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International Commission for Alpine Rescue

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about Medical Standards for Mountain Rescue Operations Using Helicopters

Iztok Tomazin, John Ellerton, Oliver Reisten, Inigo Soteras and Miha Avbelj

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Medical Standards for Mountain Rescue Operations Using Helicopters: Official Consensus Recommendations of the International Commission for Mountain Emergency Medicine (ICAR MEDCOM)*,#

Iztok Tomazin,[1,2,3] John Ellerton,[3,4] Oliver Reisten,[3,5] Inigo Soteras,[3,6] and Miha Avbelj [1,7]

Abstract

Tomazin, Iztok, John Ellerton, Oliver Reisten, Inigo Soteras, and Miha Avbelj. 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.—The purpose of this article is to establish medical recommendations for safe and effective Helicopter Emergency Medical Systems (HEMS) in countries with a dedicated mountain rescue service. A nonsystematic search was undertaken and a consensus among members of International Commission for Mountain Emergency Medicine (ICAR Medcom) was reached. For the severely injured or ill patient, survival depends on approach time and quality of medical treatment by high-level providers. Helicopters can provide significant shortening of the times involved in mountain rescue. Safety is of utmost importance and everything possible should be done to minimize risk. Even in the mountainous environment, the patient should be reached as quickly as possible (optimally < 20 min) and provided with on-site and en-route medical treatment according to international standards. The HEMS unit should be integrated into the Emergency Medical System of the region. All dispatchers should be aware of the specific problems encountered in mountainous areas. The nearest qualified HEMS team to the incident site, regardless of administrative boundaries, should be dispatched. The 'air rescue optimal crew' concept with its flexibility and adaptability of crewmembers ensures that all HEMS tasks can be performed. The helicopter and all equipment should be appropriate for the conditions and specific for mountain related emergencies. These recommendations, agreed by ICAR Medcom, establish recommendations for safe and effective HEMS in mountain rescue.

Introduction

In a medical emergency, access to emergency medical services (EMS) is generally considered a human right, which can be hindered by factors such as unsafe conditions for rescuers. Despite some controversies, in cases of severe injury or illness, delay can compromise recovery or survival (Barrett et al., 2010; Nolan et al., 2010). We believe that grievously ill and injured patients in remote or mountain areas are more endangered than their urban counterparts because of long response and evacuation times, bad weather, cold, dangerous terrain, inadequate equipment, and limited medical training of mountain rescuers. The outcome for an individual can potentially be dramatically improved by bringing rapid rescue and medical care to the accident scene, and by rapidly transporting the casualty to an appropriate medical facility

[1]Mountain Rescue Association of Slovenia, Kranj, Slovenia.
[2]HEMS Slovenia, Kranj, Slovenia.
[3]International Commission for Mountain Emergency Medicine (ICAR Medcom).
[4]Mountain Rescue (England and Wales), Penrith, England.
Department for Anaesthesia and Pre-hospital Emergency Medicine, Kantonspital Olten, Olten, Switzerland.
[6]GEM, Bombers Generalitat Catalunya, Hospital de Puigcerda, Girona, Spain.
[7]ICAR Flight Rescue Commission.
*Intended for use when helicopters are activated for the rescue and treatment of casualties in the mountainous areas: for local authorities, rescue organizations, and helicopter operators.
#This article reflects the consensus of opinion of the International Commission for Mountain Emergency Medicine, which takes full responsibility for the content.

(Isakov, 2009; Trunkey 1995). Two concepts, depending on victim's condition and other circumstances (weather, characteristics of terrain, evacuation times, etc.) are cited: a) "scoop and run" where only minimal pre-hospital care is performed with the goal of having the victim in hospital as soon as possible, and b) "stay and treat" where the doctor or other high-level medical provider, with or without assistants, attempts to stabilize the victim by performing emergency procedures according to guidelines (Davies 1997).

When feasible, deploying a helicopter is appropriate when there is a clear advantage for the casualty over ground rescue and transportation (Frankema et al., 2004; Hotvedt et al., 1996; McVey et al., 2010). We surmise that the advantages of a helicopter emergency medical service (HEMS) that have already been described will be even more pertinent in mountain rescue, as the path to and from the incident site may be dangerous or take many hours (Butler et al., 2010; Thomas, 2007). A helicopter therefore plays a significant part in an effective modern mountain rescue service (Marsigny et al., 1999; Tomazin, 2002).

