CONCEPTS

From Matterhorn to Mt Everest: Empowering Rescuers and Improving Medical Care in Nepal

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This article describes a private initiative in which professional Swiss rescuers, based at the foot of the Matterhorn, trained Nepalese colleagues in advanced high altitude helicopter rescue and medical care techniques. What started as a limited program focused on mountain safety has rapidly developed into a comprehensive project to improve rescue and medical care in the Mt Everest area for both foreign travelers and the local Nepalese people.

Key words: wilderness medicine, emergency medicine, rescue work, public health

Introduction

Until 2009, a rescue system for expedition members in the region of the highest mountain on Earth had very limited possibilities: Medical care at high altitude was insufficient in terms of response time, operations, equipment, and medical expertise. The initial focus of the initiative was to improve the rescue system in the Everest region by training Nepalese helicopter pilots and rescuers to undertake rescue missions for tourists, local guides, and porters. In collaboration with a Swiss nongovernmental organization, a program of medical training for the rescuers was added to the technical and operational training.

Unfortunately, the challenges facing Nepalese healthcare providers rival the scale of Mt Everest. Nepal is a large, developing country with extraordinarily difficult terrain that limits efforts to provide medical aid for its inhabitants. It was soon realized that further development of a local rescue system was necessary to ensure durable change and sustainable operations for the Nepalese. This program has established a local rescue chain in the Khumbu region. In the near future, helicopter-based primary care teams will extend medical aid to even very remote areas.

Mortality in High and Extreme Altitude

In 2008, Firth et al¹ published a retrospective study on the mortality on Sagarmatha (Mt Everest) between 1921

and 2006. During the study period, 125 of 8030 climbers and 67 of 6108 Sherpas died, meaning 1.6% of all climbers and 1.1% of Sherpas climbing above base camp did not return home. The mortality rate on Mt Everest is remarkably higher than on Denali (Alaska, 6194 m) with 0.03% or Cho Oyu (Tibet, 8201 m) with 0.65% mortality.¹ Although Sherpas often died because of objective hazards at lower altitude (eg, falling ice), most other climbers died after symptoms of the high altitude–related health problems HACE (high altitude cerebral edema) and HAPE (high altitude pulmonary edema), often during descent. Making note of the difficulties of rescuing climbers and their employees, the authors write: “...The difficulty of rescues at extreme altitude undoubtedly increases mortality compared with lower altitude, but this does not cause the primary problems leading to the need for rescue....”¹

Since the 1990s, the numbers of expeditions and climbers to Everest have increased. Additionally, the traditional approach, in which local porters—often synonymously called Sherpas—only climbed up to relatively safe base camps, has changed. Local porters and guides now routinely work above base camp, and so are placed at much higher risk of injury or high altitude illness. Despite this progressive crowding, the odds of death have not increased linearly. This has been attributed to improvements in logistics and extended experience for that specific peak.² Climbers recognized the need for a professional rescue system, and in the 1990s, private helicopter companies started to conduct independent rescue missions.

Conflict of interest: The authors declare no conflict of interest.

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International Help for Helicopter Rescues in Nepal

Switzerland has a long tradition of mountain rescue, especially helicopter missions at altitudes higher than 4000 m. Swiss climbers were among the first explorers of the Himalaya, and so it came as no surprise when Swiss rescuers were engaged to help their Nepalese colleagues establish a rescue system in the mountains. In 2009, pilots and rescuers from Air Zermatt, a private Swiss helicopter rescue organization, initiated a project to train Nepalese people to undertake helicopter missions in Nepal. Despite a setback in 2010, when a Nepalese pilot and a rescuer died during a rescue mission on Ama Dablam, the project has trained 2 pilots and 4 rescuers to date. In 2011, a Swiss pilot and rescuer received the Heroism Award for the highest rescue ever at 7000 m in the Annapurna region. Until 2012, the rescues were purely technical (ie, mechanically difficult rescues), and training in prehospital medical care (ie, trauma care, high altitude–related health problems, or hypothermia) was not provided. However, long prehospital transportation times without medical care pose a significant risk of deterioration to the rescued patient. It became evident that the rescuers, and possibly the pilots, should receive basic medical training to be able to handle the most urgent and important medical emergencies that might arise during rescue and transport. Bearing in mind that most of the rescuers have very limited medical knowledge, medical educators and experts in mountain rescue and mountain medicine from Nepal, the United States, and Switzerland developed a curriculum that met these needs. Rescuers would be taught simple and safe methods that should prevent further harm to patients, and stabilize or even improve their condition, until they could be handed over to a hospital-based medical team. The [Table](#) shows the core elements of the curriculum. The practical training started in autumn 2012, when 4 Nepalese rescuers came to Zermatt and were trained beside the Matterhorn by a Swiss pilot, a mountain guide, and an emergency physician and educator.

