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First Aid and Rescue of a Critically Injured Person at 5,700 m

Erste Hilfe und Rettung eines Schwerverletzten in 5.700 m Höhe

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Summary

- › **Accidents during mountaineering** are special because mountain rescue operations are time-consuming and material-intensive. Since even in Europe it takes a long time for professional help to reach the injured person, first aid regularly has to be provided by the accompanying mountaineers. This case report of a seriously injured person at an altitude of 5,700 m describes the special challenges of such a rescue operation.
- › **After the accident**, the patient has to be moved out of the immediate danger zone to enable examination, treatment must be started and further transport organized. This requires profound training in makeshift mountain rescue techniques, the use of diagnostic algorithms and safe application of medications.
- › **Generally, material and manpower** are very limited in such situations and exhaustion due to the challenging tour is an aggravating factor. Therefore, the group has to look for external help and support at an early stage. For this purpose, efficient communication equipment is required and contacts must already be established.
- › **There is a high level** of emotional stress when treating friends. In order to cope successfully with such a stressful situation, profound education and intensive training, as well as a strategy for external support developed in advance, are necessary.

Zusammenfassung

- › **Die aufwendige und materialintensive Bergrettung** sowie die hohe physische und psychische Belastung für die Bergretter machen Unfälle beim Bergsteigen besonders. Da es selbst in Europa lange Zeit dauert, bis professionelle Hilfe die verletzte Person erreicht, muss die Erstversorgung regelhaft durch die begleitenden Bergsteiger erfolgen. Dieser Case Report beschreibt anhand der Versorgung eines Schwerverletzten in 5.700 m Höhe die besonderen Herausforderungen einer derartigen Rettungsaktion.
- › **Nach dem Unfall** ist es erforderlich, den Patient aus der unmittelbaren Gefahrenzone zu retten und zu untersuchen sowie therapeutische Maßnahmen und die Organisation des weiteren Transports einzuleiten. Dafür ist eine fundierte Ausbildung in behelfsmäßigen Bergrettungstechniken, der Anwendung von Diagnosealgorithmen und die Anwendungssicherheit bei verabreichten Medikamenten erforderlich.
- › **Da es in solchen Notsituationen** immer zu erheblichen Einschränkungen beim zur Verfügung stehenden Material und bei der Manpower kommen wird, muss sich die Gruppe frühzeitig um externe Hilfe und Unterstützung kümmern. Hierfür sind funktionsfähige Kommunikationsmittel erforderlich und es müssen die Kontaktmöglichkeiten gebahnt sein, d. h. z. B. Telefonnummern und Kontaktpersonen bekannt sein.
- › **Nicht zu unterschätzen ist** der hohe emotionale Stress bei der Behandlung von nahe stehenden Personen. Um eine größtmögliche Handlungssicherheit in einer derartigen Situation zu erreichen, ist eine fundierte Ausbildung und intensives Training sowie eine im Vorfeld ausgearbeitete Strategie für externe Unterstützung notwendig.

KEY WORDS:

Mountain Rescue, Traumatic Brain Injury, S-Ketamine, Remote Area, Wilderness Medicine

SCHLÜSSELWÖRTER:

Bergrettung, Schädel-Hirn-Trauma, Ketamin S, fehlende Infrastruktur

Introduction

Despite of all careful attention, accidents occur during mountaineering (see Faulhaber same issue) (10). These accidents are special because, even in Europe, mountain rescue operations are time-consuming and material intensive. The mountain rescuers are exposed to high physical and psychological demands (see Küpper same issue). Another characteristic of accidents in the mountains is the long time it takes for professional help to reach the injured person (6, 10). Therefore, first aid has to be provided at first place by the accompanying mountaineers (10). This case report presents first aid and rescue of a criti-

cally injured person at an altitude of 5,700 m and highlights the special challenges of this kind of rescue operation.