However, HEMS missions in the mountains are especially challenging and place unique demands on the persons, organizations, and resources involved (Elsensohn, 2002). Many rescuers have lost their lives during rescue attempts. Safety must be the highest priority in mountain rescue. Missions frequently encounter risk factors, such as bad weather and flying at night, known to be associated with higher accident rates (Baker et al., 2006; Elsensohn, 2002; Shimansky, 2008; MRA, 2011). Crashes in darkness, in bad weather, and crashes followed by fire are associated with much higher risk of fatalities (Baker et al., 2006; Isakov, 2006). In order to use the helicopter to its best advantage and minimize risk, all facets of the organization and its staff (including their training) should be optimized wherever possible.

The topography and social geography of mountainous areas around the world differs markedly. Some areas, such as the European Alps, have a sophisticated infrastructure and economy that inter-digitates into the area whilst other areas have huge distances, limited infrastructure, inclement weather, and a sparse population to support EMS. The opportunities to finance a service vary enormously. Tourism is frequently seasonal, resulting in a fluctuating demand. HEMS providers—both the organizations and individuals—have to face these significant challenges. The purpose of this article is to make recommendations on standards for a safe response to medical problems in the mountain environment within countries with a highly developed HEMS system, examples of which can be found in the European Alpine countries. The Commission recognizes that different regions have different rescue and EMS systems, and that the type and availability of helicopters varies widely (Brugger et al., 2005). Countries with less developed systems, including organizations with poor resources to train rescuers and those working in very remote areas or at very high altitude, may have to adapt or deviate from our standards. However, the goal to provide the 'highest level of care available' for that area should be enshrined in the organization and efforts towards improving care to meet, or exceed, standards of the International Commission for Mountain Emergency Medicine (ICAR Medcom) should be ongoing.

Methods

A nonsystematic search for medical literature using the Medline database (last accessed in January 2011) was carried out. In addition, other references relevant to mountain rescue, EMS, and HEMS between 1984 and 2010 were reviewed and discussed among the authors. The draft recommendations were presented and discussed by ICAR Medcom at six meetings between March 2007 and April 2010, and at two joint meetings with ICAR air rescue commission (Chamonix 2008 and Zermatt 2009). The consensus paper was agreed at the ICAR Medcom meeting in Laterns, Austria (April 2010).

Results

The fundamental principles of (H)EMS have been defined by a number of authors; organizational, training, responsibility and cooperation/integration with other service providers are key factors (Earlam, 1997; Fleischmann and Fulde, 2007; Langhelle et al., 2004; Mustalish and Post, 1994; Tomazin and Kovacs, 2003; Trunkey, 1995). Scientific evidence and consensus of experts of the importance of the summary points are detailed in Table 1.

Recommendations

Organization

In mountainous areas, at least one helicopter with a mountain rescue competent crew should be dedicated to HEMS within a region. The service must be licensed by the appropriate national agency and meet all national/international regulations specific to its operations. Policies to address qualifications, certification, training, duty times, and scheduling in accordance with national requirements are recommended, as well as a mission and scope of care statement (EURAMI, 2005). Ideally,

Table 1. Summary of Fundamental Principles

- Safety is most important issue in mountain rescue (Elsensohn, 2002).
- Speed and quality of EMS, including HEMS, in mountains as in other places are often critical factors in a patient's ultimate outcome (Brugger et al., 2001; Brugger et al., 2010; Nolan et al., 2010)
- Cooperation amongst all the involved services, including strategies for dealing with exceptional conditions, is of utmost importance.
- Helicopters performing in mountainous areas should meet technical characteristics for safe and effective rescue work in specific conditions (Tomazin and Kovacs, 2003; ICAR, 2011).
- Rescue and medical equipment should be light, portable and appropriate to the conditions
- Operational HEMS staff must be appropriately trained and able to perform their duties in difficult mountain terrain (UIAA, 2010; ICAR, 2011). They should be available for all missions in the mountains.
- Continuous training and education of all involved personnel are of utmost importance.
- Trying to meet "the golden hour" target from the time of the accident to arriving at an appropriate hospital is a laudable goal (Barrett et al., 2010).

every medical emergency within the region should be reached in less than 20 minutes. Managers of a HEMS unit should have knowledge of the peculiarities of mountain rescue. The appropriate financial model of the organization will depend on the state, but it should not compromise safety nor basic principles that the service is for everyone according to medical and rescue need, regardless of nationality, insurance, or other influences.