Collaboration With Pasang Lhamu Nicole Niquille Hospital in Lukla

This program proved so successful that it has rapidly changed the referral pattern from the Everest region. Traditionally, patients evacuated by helicopter from the Everest region have almost inevitably bypassed local hospitals and been flown to far distant Kathmandu. In spring 2012, as rescue teams with Swiss instructors became familiar with the helipad and capabilities of the local Pasang Lhamu Nicole Niquille (PLNN) Hospital in Lukla (2850 m, Khumbu), this hospital was unexpectedly confronted with a surge of more than 20 patients

arriving from high altitude areas by helicopter. Lukla is the entrance port for the Everest region from the Nepalese side. Its local hospital, founded by the Nepalese Pasang Lhamu Foundation and the Swiss Nicole Niquille Foundation, opened in 2005 and mainly covers the medical needs of the local community. Tourists were rarely seen as patients because most of the medical problems of trekkers and members of expeditions occur at elevations above Lukla. The patients who were flown to the hospital—often without prior announcement to the hospital staff—were frequently severely injured or showed signs of late stages of HACE or HAPE (based on the mission report 2012 by Dr Hanna Gubler, a Swiss expatriate, to the Nicole Niquille Foundation). The medical team struggled to establish a quick triage to decide who could be treated in the local hospital in Lukla and who should be evacuated to a larger hospital in Katmandu. The Nepalese physicians working in Lukla at that time were very experienced general practitioners but had not been trained in medical emergencies secondary to high altitude exposure. Medical training in mountain rescue for the hospital staff and basic medical training for the mountain rescuers would have aided the decision making for these emergencies and facilitated the process of handovers and shared responsibilities. This process was further complicated by a lack of shared training: the helicopter teams and the nurses and physicians from the PLNN Hospital did not know each other and were not aware of each other's operational abilities and needs. A first step to improve the shared knowledge was made in spring 2013 by giving joint medical training for the helicopter rescuers and the medical staff of the PLNN Hospital in Lukla. This continuing education program focuses on high altitude–related health problems, hypothermia, and freezing injuries, as well as traumatology. Additionally, the hospital staff learns how to quickly and safely interact with the rescue helicopter during the landing at the helipad. The idea behind this joint training was not only to improve the competencies of all the participants but also to develop a small and local rescue chain from the mountains to the hospital. A communication system between the helicopter and the hospital was established by using the tower of the local airport in Lukla to alert the hospital staff before the helicopter arrives with a patient. In the future, one of the big challenges will be to improve this chain of survival by achieving and maintaining the technical and medical competency of the rescue teams, while providing the optimal care to the rescued patients in the local hospitals and ensuring optimal communication between the involved parties. As the hospital in Lukla is a small facility with limited resources and competencies, another challenge will be to establish good

Table. Content of medical training for rescuers in Nepal*Basic module*

Self-protection	Danger of communicable diseases
Analgesia	Immobilization techniques: splinting, stretchers, mattresses, other devices (KED)
Patient check	Introduction to ABCDE
	Application of oxygen with different devices
	Position of the patient with circulatory instability
Trauma	Fractures and dislocations
Hypothermia and frostbite	Evaluation, therapy of minor problems
Altitude-related health problems	HACE and HAPE
CPR	Provide cardiac compression and ventilation via pocket mask
	Decision making for stopping CPR
Advanced module	
Drug therapy	Essential medicaments for analgesia (paracetamol), frostbite (NSAID), and HAPE or HACE (nifedipine, dexamethasone)
Medical problems	Cough and asthma, abdominal pain (appendicitis), confusion and seizures
Vital problems in trauma	Thoracic trauma including tension pneumothorax with needle decompression
	Hemorrhage: stop the bleeding, direct compression
	Special pelvic fractures: application of pelvic binder
	Traumatic brain injury: position of the patient, importance of oxygenation and circulatory stability

ABCDE, airway, breathing, circulation, disability, exposure; CPR, cardiopulmonary resuscitation; HACE, high altitude cerebral edema; HAPE, high altitude pulmonary edema; NSAID, non-steroidal anti-inflammatory drugs.

tools for decision making on when to transport a patient directly to Katmandu. To improve the medical competencies in emergency medicine, the directors of the PLNN Hospital are ready to engage an emergency physician from a Western country to reinforce the medical staff during the tourist seasons in spring and fall. The helicopter rescuers additionally will need the competence to decide either to fly directly to the capital or first to bring the patient to Lukla where they can be stabilized and then further be transported to Katmandu if indicated. As this is a very challenging task even for experienced emergency physicians, systems like an emergency physician who is on call for direct contact with the rescuers might be a solution for the near future.

