," and there is a lack of randomized, controlled studies to sufficiently answer the question.

Favorable outcome may decrease with systolic arterial blood pressure $\leq$ 90 mmHg (Revell et al., 2003; Vaid et al., 2006); but in a patient with uncontrolled hemorrhage, there is increasing scientific evidence that raising systolic arterial blood pressure (SABP) with aggressive fluid resuscitation will increase bleeding (Riddez et al., 1998; Krausz et al., 2001; Roberts et al., 2001) and does not improve survival (Kaweski et al., 1990; Bickell et al., 1994; Deakin, 1994). Therefore, it has been argued that withholding fluid, or using limited amounts of fluid, and aiming for a SABP lower than normal levels (permissive hypotension) (Kreimeier et al., 2000) may improve outcome. Experience from military medicine during combat conditions suggests that a strategy of limited, intermittent bolus administration of fluid aiming to just maintain consciousness and/or palpable central pulse (indicating a systolic blood pressure exceeeding 60 mmHg) may be reasonable for patients in traumatic shock even when prehospital time is prolonged (Revell, 2003). This concept seems to benefit patients with certain trauma patterns, such as penetrating trauma or abdominal visceral injury (Bickell et al., 1994; Kreimeier et al., 2002). However, convincing scientific evidence from clinical studies to support these strategies in patients with other trauma patterns is lacking. On the other hand, there is reasonable scientific evidence that a reduced SABP is poorly tolerated in traumatic brain injury (Manley et al., 2001) and that normal levels of blood pressure may improve outcome in these patients (Chesnut et al., 1993).

There are two decisive key conditions to recognize in the prehospital setting: the presence of uncontrolled pressure-dependent hemorrhage and severe TBI (Kreimeier et al., 2000). Both are difficult, if not impossible, to diagnose accurately in the prehospital environment. Uncontrolled pressure-dependent hemorrhage should be suspected in any patient responding transiently, or not at all, to initial fluid resuscitation. Impaired consciousness in a patient with shock may be caused by one or a combination of the following factors: arterial hypotension, hypoxemia, cardiac dysfunction, hypothermia, and TBI. Therefore, a Glasgow coma scale (GCS) below 9 does not necessarily indicate severe TBI, although the presence of external signs of head injury or anisocoria is suggestive (Moppett, 2007).

Despite all the controversies surrounding fluid resuscitation, scientific evidence and common sense suggest the following:

1. Fluid resuscitation should never markedly delay transport to hospital and in-hospital treatment (Pepe et al., 2002).
2. Control of external bleeding should precede fluid resuscitation (Voelckel et al., 2004; Soreide and Deakin, 2005).
3. Maintenance of a minimal arterial blood pressure ($\geq$90 mmHg) that improves coronary and cerebral perfusion may increase short-term survival (Soreide and Deakin, 2005).
4. Aggressive fluid management may cause hypothermia and dilution coagulopathy (Marshall et al., 1997; Innerhofer et al., 2002).
5. Increasing SABP may intensify bleeding.
6. Reduced SABP is poorly tolerated in TBI.
7. Causes of traumatic shock not related to hypovolemia should be considered and treated promptly (e.g., deflating a tension pneumothorax)
8. Transferring a multisystem trauma patient in shock directly to the nearest level 1 trauma center improves outcome (Härtl et al., 2006; Rainer et al., 2007).
9. The use of hypertonic saline/dextrane improves survival in both hypotensive patients with TBI and patients with penetrating injuries requiring immediate surgery (Soreide and Deakin, 2005).

Recommendations

A flow chart (Fig. 1) based on therapeutic decisions sets out our recommendations for the management of traumatic shock in mountainous terrain and remote areas. This algorithm is suitable for both physician- and paramedic-staffed mountain rescue systems.

Traumatic shock should be suspected in any patient with hypotension and tachycardia or a mechanism of injury that is expected to cause substantial trauma. If scene safety al-

