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**International Commission for Alpine Rescue  
Commission for Mountain Emergency  
Medicine (ICAR MEDCOM)**

## **Equipment of Medical Backpacks in 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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# Equipment of Medical Backpacks in Mountain Rescue

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## Abstract

Elsensohn, Fidel, Inigo Soteras, Oliver Reisten, John Ellerton, Hermann Brugger, and Peter Paal. Equipment of medical backpacks in mountain rescue. *High Alt. Med. Biol.* 12:343–347.—We conducted a survey of equipment in medical backpacks for mountain rescuers and mountain emergency physicians. The aim was to investigate whether there are standards for medical equipment in mountain rescue organizations associated with the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). A questionnaire was completed by 18 member organizations from 14 countries. Backpacks for first responders are well equipped to manage trauma, but deficiencies in equipment to treat medical emergencies were found. Paramedic and physicians' backpacks were well equipped to provide advanced life support and contained suitable drugs. We recommend that medical backpacks should be equipped in accordance with national laws, the medical emergencies in a given region, and take into account the climate, geography, medical training of rescuers, and funding of the organization. Automated external defibrillator provision should be improved. The effects of temperature on the drugs and equipment should be considered. Standards for training in the use and maintenance of medical tools should be enforced. First responders and physicians should only use familiar tools and drugs.

**Key Words:** Emergency medical service; medical equipment; mountain rescue; prehospital emergency care; backpack

## Introduction

MOUNTAIN RESCUE TEAMS ARE TRAINED to treat patients according to international standards (Anonymous, 2005), but treatment in remote and mountainous areas can be limited by personnel and equipment. In most situations, a medically trained mountain rescuer acts as first responder on Basic Life Support (BLS) level before an emergency physician or a paramedic will provide Advanced Life Support (ALS) treatment. The contents of a medical backpack are determined by many factors, such as national laws, funding, medical training of rescuers, common medical emergencies of a given region, and personal preference. Difficult terrain, harsh weather conditions, and long access and evacuation times require light and space-saving equipment. Backpacks are more in use now than hand-carried bags because they are more comfortable to carry and allow the rescuers' hands to be

free which is important in difficult terrain. Recently, the injury patterns of mountain casualties (Hearns, 2003), the status of mountain rescue services (Brugger et al., 2005), and medical training in mountain rescue (Elsensohn et al., 2009) have been reported. However, neither an overview, nor recommendations exist on which medical equipment should be employed in the treatment of mountain casualties. The purpose of this study was to evaluate the contents of medical backpacks designed for terrestrial missions in mountain rescue organizations associated with the International Commission for Mountain Emergency Medicine (ICAR MEDCOM) and to give recommendations regarding medical equipment.

## Aims and Methods

A standardized questionnaire was distributed and collected in 2006 among ICAR MEDCOM representatives. This

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study analyzed only the contents of medical backpacks and did not ask how frequently technical and medical devices are used. The results and recommendations were discussed among the authors, and presented at the ICAR MEDCOM meetings in Chamonix, France, in October 2008 and in Bansko, Bulgaria, in March 2009. Finally, the ICAR MEDCOM approved the recommendations in Zermatt 2009. Nominal data are given as counts (percentages). Figures were arranged with Excel 2008 (Microsoft, Seattle, WA).

## Results

Eighteen mountain rescue organizations from 14 countries in North America and Europe returned the questionnaire (Table 1). Sixteen organizations provide a special medical backpack for mountain rescuers who are acting as first responders, whilst all 18 organizations provide a special medical backpack for mountain rescue physicians. The contents of the mountain rescuers' medical backpacks are shown in Figure 1. Eight of 16 (50%) backpacks are equipped with oral nitroglycerin, five (33%) contain oral analgesics, but seven (43%) backpacks contain no drugs. Medical equipment in medical backpacks of mountain rescuers is defined by law in two (12%), by internal or national standards in 10 (63%), and by no specific standards in four (25%) organizations.