Medical director

The unit must have a Medical Director able to give medical direction through quality management, clinical governance, education, and practical HEMS work. For units frequently performing in the mountains, it is desirable that an additional postgraduate qualification, such as the UIAA-ICAR-ISMM Mountain Emergency Medicine diploma, is aspired to (UIAA, 2010). The Medical Director is not expected to be an aviation expert but must understand the important concepts and limitations of helicopters. A key role is to integrate the medical and aviation teams, and ensure that safety issues are given priority. Specific duties of the Medical Director are (EURAMI 2005; Martin, 2006):

- Active participation in the safety program, including drafting and reviewing protocols and standard operating procedures;
- Supervision and evaluation of the quality of medical care;
- Ensure all medical personnel are competent to perform an appropriate level of care.

Duty shifts

The duty shift pattern must be designed to take into account the frequency of incidents, the high stress environment, and its effect on crewmembers. Usually daylight hours will need to be covered; in many instances the workload will allow this to be done as a single shift. If night missions are performed, a second shift is recommended. Facilities should be available for training, pre-mission planning, and rest.

Safety

Exposing flight crew and patients to risk must be outweighed by a tangible benefit for the patient (Isakov, 2006). A HEMS operator should appoint a Safety Officer responsible for a Safety Management System (SMS) to minimize operational risk. Safety could benefit from using standardized 'fly/no-fly' decision protocols, which consider multiple factors for making safe decisions (Baker et al., 2006). Risk assessment and contingency planning for a two-stage evacuation from technical ground (particularly at altitude) or a terrestrial rescue phase have to be incorporated into standard operating procedures. As the weather, darkness, and fire are major determinants of survival after a helicopter crash, it is necessary to improve helicopter equipment and crashworthiness. For example, night vision equipment, energy-absorbing seats, and crash-resistant fuel systems may be of value at reducing risk (Baker et al., 2006). Where other air traffic is anticipated, an aircraft collision avoidance system is recommended.

Integration and cooperation

HEMS operating in the mountains should be integrated within the EMS and other emergency systems of the particular area so as to provide a seamless service irrespective of the emergency (Brugger et al., 2005; Earlam, 1997; Marinangeli et al., 2007; Martin, 2006; Mustalish and Post, 1994; Tomazin and Kovacs, 2003). We suggest that every HEMS organization operating in the mountains follow and contribute to the work of the ICAR Air Rescue Commission and the Commission for Mountain Emergency Medicine. Where appropriate, strategies for cooperation across international boundaries are essential. This can be achieved by joint meetings and training that break down artificial boundaries.

Dispatching

We recommend integrated dispatch centers where all emergency medical and rescue calls are received. Access should be by a widely publicized internationally recognized calling number such as 112 in Europe or 911 in North America (Britvic et al., 2007; ICAR, 2010; Vaardal et al., 2005). All persons dispatching a helicopter should be aware of the specific problems encountered in mountainous or wilderness areas. To make an informed decision on which is the most suitable asset(s) to deploy, the dispatcher should assess all available forms of patient access and transportation (Isakov, 2009; Rhodes et al., 1986; Tomazin, 2002). A computer-based Advanced Medical Priority Dispatch System (AMPDS) and a written checklist, specific to the area, covering available resources, protocols for activation of ground and air rescue units, as well as indications for activating HEMS may be a basis for the decision-making but should not exclude personal knowledge or experience (Ringburg, 2009). The decision to dispatch HEMS should be between the dispatch center and the HEMS team, and should exclude unnecessary bureaucratic steps. A final decision to perform the mission remains with the HEMS team. The nearest qualified HEMS team to the site of the mountain accident, regardless of administrative boundaries, should be dispatched (Tomazin and Kovacs, 2003).