When descending from Huascarán (6,768 m, Peru) on the way down from the so-called "Garganta" to high camp 1, a mountain flank that is endangered by ice falls (at 5,700 m) has to be traversed. Therefore, this section is usually passed without using a rope in order to maintain long safety distances between the mountaineers and not to restrict their mobility. In this area (Figure 1) one of the climber slid and tried to use the ice-axe for self-arrest, which was initially



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successful. However, during this breaking process he fell over a small step of less than 1 m and then slid down an approximately 100 m long snow flank without any reaction until a 7 m deep crevasse stopped him. There he was found after 10 minutes by the expedition leader in an upside-down position with a destroyed climbing helmet. The patient was unconscious and suffered the following injuries:

1. Craniocerebral injury with marked brain swelling
2. Subtotal amputation of the nose with midface injury
3. Tongue bite
4. Bulbus contusion of both eyes with hematoma formation in the area of both sclerae
5. Aspiration of blood in the left lobe of the lung
6. Contusion of the right kidney
7. Several minor wounds on forehead, lip and chin.

After appropriate primary survey and technical preparations the patient was rescued out of the crevasse by the group. On the glacier the patient was still unconscious. He was placed on a platform in recovery position and thermally insulated for further examination (Figure 3). No further injuries were found apart from the head injuries. The patient was vital stable at all times.

Evaluation of the Incident

The accident happened during a military training expedition consisting of 8 highly fit and excellently trained military mountain guides. The incident can be divided into several phases. However, the phases flow into each other and sometimes even run parallel. The altitude profile of the summit day with the subsequent rescue operation is shown in Figure 4.

Phase 0: The Accident

As the visibility was good and the terrain of the snow flank easy to climb, walking without ropes and with large safety distances serves to minimize risks. About 15 minutes before the accident happened, an ice avalanche occurred while the expedition group crossed the snow flank. Due to the large safety distances only one person was directly affected. With a fast sprint this mountaineer was able to cover behind a block of ice and remained uninjured.

When walking with crampons, stumbling can occur. Therefore, all military mountain guides are intensively trained in holding falls in icy terrain with the help of the ice axe in all conceivable body positions. The casualty was well trained too and reflexively used this breaking technique. However, when sliding over a step, he rammed the ice axe into his midface and obviously lost consciousness, which explains the further uncontrolled fall.

Phase 1: Rescue out of the Immediate Danger Zone

The aim of this phase is to extract the patient quickly from the immediate danger zone (crevasse) to enable a full examination and to organize the further transport.

For the rescuers it is crucial to get to the patient quickly in order to get an overview. Fortunately, the crevasse was wide and therefore easily accessible, so that after a short time the expedition leader and a little later the expedition doctor could abseil down to the patient. After a first body check (ABCD-algorithm) and cervical spine immobilization they turned the unconscious patient in an upright position. In case of an obviously severe impact on the head (facial injury, destroyed climbing helmet, high-velocity accident) cervical spine protection is necessary (4, 13).



Figure 1

The place of the accident in 5700 m at Huascarán.



Figure 2

Facial injuries of the patient.



Figure 3

Thermo-insulated patient in recovery position on the glacier.

With the limited resources during mountaineering, the use of a SamSplint® is a good makeshift option to immobilize the cervical spine (9). For the rescue out of the crevasse, the patient was treated with Piritramid (7.5 mg intramuscular) and was monitored by pulse oximetry. Under these circumstances, the application was done intramuscular in the M. vastus medialis directly through the clothing. The rescue out of the crevasse was easy for such an experienced group by using a loose pulley and was done very quickly.

Phase 2: Full Examination of the Patient and Organization of Further Transportation

Further examination was carried out after the rescue out of the crevasse. For this, the patient was placed on a platform that had been dug into the snow (Figure 3). In the mountains, injured persons are threatened by hypothermia, >