The contents of the mountain rescue physicians' medical backpacks are shown in Figures 2 and 3. Their content is defined by law in three of 18 (17%), by internal standards in 13 (72%), and by no specific standards in two (11%) organizations. These backpacks always stay with the mountain rescue physician in 12 (67%) organizations, whilst in the remaining six (33%) organizations the backpack is brought to the scene independently of the mountain rescue physician, just in case another physician reaches the scene first. Drugs are provided and maintained by the mountain rescue physician in 13 (72%) organizations.

TABLE 1. MOUNTAIN RESCUE ORGANIZATIONS PARTICIPATING IN THE SURVEY

Country	Organization
Austria	Mountain Rescue Salzburg
Austria	Mountain Rescue Styria
Austria	Mountain Rescue Vorarlberg
Bulgaria	Mountain Rescue Service
Canada	Canadian Ski Patrol
Canada	Canadian Mountain Holidays
Croatia	Mountain Rescue Service
England	Mountain Rescue Council
Germany	Bergwacht
Italy	Corpo Nazionale Soccorso Alpino e Speleologico
Norway	Mountain Rescue Service
Poland	Polish Mountain Rescue (TOPR)
Slovenia	Mountain Rescue Service
Slovakia	HSNS Mountain Rescue Service
Slovakia	HZS Mountain Rescue Service
Spain	Mountain Rescue Service
Switzerland	Kantonale Walliser Rettungsorganisation (KWRO)
United States of America	Mountain Rescue Association (MRA)

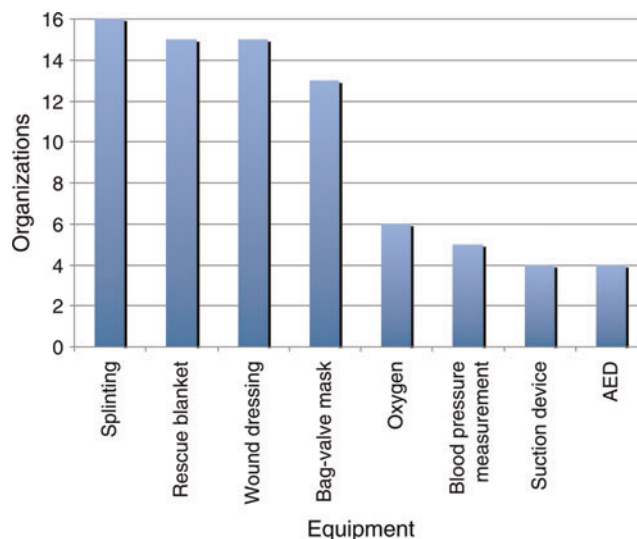


FIG. 1. Medical equipment of first responders' backpacks (organizations  $n=16$ ; chart limited to equipment with  $>1$  item).

## Discussion

In terrestrial rescue, the physician is frequently not the first rescuer on the scene. Trained mountain rescuers, acting as first responders, will perform the initial assessment and maneuvers such as BLS, splinting, wound dressing, and protecting the patient from further heat loss. In some countries these first responders may be paramedics, mountain guides (e.g., in North America) or casualty care certified mountain rescuers (e.g., in United Kingdom) able to give a restricted range of drugs.

In such a circumstance, these drugs may become part of the mountain rescuer's backpack (Arntz et al., 2010; Ellerton, 2006). Thus, most organizations have tailored their medical backpacks into one for trained mountain rescuers and one for physicians. The degree to which these backpacks are complementary, thus avoiding weighty duplication, will depend on the organization's necessities. All monitored medical backpacks for mountain rescuers are equipped with medical equipment for trauma therapy. In contrast, only eight of 16 (50%) organizations provide an Automated External Defibrillator (AED) thus, potentially compromising the management of a primary cardiac arrest. At mass events, rescue missions in frequented ski resorts, or remote villages with long access time for ALS providers an AED may potentially save lives (Elsensohn et al., 2006).

In addition to the mountain rescuers' backpacks, the physicians' medical backpacks have equipment to give oxygen, cannulate a peripheral vein, and administer intravenous fluids. All backpacks for physicians are equipped with ALS material according to the International Liaison Committee On Resuscitation (ILCOR) guidelines (Morrison et al., 2010; Nolan et al., 2010).

