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Epidemiology of Alpine Emergencies with Special Regard to the Requirements of Medical Knowledge of Rescue Personnel

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SUMMARY

Objective: Injury patterns in mountain rescue change with new styles of sports coming, and often recommendations for training and equipment of rescue personnel are based on out-dated information. Therefore epidemiology of emergencies in the mountains have to be re-investigated from time to time.

Conclusions: Diagnoses made during alpine rescue operations are not congruent with those expected, especially specific "alpine" ones are missing. We conclude, that this bases on a lack of specific training of the personnel involved (physicians and paramedics), whose education is normally based on standard recommendations for "civilization". This basic education should be completed by a specific training in alpine medicine.

Fig.1: Winch operation of a patient with polytrauma using Alouette III helicopter at the south face of Riffelhorn. Matterhorn in background (Furgg Ridge, Hörnli Ridge, North Face and Zmutt Ridge from left to right).

MATERIAL & METHODS

A total of 2,730 patients and dead persons of alpine rescue operations were analyzed. These operations included two different alpine regions (Oberwallis / Switzerland, n = 1,082; Tirol / Austria, n = 1,649).

Prime parameters of the analysis were diagnosis, severity of the emergency (NACA injury index, Glasgow Coma Scale), cardiopulmonary situation of the patient, and medical treatment.

Statistics were performed with SPSS11.0. Non-parametric tests were performed, P<0.05 was defined as significant

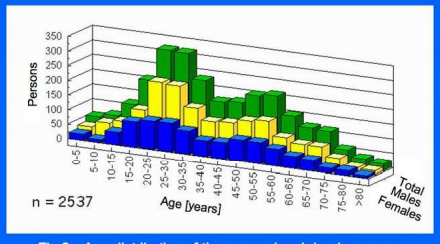

Fig.2: Age distribution of the rescued and dead persons

Fig.3: Severe HAPE + AMS at Marherita Hut (4,560m) with typical X-ray

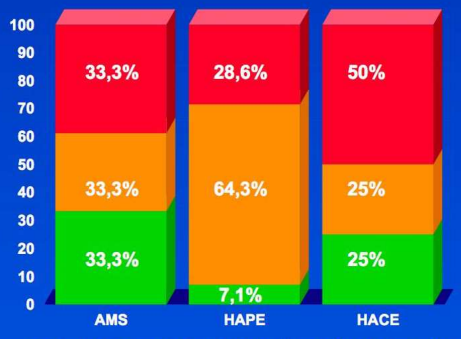

Fig.4: Not diagnosed or false treated altitude-related emergencies

▸ Alarm call	???	>>30 min.!
▸ Alarm - takeoff of helicopter	17,9 +/- 50,6	min.
▸ Approach	10,0 +/- 8,9	min.
▸ Rescue / medical treatment	12,7 +/- 28,8	min.
▸ Winch operation	1,3 +/- 3,3	min.
▸ Flight to hospital	11,5 +/- 11,0	min.
▸ Flight back to base	11,0 +/- 11,5	min.

Tab.1: Time of different parts of rescue operations
Note: Patient and comrades have to manage the emergency for at least 30 min. completly self-sufficient, although Zermatt provides a perfect rescue infrastructure!

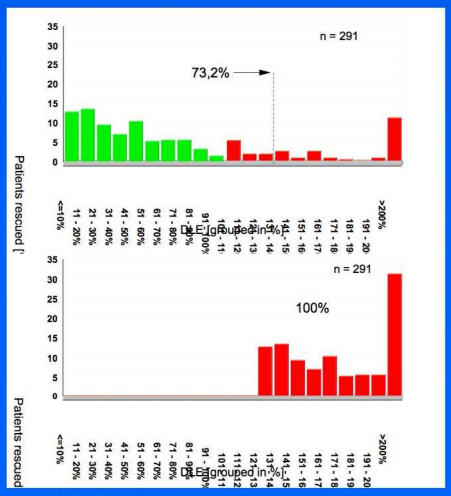

Fig.5: Excess of duration of limited exposure (DLE) (>100% means hypothermic patients)
Summer rescue operations, alarm call with mobile phone (above) or mobile phone missing (below) [3]

RESULTS

Data of 2,537 (92.9% rescued and dead persons were complete and analyzed in detail (Oberwallis = 1003, Tirol = 1534). 87.9% of them were patients, 4.8% were dead, and 3.0% healthy. The age distribution shows two maxima (at 20-30 and 45-55 years, fig.2). There was no significant difference between Tirol and Oberwallis.