Time

The outcome of severely injured or ill patient, especially in hostile rural or mountain environment, is improved with rapid on-site medical treatment and transport to the nearest appropriate medical facility (Brugger et al., 2001; Elsensohn 2002; Falk et al., 1994; Haegeli et al., 2011; Isakov, 2009; Larsen et al., 1993). With optimal organization and modern helicopters, it is possible to have an activation time (time from emergency call to HEMS take off) of < 5 minutes. From a medical perspective, an approach time (from emergency call to HEMS team reaching the victim) of < 20 minutes is favorable. This is possible for HEMS bases covering a range of ≤ 50 km in diameter. These are ideal goals; a minimal standard should be 'as fast as feasible without compromising safety' (EURAMI, 2005). Safety supersedes medical considerations at all times. Bad weather and night missions frequently have longer activation and approach times because of more demanding flight preparations and slower flying speeds.

Communication

Robust two-way communication between HEMS crewmembers, dispatching centers, other emergency services, and the incident site is essential for safety, efficiency, and medical outcome. All team members should have a personal helmet with an integrated two-way radio headset allowing communication at all times. Crewmembers should be familiar with

the international recognized hand signals as described by the International Civil Aviation Organization and NATO.

Team

All HEMS team members must be qualified and licensed for their work. All members, including medical personnel, should be trained and regarded as members of the air crew, and have leadership qualities in their area of expertise (Fisher et al., 2000; Grissom et al., 2006; Prince and Salas, 1993). Education and training in aspects of mountain rescue and safety, and cooperation with terrestrial teams is essential. This can be achieved by internationally or nationally recognized courses that include the basics of mountaineering, ground and air rescue techniques, and the medical treatment. The operator should ensure medical staff are trained in their safety management system and in crew resource management (EURAMI, 2005; Fisher, 2000; Salas et al., 2006). Initial and refresher training must be established and recorded. Local knowledge is essential if the best use is to be made of available resources. The team must have proper protective and communication equipment and, ideally, be present at the HEMS base ready for immediate activation. As a minimum standard, it may be appropriate, depending on the service, for rescue and medical members to be on call with an appropriate activation time. The team must be able to fulfill the tasks in Table 2. This 'air rescue optimal crew' concept allows for different persons to perform the tasks required, permitting flexibility in crewing depending on the nature and complexity of the mission, and the carrying capacity of the aircraft (Arthur et al., 2005; Campion et al., 1996). Specific criteria and qualifications are recommended for these tasks. It is strongly recommended that medical personnel assess a casualty at the site of the accident except when the terrain is extremely dangerous and beyond the mountaineering competence of the medical crewmember (Martin, 2006;Rammlmair, 2002).

Helicopter

The HEMS helicopter should fulfill the requirements of region's Aviation Authority. Aircraft safety equipment according to international and national standards should be fitted. From the medical perspective, the helicopter must be able to bring the HEMS team to the incident site with all necessary rescue and medical equipment. After stabilizing and packaging the casualty, the helicopter must be able to pick up the casualty and HEMS crewmember(s) from the incident site. Ideally, helicopters performing in mountain rescue should be equipped with a hoist of minimum length of 50 m and capable of carrying two persons. An alternative is a 'fixed rope' ('external load', 'short haul') capability where a human load is slung under the helicopter by a rope with releasable double attachment points (Ellerton and Gilbert, 2010). The main advantages of a hoist compared with a 'fixed rope' (short haul) are versatility and speed, as it is possible to deploy the onboard HEMS team directly to the site of incident, and then recover the team and patient into the helicopter without necessarily landing. Its disadvantages are cost, additional weight, reduced maneuverability of the helicopter, and the possibility of its malfunction. On large steep mountain faces, a technique using a very long (up to 200 meters) fixed rope ('long line') is necessary to reach the victim; special training in this technique is necessary. On board the helicopter, there should be adequate space for performing medical treatment and monitoring (EURAMI, 2005; Martin, 2006; Tomazin and Kovacs, 2003).

Special equipment for search and rescue, and for night rescue work may be appropriate depending on the mission. Ideally, a back-up helicopter should be available during scheduled maintenance or malfunction of the primary helicopter. Where environmental circumstances—such as high altitude, extreme terrain or temperatures—compromise safety, the 'rendezvous' system could be used where a rescue helicopter, performs the technical extrication of the casualty and then, if appropriate, rendezvous with the HEMS helicopter or ground ambulance for onward transfer to hospital.