Blood pressure measurement devices are part of all backpacks and pulse-oximetry in 13 out of 18 (72%). The additional weight of a blood pressure cuff must be evaluated against other ways of monitoring and clinical findings and the less weight of a pulse oximetry. However, in cases such as traumatic brain injury (TBI) or permissive hypotension treatment

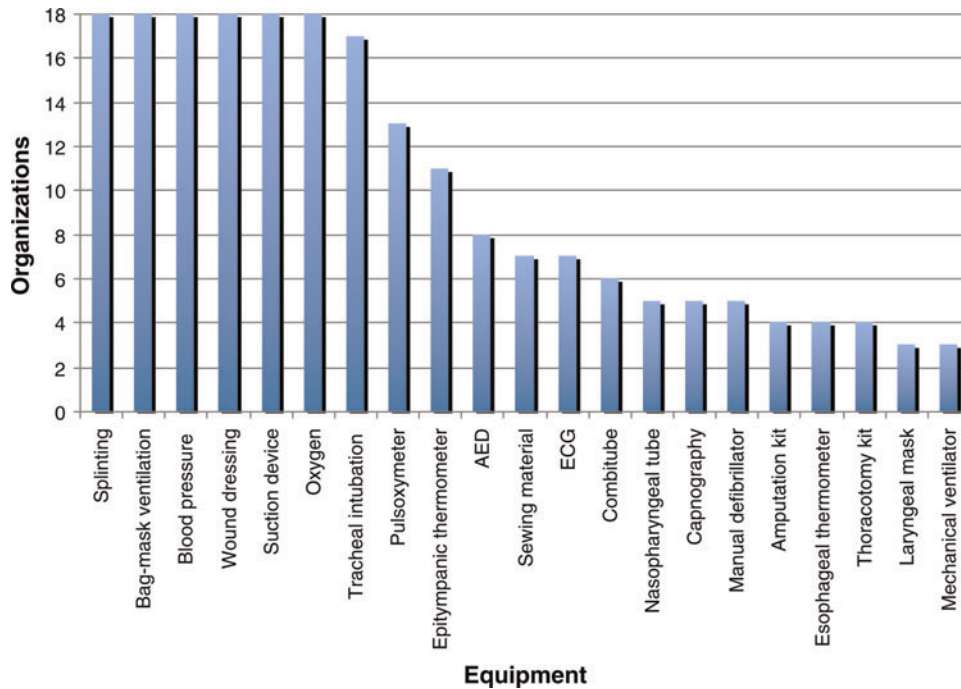


FIG. 2. Medical equipment of physicians' backpacks (organizations  $n=18$ ; chart limited to equipment with >1 item)

(Sumann et al., 2009), accurate blood pressure measurement is mandatory.

Seventeen out of 18 (94%) of the physician's backpacks have equipment for tracheal intubation or a supraglottic airway device (Cook et al., 2006). Mirroring the finding of the rescuers' backpacks, an AED or a manual defibrillator is less frequently part of the equipment (8/18, 44%). An ECG is included only in 7/18 (40%) of physicians' backpacks. A monitoring device with the possibility of defibrillation should be considered to be part of every physicians backpack to detect and immediately treat

arrhythmias or other cardiac dysfunctions. This should also be fact for all medical helicopter operations.

Drugs are limited because of weight and available space. A minimum drug equipment should include acetylic salicylic acid, a strong opioid (e.g., morphine) and nitroglycerin (to treat an acute coronary syndrome) (Arntz et al., 2010); cristalloids/colloids and a vasopressor for shock (Sumann et al., 2009), and ketamine/midazolam for analgesia/sedation during procedures (Bredmose et al., 2009; Ellerton et al., 2009). Hyperosmotic solutions so far did not show improved