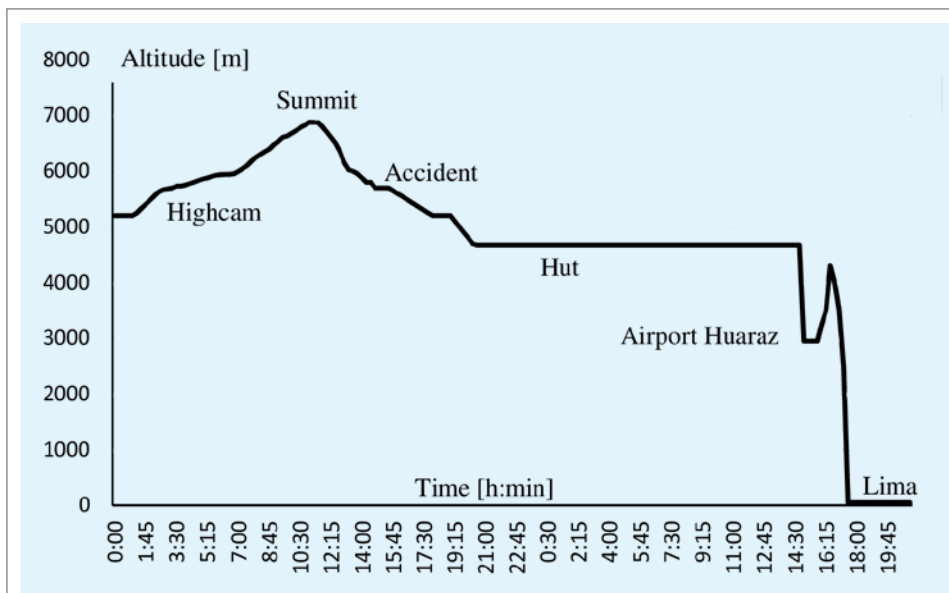


Figure 4

Altitude profile of the summit day with subsequent rescue operation.

therefore maintaining warmth is crucial (2). Backpacks as insulating underlay and down jackets to cover are very suitable for this purpose. It is obvious that a complete undressing of a patient in glaciated terrain is not possible due to the danger of hypothermia. In order not to miss anything essential, standardized examination procedures such as the ATLS (Advanced Trauma Life Support) algorithm are helpful (12). Respiration was affected by the injuries, but still sufficient. Fortunately, the bleeding from the facial wounds was moderate.

For the evaluation of consciousness the Glasgow Coma Scale (GCS) is common. The patient had a GCS of 8-7 (Eyes open: no response=1; Best motor response: withdraw=4; Best verbal response: Inappropriate words/sounds=3-2). By definition, a patient in this condition has a severe craniocerebral trauma and the airway should be secured by endotracheal intubation in order to prevent aspiration (1). However, this is not feasible under the given circumstances, as an anesthesia cannot be maintained.

The victim was located in difficult terrain above 5,500 m and the nearest rudimentary infrastructure was camp 1 more than 300 m below. All group members were exhausted after a strenuous climb at extreme altitude of more than 14 hours. It was already 3 pm, 3 hours before getting dark. A helicopter rescue is not possible at this altitude in Peru. Therefore, the patient had to be evacuated using improvised mountain rescue techniques. He was abseiled over several sections and transported secured by ropes over two larger crevasses. High camp 1 at 5,200 m was reached with the onset of the night. There the patient was put into a tent on a thermal mat and was rewarmed using a modified Hibler pack (5).

For analgesia during the difficult and demanding transport to camp 1 and further down to the hut the patient received Piriramid 7.5 mg intramuscular and repetitive S-Ketamine 20 mg orally. Orally the dose of S-Ketamine is 2.4 times higher than intravenously, a steady state is reached after 3 administrations. (3) S-Ketamine has several advantages in remote areas:

- It does not affect the respiratory drive and the hemodynamic stability. (7)
- It is temperature insensitive in the range from -15 to +40 °C. (8)
- It has a wide therapeutic range and can be administered in all conceivable ways. (8,11)