Medical equipment

The medical equipment should meet national and international standards (EURAMI, 2005). It must be light, portable

Table 2. "Air Rescue Optimal Crewmember' Concept

Task	*Crewmember*	*Qualifications*
Helicopter flying and operation	Pilot & HEMS crewmember	According to relevant local and international regulations and ICAR Air rescue commission recommendations (ICAR, 2011).
Medical	Doctor (preferably an emergency physician), Advanced Life Support (ALS) paramedics, EMT or nurse. Ideally, a BLS-trained EMT, nurse or paramedic should assist the ALS-trained member.	According to relevant regulations and ICAR MEDCOM recommendation no. 3. This includes mountaineering and the ability to perform mountain and helicopter rescue techniques as well as appreciate mountain safety (Rammlmair et al., 2002). A higher qualification in Mountain Emergency Medicine should be aspired to (UIAA, 2010).
Rescue	Mountain rescue specialist or mountain guide trained in mountain rescue. (A minimum of BLS training is required but preferably a higher medical standard should be achieved.)	A high level of experience, knowledge and proficiency in mountaineering, and mountain and helicopter rescue techniques.
Special tasks (Appropriate activation times should be pre-defined.)	Avalanche dog handler, cave rescuers and medical specialty personnel.	Regular education and training in helicopter safety and rescue.

(so as to be brought to the patient), and robust. It must be safely secured during the mission. Diagnostic and therapeutic equipment to perform ALS, relieve pain, and immobilize and splint the patient at the incident site should be available (Ellerton and Gilbert, 2009; Grissom et al., 2006). This should be packaged in ergonomic and compartmentalized medical rucksacks. Martin has published an extensive list of suggested medical equipment (Martin, 2006) and Elsensohn et al. (2011) a survey of medical equipment carried by mountain rescuers and physicians should readers require detailed guidance.

Specialist medical equipment and drugs to manage specific mountain-related emergencies such as hypothermia, altitude illness, or snakebite may be appropriate (Boyd et al., 2007; Durrer, 2003; Gallagher and Hackett, 2004; Plant and Aref-Adib, 2008). The equipment requires regular checking and maintenance to ensure that it is in full working condition. A record should be kept and the crewmember responsible clearly identified; this person is usually an operational crewmember. In specific circumstances, a helicopter without medical equipment may be an alternative (Tomazin and Kovacs, 2003). These include: technical rescue using a hoist, short haul or long-line; transport of rescue specialists (e.g., search dogs and their handlers) and their equipment; evacuation of noninjured persons and those stranded in very remote or at very high altitude where terrestrial rescue is inappropriate.

Rescue equipment

The mountain rescue specialist should guide the team on the appropriate rescue and technical equipment bearing in mind the type of incident, the anticipated forces, and the additional weight for the helicopter. We recommend the following basic rescue equipment in every HEMS performing mountain rescue: climbing rope, a selection of technical climbing equipment (slings, karabiners, anchor devices, etc.), casualty bag and stretcher, and a triangular seat for a hoist evacuation.

Personal/protection equipment

Every regular HEMS member should have their own personal protection equipment and clothing appropriate to environmental conditions. A suitable helmet for tasks inside and outside the helicopter should be used, noting that most aviation helmets do not protect sufficiently against rock fall and block external sound, making them inappropriate for terrain where this may occur. Specific safety equipment is needed in special situations, for example, during avalanche operations (Brugger et al., 2007).

Conclusions

For the severely injured or ill patient, survival in hostile mountain environment is often time dependent and helicopters can significantly shorten mountain rescues. Safety is of utmost importance and everything reasonably possible should be done to minimize risk. The patient should be reached as quickly as possible (optimally < 20 min) and receive on-site medical treatment according to international standards. An integrated, well-organized, and maintained HEMS operating within an EMS, is essential. The air rescue optimal crew concept ensures that all HEMS tasks can be performed by flexible and adaptable crewmembers. This article, agreed by a wide range of mountain rescue medical experts, establishes recommendations for safe and effective HEMS in mountain rescue.

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Address correspondence to:
Iztok Tomazin
Director, Health Center of Trzic
Blejska 10
4290 Trzic,
Slovenia

E-mail: itomazin@siol.net

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