Humanitarian Aid by Helicopter for the Nepalese Community in Remote Areas

The training of Nepalese professionals to provide quick and safe help for climbers and their Nepalese employees and the development of a local rescue chain in the Khumbu region is only one side of the Swiss initiative in Nepal. Nepal is notably medically underdeveloped. According to World Health Organization (WHO) statistics, Nepal's infant mortality in 2010 was 41/1000 live births, the probability of dying by age 5 is 50/1000, and tuberculosis incidence is 163/100,000 population per year.³ Many remote valleys all over the country still

lack basic medical supplies. Therefore, a parallel project was developed to focus on the needs of the local Nepalese people by transporting a medical team via helicopter to remote, underserved villages lying in the perimeter of Lukla hospital. According to the official data from the Solukhumbu district in 2006–2007 more than 119,000 people live in this region. Almost 17,000 are younger than 5 years, and 10% of the children are declared malnourished. Eighty-six percent of the deliveries take place at home without the assistance of trained health staff. According to records from the 2 hospitals in Phaplu and Khunde, 3 of 118 deliveries were stillbirth, and 2 newborns weighed less than 2.5 kg. This shows that even in the regions with existing health facilities, there is a need for basic medical support. The medical team from the Lukla hospital will be transported by helicopter to the prior defined villages and stay for 2 to 4 days in these valleys with minimal access to health facilities. In addition to providing general medical aid, the team (usually a physician and a nurse or health worker) will also conduct the national vaccination program. This project currently is in development and conducted in close collaboration with the district health office of the Solu Khumbu. The first took place in December 2013. A medical team of 2 experienced Nepalese general practitioners with vast experience in medical aid for remote areas and 2 nurses from Lukla Hospital were flown to Bung, a small village in the

Khumbu valley. They established a medical camp for 2 days and saw more than 700 patients. After this the helicopter brought them back to Lukla hospital. To ascertain the highest safety standards, only pilots who have been trained by the Alpine Rescue Foundation (ARF) are accepted to fly the medical staff.

Challenges and Limitations

Since its beginning in 2009 the project has rapidly developed: What started as a very small local initiative to train Nepalese pilots and rescuers has not only gained international interest but also led to the development of 2 other projects integrating a local primary care facility and a project to bring basic medical aid to Nepalese people living in remote areas.

At the beginning, the instructors from Switzerland started to train Nepalese helicopter pilots with limited experience in high altitude and especially in the transport of external cargo. After the departure of the Swiss trainers, a Nepalese helicopter crew suffered a fatal accident at Ama Dablam in 2010. To further bolster critical skills, Nepalese rescue pilots are now regularly trained in Nepal and in Switzerland to increase their flight hours and the special techniques for so-called human external cargo, a common operation used to rescue people when the helicopter cannot land. Moreover they routinely work for commercial missions in Nepal and improve their skills in sling operations for normal external cargo.

When it became evident that rescues in very high altitude were possible, the interest to be active in this field rose. Already existing helicopter companies started to run rescues, and new companies appeared. As the pilots and rescuers started to change the helicopter company they worked with, the Swiss program was confronted with the question whether to keep the contact with the company or the already trained. It was decided in this situation to follow pilots and rescuers who had received prior training, wherever they would work. This proved to be a successful step; one of the pilots and one of the rescuers are now the core team in Nepal and have started to recruit new people for future trainings.