Phase 3: Secure Infrastructure and Organization of External Support

Parallel to the transportation of the patient to camp 1, one of the expedition members went down to a hut at 4,600 m to get help. In addition, he informed the German embassy in Lima to organize the further rescue. While waiting in camp 1 for the helpers from the hut, the patient became conditionally responsive and received a broad-spectrum antibiotic (Tavanic 500 mg) orally. From camp 1 the way further down to the hut is technically easy and with the help of volunteers (mountaineers without any special medical skills) who had rushed to the site and had brought a stretcher, the transportation of the patient was fast and unremarkable. After arrival there,

a complete body check was done without further findings. The patient was continuously monitored by pulse oximetry. He gradually improved and was able to go to the toilet with assistance. Due to the tongue injury with massive swelling, breathing had to be done mainly via the wound in the sub-totally amputated nose area. The associated pain required the repeated administration of Piriramid, which in each case led to an increase in oxygen saturation through improved ventilation. This point deserves special attention. Often, there is a pronounced fear among practitioners regarding the respiratory depressive effect of opiates, especially with regard to Piriramid. In this specific case, the pain-related respiratory insufficiency of the patient was successfully treated with opiates.

The next day, the patient and the expedition doctor were taken by a military helicopter that had been organized by the German embassy to Huaraz airfield, where an ambulance jet with an emergency physician was already waiting. The further transport to Lima took place immediately. At Lima airport, they were picked up by an ambulance with the medical officer of the German embassy onboard and brought them to a hospital of European standard. 28 hours after the accident, the patient arrived there at the intensive care unit. After a detailed handover and physical examination, CT scans of brain / facial skull, cervical spine, thorax and abdomen were performed immediately. In addition to the external injuries, a marked cerebral edema, an aspiration in the lower left lung lobe and a small hematoma in the area of the upper pole of the right kidney were found. An ENT doctor and an ophthalmologist were consulted and all wounds, especially the nasal wound, were treated plastic-surgically. On the following day the patient was extubated and spent 2 more days in the intensive care unit before he was repatriated to Germany by a medevac airplane.

In Germany he was admitted to the military hospital. During the rehabilitation process only a superficial correction of scars was necessary. The patient has fully recovered and is fully operational as a soldier of the Special Forces.

Special Aspects of Emergency Care in Remote Areas

Based on this case report, several special aspects of emergency care in remote areas can be identified.

The Self-Reliant Group with Limited Equipment

In remote areas no external support is available most of the times, but the initial treatment of a patient is of crucial importance (6). Personnel resources of the group are always limited and mostly physical exhaustion is an additional compromising factor, as it was in this case after 14 hours of climbing at extreme altitude. Therefore, it is essential to get help, even if a person has to be delegated for this (get help at the hut).

The equipment is limited, too (6). Especially during the summit day only very limited medical equipment can be carried. In case of an emergency, improvisation will be necessary (6). A good example are the stretchers that are too bulky to carry, but a makeshift stretcher can easily be built out of two backpacks. It is therefore essential that the whole group is familiar and well trained in the procedures of improvised rescue techniques and treatment of injured persons. Intensive practice beforehand is therefore essential. All participants of the described expedition were military mountain guides and well trained.

Communication

Closely related to the previous point is the communication for getting support. This presupposes that suitable devices for communication (e.g. a satellite telephone) are available and their energy supply is guaranteed. In addition, necessary telephone numbers (e.g. of the embassy) must be available and ideally the person calling should be known there. Since a military training expedition is registered via the embassy, this was assured in the presented case. For commercial expeditions the organizer has usually the appropriate contacts. Individual tourists should plan a suitable strategy in advance.

High Emotional Stress

The person to be cared for is not an abstract patient, but a good acquaintance or even a friend with whom one has been traveling for a long time. This generates stress and makes the medical care demanding. In addition, physical exhaustion caused by the long tour may impair the own performance. As man-power is restricted, nobody can take special care of an accompanying physician. Therefore, everybody must be able to operate independently in the alpine terrain.

Treatment algorithms help not to miss anything relevant. The personal safety in handling a drug or a medical procedure is a very decisive point as well. Therefore, medication should be used that is well known and with which one is confident and familiar.

Conclusion

Every emergency is different and can therefore never be exactly anticipated. In remote areas, however, a worst-case scenario must always be assumed. Therefore, a group must be able to organize the first aid of an injured person and his transport out of the danger zone on their own without (professional) help. This requires intensive training considering the limited resources available. This necessarily includes a strategy how to get support in the respective situation

Conflict of Interest

The authors have no conflict of interest.

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