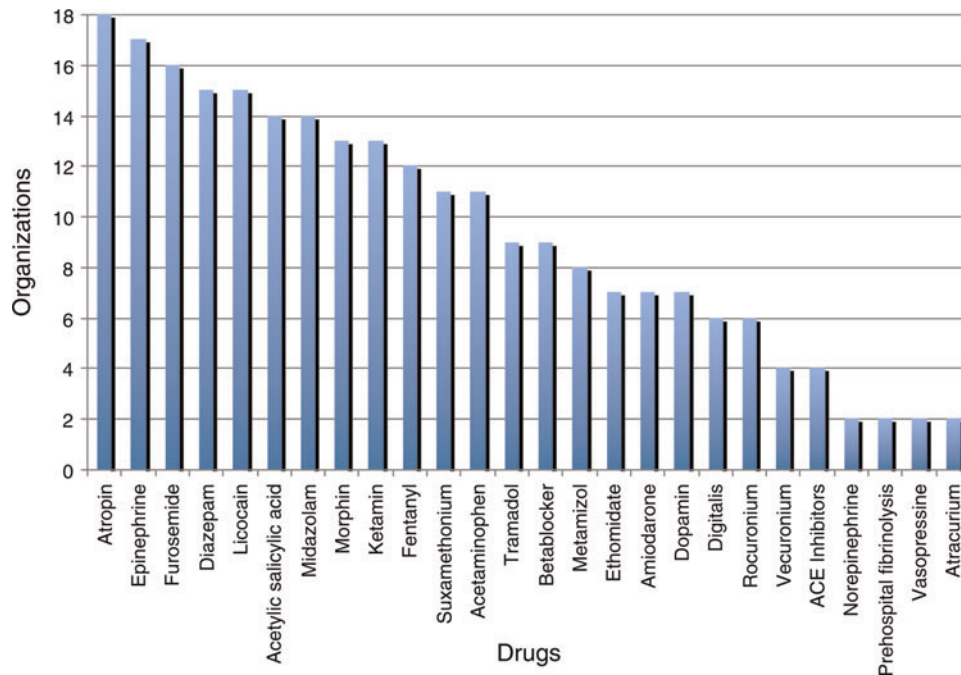


FIG. 3. Drugs in physicians' backpacks (organizations  $n=18$ ; chart limited to equipment with >1 item)

TABLE 2. RECOMMENDATIONS FOR MOUNTAIN RESCUER'S MEDICAL BACKPACK

<i>Drugs</i>	
Drugs	According to national and internal regulations, for example, nonsteroidal anti-inflammatory drugs (e.g., acetylsalicylic acid, diclofenac, ketoprofene), morphine, nitroglycerin
<i>Medical equipment</i>	
I.V. line	Intravenous line set and infusions (e.g., 500 mL crystalloid)
Miscellaneous equipment	Adhesive tape, aluminum blanket, gloves, scissors
Monitoring	Blood pressure measurement, pulse oximetry, epitympanic thermometer
Trauma	Splinting (e.g., cervical collar, SAM splint®, wound dressing)
Ventilation	Bag-valve mask, manual suction device, nasopharyngeal and oropharyngeal tube, oxygen, pocket mask®, Venturi mask

TABLE 3. RECOMMENDATIONS FOR PHYSICIAN'S BACKPACK IN MOUNTAIN RESCUE

<i>Drugs</i>	
Advanced life support	Amiodarone, atropine, epinephrine
Analgesics	Strong opioid (e.g., fentanyl, morphine), ketamine, nonsteroidal anti-inflammatory drug (e.g., diclofenac, ketoprofene)
Sedatives	Ethomidate, midazolam, propofol
Muscle paralytics	Rocuronium, suxamethonium
Cardiovascular drugs	Acetylsalicylic acid, beta-blocker, fibrinolytic, heparin, nitroglycerin, vasopressor (e.g., dopamine, norepinephrine)
Bronchodilators	Beta-agonists (inhalative and i.v.), corticosteroids (inhalative), theophylline
Other drugs	Flumazenil, furosemide, glucose 33% or 40%, H <sub>1</sub> - and H <sub>2</sub> -receptor antagonists, naloxone, corticosteroids (i.v.)
<i>Medical equipment</i>	
I.V. line	Intravenous line set and infusions (e.g., 500 mL crystalloid), hypertonic fluid
Miscellaneous equipment	Adhesive tape, aluminum blanket, gloves, indwelling urinary catheter and bag, scissors
Monitoring	Blood pressure measurement, capnography, electrocardiogram, glucometer, pulse oximetry, stethoscope, thermometer (esophageal and epitympanic)
Trauma	Replantation bag, splinting (e.g., cervical collar, SAM splint®, wound dressing)
Ventilation	Alternative airway device (e.g., laryngeal mask), bag-valve mask, manual suction device, nasopharyngeal and oropharyngeal tube, oxygen, thoracotomy set, tracheal intubation set (plastic laryngoscope scoop preferable with cold weather, Venturi mask)