There are other projects in Nepal covering similar aspects in mountain rescue, and efforts were undertaken to bring all involved parties together. In the last 3 years, courses in mountain medicine for physicians have been organized with the help of an international team of experts in mountain medicine as instructors. The participants can be awarded the International Diploma in Mountain Medicine of the 3 most important organizations involved in mountain rescue and mountain medicine, the International Commission of Alpine Rescue (ICAR), the Union Internationale des Associations d'Alpinisme (UIAA), and

the International Society in Mountain Medicine (ISMM). Other projects supported by mountaineering organizations from Western countries focus on terrestrial rescues. As it is difficult to keep an overview of all the projects, there is a need to coordinate them to avoid idle time and overlapping: At the International Congress in Mountain Medicine 2014 of the ISMM, a full day is dedicated to the activities of rescue organizations and groups in Nepal, and in the ICAR representatives of the different projects are regularly updating their information.

Another challenge is the medical competency of the rescuers and the medical staff of the PLNN Hospital. Even for very experienced emergency physicians, the decision making in the prehospital setting is difficult, and the PLNN Hospital is a facility with limited resources—although the standard of care is comparable with a small rural hospital in Western countries. The medical staff comprises experienced generalists as doctors and very experienced nurses with additional competences in obstetrics, emergency medicine, or ophthalmology. The hospital has its own laboratory, and conventional x-rays are routinely done. Therefore, there are situations in which it definitely makes sense to bring patients to Lukla hospital. Patients with mild to moderate symptoms of high altitude-related health problems can be treated in Lukla, and in very serious situations the patient can be stabilized before the flight of almost 1 additional hour to Kathmandu. The integration of experienced emergency physicians from Europe in the Nepalese medical team of the PLNN Hospital during the busy time in spring and fall should enable this rural hospital to provide a simple but safe medical service or first therapy for all patients transported to PLNN Hospital and brings an additional training in emergency medicine for our Nepalese colleagues.

There are still problems to be overcome, including the best methods for the helicopter rescue team to be notified and initiated from the field and how best to direct communication between the rescue team and the attending hospital. These issues need a very deep knowledge and understanding of both cultural and political contingencies. As non-Nepalese we must be cautious in how these strategic and political decisions are approached. We can bring some ideas from Western countries, but the solutions must be found within the Nepalese community. Still, to develop sustainable structures, we are obliged to pursue excellence and long-term quality in our educational efforts. For these ends to be accomplished, we must adopt internationally accepted rules and regulations for training and daily operations, and structure regular visits by former instructors to ensure that these regulations are still followed in the years to come.

All these projects were possible thanks to very generous funding from Western companies and private

persons: The Pasang Lhamu Nicole Niquille Hospital in Lukla has become well known in many parts of Europe, and funding is secured at least for the next 10 years to come. The pioneers from the Air Zermatt set up a foundation called ARF Zermatt and received the necessary funds for the travel of their experts to Nepal and training of Nepalese pilots in Switzerland for at least 5 more years. The new project to improve basic medical aid in very remote areas is based on collaboration between the Nicole Niquille Foundation and the Alpine Rescue Foundation ARF Zermatt. A startup financing plan has been guaranteed by a nongovernmental organization, and the project seems to be very attractive for different media. So the project should gain not only interest but also additional support in Switzerland and other European countries.

Conclusions

The current model of medical aid for developing countries in which Western experts train local providers is more durable and cost-effective than prior systems, which paid for infrastructure and the continued presence of Western experts to provide direct patient care. The Swiss initiative started with the limited aim of training Nepalese pilots and rescuers to conduct high altitude rescue missions. A critical prehospital system now reaches from the glaciers of Everest down to the underserved, isolated communities that surround it. One part of this mission, the training of Nepalese pilots and rescuers to safely undertake rescue missions at the very high altitudes of the Himalaya, is done routinely in Nepal and in Switzerland. By transferring these professional medical rescue skills from Switzerland to Nepal, we aim to improve and maintain the operational,

technical, and medical competence of these rescue teams. With the help of local health professionals, collaboration between them and Nepalese hospital staff should result in the development of a sustainable local chain of survival both in the mountains and in the valleys. Limitations and challenges of the projects are recognized and carefully taken into consideration. By recognizing local needs and nurturing international expertise, collaborators can overcome healthcare obstacles that rival Everest in their scale. The involved people are aware that this project has limited effect for a larger community, but it might serve as a role model for similar initiatives either in different parts of Nepal or in other developing countries with high mountains.

Acknowledgments

Financial support was given by Alpine Rescue Foundation Zermatt by paying wages, travel expenses, and lodging during the instructors' stay in Nepal. Nicole Niquille Foundation paid the medical instructor's travel expenses and lodging during her instruction for the staff of Pasang Lhamu Nicole Niquille Hospital in Lukla, Nepal.

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