In total 4,139 diagnoses were recorded. 72.8% of them were trauma, 16.6% of internal medicine and neurology, most of which concerning cardiocirculatory problems. Typical "alpine" diagnoses (AMS, HAPE, HACE, hypothermia I-III°, frostbite I-III°, exhaustion, sunstroke, heat stroke) were represented in only 3.8% (1% of which were altitude-related problems). Only 2.1% of all diagnoses are recorded as hypothermia (i°: 1.6%; II°: 0.4%; III°: 0.1%). Gyaecological diagnoses were represented in 0.5%. The latter are more frequent than hypoglycaemia (0.3%). 0.5% of patients were boozed, (attempted) suicide was recorded in 0.2%.

Typical „alpine" diagnoses were nearly exclusively recorded from personnel with additional training in (high) altitude medicine. In Tirol were significant more diagnoses per patient recorded than in Oberwallis region (1.7 vs. 1.3; P<0.05).

DISCUSSION

Trauma diagnoses and those in the field of internal medicine and neurology are comparable to those of previous investigations. The problems are mainly the same: breathing insufficiency in case of thorax trauma, the severity of cerebral trauma and of polytrauma are underdiagnosed in a significant number of cases.

To our knowledge this is the first study which also focuses typical "alpine" diagnoses. Here some major deficiencies were detected which should be taken into account for any training before medical staff joins alpine rescue organizations.

A problem of underdiagnosis are altitude-related emergencies: If those cases, where typical symptoms were reported, but neither the diagnosis AMS/HAPE/HACE (fig.3) was done, but the symptoms decreased without therapy except transport down to the valley, are included into the group of altitude diseases, a significant amount of these problems is underdiagnosed or treated not according to state of the art (fig.4).

It is very unlikely that the negligible amount of hypothermia reflects reality in the mountains. A rate of hypothermic patients which is comparable to those with gynaecological problems in the mountains? With the data summarized in [1] and the insulating capacity of typical clothing of mountaineers the maximal exposure time can be estimated. With the total duration of the rescue operations plus the time needed to transmit the alarm call the relation between reality and maximal exposure time can be calculated. Assumed the short rescue times in Zermatt (helicopter based in the centre of the region, tab.1) a significant amount of victims must be assumed to suffer from hypothermia (fig.5). As consequence it can be stated, that a significant part of "cardiocirculatory problems" reported during rescue operation or transport are problems of afterdrop in hypothermic patients, a problem which is not sufficiently recognized by the rescuers.

As consequence of these and other results (for details see [2]) we recommend additional training in altitude and alpine medicine to basic training in First Aid and Emergency Medicine to anybody going to the mountains, but especially for members of alpine rescue organizations. For the latter this should be a "must", because all (!) diagnoses concerning "alpine" problems were done by professionals with such an additional specific training!

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Ice Climbing Injuries

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Introduction: Ice climbing is widely considered to be a hazardous sport with a high risk of injury. To date, there has been no scientific analysis to characterize and reveal the prevalence of injury in this sport. The purpose of this study was to quantify and rate ice climbing injuries.

Methods: 88 ice climbers (water ice!) (13 female, 75 male, mean age 34.6 years) from nine countries completed a complex questionnaire on ice climbing accidents and injuries, climbing frequency and risk behavior. Ice climbing hours were quantified and injuries rated according to the NACA (National Advisory Committee for Aeronautics) and AIS (abbreviated injury) score. To enable comparison to other sports, injury risk was calculated per 1,000 hours of participation in a given sport.

Results: The 88 ice climbers (in average 11 years of ice climbing experience) recorded 21606 ice climbing hours over a three-year period, 121 injuries NACA 1-3 (5 NACA 3, none NACA 4-7) and 15 overuse syndromes (12 NACA 1, 3 NACA 2). The average ice-climbing level was WI 5+ and M 9- (if mixed-climbing was performed). Our calculations from this data found 5.6 injuries NACA 1-3/1000 hours, 1.3 injuries NACA 2-3/1000 hours and 0.23 injuries NACA 3/1000 hours of ice climbing. Overuse syndromes occurred in 0.69/1,000 hours ice climbing.