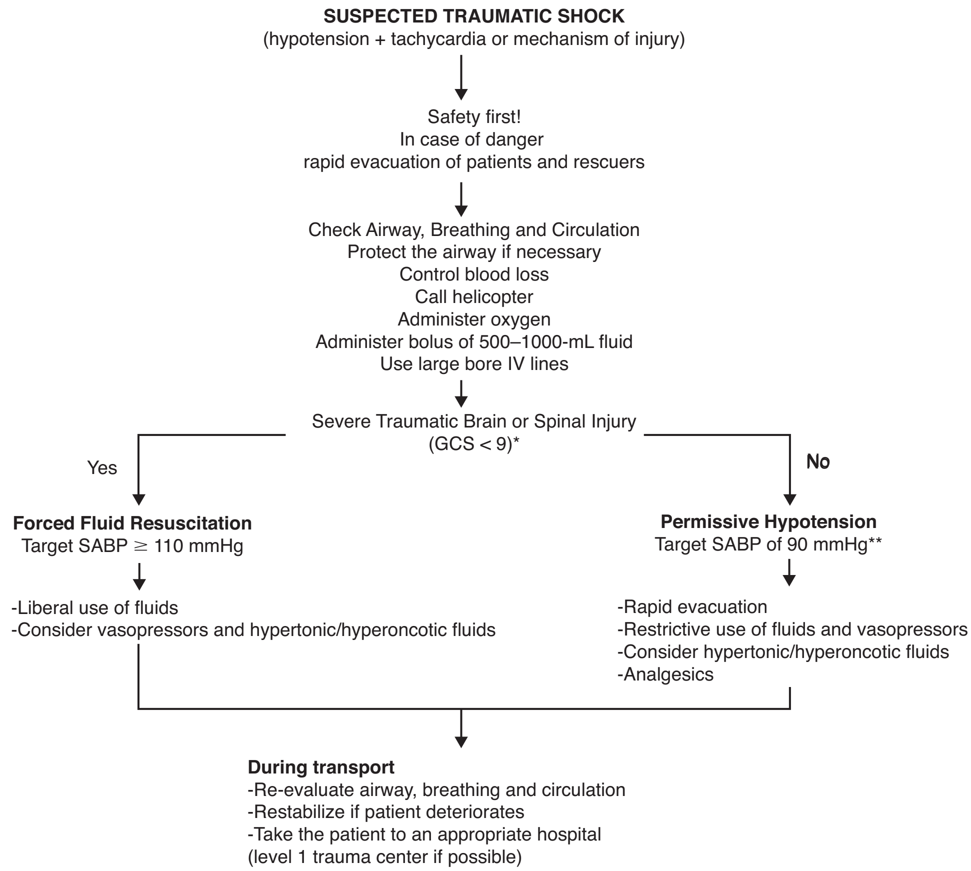

FIG. 1. A protocol for the prehospital management of patients in traumatic shock with or without brain or spinal injury in mountainous terrain and remote areas. * Impairment of consciousness does not necessarily indicate severe TBI in a shock patient; hypoxia, tension pneumothorax, cardiac dysfunction and hypothermia should be excluded. ** If uncontrolled hemorrhage is suspected lower values maintaining consciousness and/or palpable central pulses may be reasonable. GCS = Glasgow Coma Scale; SABP = systolic arterial blood pressure.

lows, first secure the airway and ensure adequate breathing. Stop external bleeding (e.g., by tamponade of a wound or alignment of fractured bone) and start oxygen. Whenever possible, immediately activate HEMS for a rapid evacuation to the nearest trauma center. Insert an intravenous line without markedly delaying evacuation; if this is not possible, intraosseous access can be an easy and safe alternative (Calkins et al., 2000). Fluid resuscitation at the scene should be started with a bolus of 500 to 1000 mL of isotonic fluid; the isotonic fluid of choice is still under debate (Brummel-Ziedins et al., 2006). Further assessment of the GCS for the presence of TBI or for a spinal lesion should be carried out if time permits.

1. If severe TBI or a spinal lesion is suspected, the SABP should be maintained equal or higher than 110 mmHg to ensure adequate central nervous system perfusion. The use of hypertonic and hypertonic/hyperoncotic solutions may be an option to achieve a rapid elevation of blood pressure and an improvement in hemodynamics. These solutions should be administered at a dose of 4 mL/kg as an infusion over 10 to 20 min, rather than as rapid bolus (Gemma et al., 1996; Anderson et al., 1997; Mauritz et al., 2002; Schimetta et al., 2002; Soreide and Deakin, 2005; Dubick et al., 2006). One infusion bag of 250 mL is sufficient for one patient and can easily be carried during terrestrial and cave rescues. Pressure infusion may be used to aid the fast administration of additional fluids. Adding catecholamines may be advantageous to using fluids only (Raedler et al., 2004; Voelckel et al., 2004; Krismer et al., 2006). The prognosis for patients with TBI and traumatic shock during HEMS missions may be similar to that for urban EMS, but will deteriorate in terrestrial mountain rescue missions.
2. If TBI is absent, we recommend that the initial prehospital fluid administration should be targeted at achieving a SABP of 90 mmHg. If uncontrolled hemorrhage is suspected, acceptance of even lower SABP values so as to just maintain consciousness and/or palpable central pulses (SABP $>$60 mmHg) may be a reasonable option. Once intravenous or intraosseous access has been achieved, adequate analgesia should be strongly considered as it may reduce the untoward effects of excessive sympathetic stimulation (Terkelsen et al., 2005) and hasten evacuation.

During the transportation phase, airway, breathing, and circulation should be reassessed and restabilized if needed. Ideally, every patient in traumatic shock should be transferred directly to a level 1 trauma center without delay (Härtl et al., 2006; Rainer et al., 2007).

Limitations

The authors are well aware of the poor prognosis for traumatic shock during terrestrial mountain rescue missions, especially in patients with uncontrolled bleeding or TBI; it is unknown whether outcome can be improved by fluid management or vasopressors. Shock management is subject to continuous reevaluation and needs to be individualzed for each patient. Changing to an alternative strategy of fluid resuscitation may be considered during the mission. These recommendations result from a broad expertise on mountain rescue missions by the authors and commission members. They are based on the current state of knowledge and would need to be reviewed as new therapeutic strategies are developed (Raab et al., 2007).

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