outcome of traumatic hypovolemic shock and severe TBI (Bulger et al., 2011; Rockswold et al., 2009) but may reduce weight. Also their considerable volume effect may be advantageous in mountain rescue missions (Kreimeier et al., 2002; Nolan, 2001). The storage and operating environmental temperature of equipment and drugs should be considered (Kupper et al., 2006). The specialization of a physician influences the backpack contents in many instances. For example, an anesthesiologist's backpack, when compared to one of a general physician, may contain more advanced airway management equipment, hypnotics, and muscle relaxants.

Oxygen is a universal part when treating patients with medical and trauma emergencies, yet only six of 16 mountain rescuers' backpacks contain it. Frequently, oxygen is in limited supply because of its weight, even when lightweight high-pressure cylinders are used (Ellerton, 2006). Techniques to employ oxygen efficiently such as a Venturi mask with a reservoir (Murphy et al., 2001) or an Oxymizer® ([www.chadtherapeutics.com/usa/Disposable-Conservers/Oxymizer.html](http://www.chadtherapeutics.com/usa/Disposable-Conservers/Oxymizer.html)) allow tailoring the oxygen flow rate to the oxygen saturation as determined by pulse oximetry (Leach et al., 2009).

The weight of backpacks: monitoring devices range from 490 grams (AED with ECG function) and 2100 g for the smallest ECG with complete monitoring functions. Physician's backpacks with all recommended items usually weigh approximately 12 to 20 kg. Backpacks for first responders range from 5 to 8 kg.

### Limitations

One limitation of this study should be mentioned. First, only 14 out of 21 member countries participated in this inquiry. The possibility that the questionnaire did not include all drugs or equipment used by the participating organizations in a defined area should also be mentioned. A responder bias may be inherent to this questionnaire. Generalization of our data may be limited, because not all organizations associated with ICAR MEDCOM participated in this study. According to the aims of this study, adequacy and usefulness of technical medical devices and drugs have not been evaluated as this would be a task of another study. We are not recommending a detailed list of contents as there are no scientific data to evaluate a specific pattern of injuries under special circumstances in a given area. Therefore the recommendations are a consensus of experts.

### Conclusion and Recommendations

In mountain rescue, medical equipment transported to a casualty has to be restricted to the most essential items because weight in helicopter emergency medical services is at a premium or during terrestrial rescues the equipment has to be carried long distances over a prolonged time (Tomazin, 2003). Medical backpacks should be equipped according to national laws, medical emergencies in a given region, climate, geography, medical training of rescuers, and funding. Backpacks for first responders should contain equipment for BLS (Elsensohn et al., 2006; Paal et al., 2007), splinting (Ellerton et al., 2009), wound dressing, blood pressure, and temperature measurement. Recommendations for mountain rescuer's medical backpacks are shown in Table 2. Backpacks for physicians should enable ALS, and treatment of trauma, anaphylaxis, pulmonary edema, and hypertensive urgency. Recommendations for physician's backpack in mountain rescue are shown in Table 3. However, the contents of a physician's and paramedic's back-

pack should be adapted to the skills of a given rescuer. Oxygen, for example, may be the most important drug in AMS; however the weight can exceed manpower and the limited capacity may reduce usefulness. A defibrillator should be considered to be in every physician's backpack. In order to save weight, the physician's backpack should be complementary to the mountain rescuers' medical backpack. Standards for training in the use and maintenance of medical equipment should be enforced (Elsensohn et al., 2009). Mountain rescuers, paramedics, and physicians should only use familiar tools and drugs.

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