Injuries

	n	%
Wounds	53	55.2
Haematoma	22	22.9
Frostbite	11	11.5
Fractures	2	2.1
Other	17	17.7

Injury Distribution

	n	%
Head	50	52.1
Finger	17	17.7
Leg	15	15.6
Foot	7	7.3
Arm	6	6.3
Shoulder	4	4.2
Chest	3	3.1
Back	2	2.1
Neck	1	1
Perianal	1	1
Abdomen	0	0
Urogenital	0	0
Other	18	18.8

Cause of Injury

	n	%
Icefall	47	49.0
Technical Mistake	29	30.2
Cold Temperature	5	5.2
Equipment	5	5.2
Rockfall	3	3.1
False belay	1	1
Other	1	1

Sport Injuries per 1000 hours

Sport	Injuries / 1000 hours (Competition/Training)	Literature
Soccer (UEFA Champions League)	31.6 / 3-5	Ekstrand 2006
American Football (German First League	15.7	Axel, Balzer et al. 1998
Handball (male)	14.3 / 0.6	Seil, Rupp et al. 1998
Soccer (female, German First League)	3.1 / 1.4	Becker 2006
Indoor Climbing World Championship	3.1	Schöffl, Küpper 2006
Ice Climbing (NACA 2-3)	1.3	Present study
Mountain biking	1	Gaulrapp, Weber et al. 2001
Skiing, Snowboard	1	Aschauer et al. 2007
Surfing	0.41	Dau et al. 2005
Indoor Climbing	0.027 0.079	Limb 1995 Schöffl, Winkelmann 1999

Conclusion: Contrary to the popular perception, our study demonstrated that ice climbing is not a sport with a high risk of injury. All NACA I injuries are of minor medical relevance (skin abrasions, minor cuts) and would normally not need special treatment or a doctor´s attendance. The results of injury risk per 1000 hours of participation in ice climbing was comparable to that of indoor competition climbing (3.1/1000 hours) and other outdoor sports (hiking, mountain biking, kayaking); the injury risk was also much less than a standard sport e.g. 'soccer' with 30.3/1000 hours injuries in competitions and 6.5/1000 hours in training.

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Review of the Physiological Responses to Rock Climbing in Young Climbers

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BACKGROUND: Key questions regarding the training and physiological qualities required to produce an elite rock climber remain inadequately defined. A paucity of research exists on young climbers.

PURPOSE: To critically review climbing literature alongside relevant literature characterising physiological adaptations in young athletes. Evidence-based recommendations were sought to inform the training of young climbers.

METHOD: From 200 studies on climbing, 50 were selected as being appropriate to this review, and were interpreted alongside large-scale physiological studies highlighting specific common development growth variables in youngsters that were to this review.

RESULTS AND SUMMARY OF FINDINGS:. Isometric and explosive strength improvements are strongly associated with the latter stages of sexual maturation and specific ontogenetic development. Improvement in motor abilities declines at ages closely associated with the second and third stages of sexual maturation. Climbing literature uses chronological age, rather than measures such as Tanner stages, to mark biological or pubertal maturation. It is not known whether selection, intensive training and/or disordered dietary habits can account for limited data on competitive young climbers who were shorter, lighter and with less body fat than athletic controls and normative data. Somatotyping that might identify common physical attributes in elite climbers of any age was incomplete.

- Climbers aged <16 years should not undertake intensive finger strength training and cannot participate in international bouldering competitions.
- As feet grow up to age of 15, wearing constrictive climbing shoes is not recommended to ensure feet reach genetic growth potential, and to prevent foot injuries and deformities
- Growth velocity charts should be sensitively and regularly plotted. If possible, menarche age and cycle details should also be collected. Referral for complete evaluation of underlying pathologies should be undertaken whenever height is in the lower fifth growth percentile or there is a downward trend of growth indices across two major percentile lines.
- The final growth spurt ~ages 13-17 is associated with an increased risk of injuries and physeal fractures.
- The age at which a climber should specialise in climbing is unknown.
- The incidence of spondylolysis has not been documented and warrants investigation.
- Climbers should be educated in the importance of an appropriate diet and timing of this intake for health and performance.
- Prepubescent children have a limited capacity to develop an adaptive metabolic response to specific training, but possess an accelerated ability for motor development. This suggests the emphasis of training should be on climbing an increased volume and diversity of climbing routes to improve fluency and mechanical efficiency of climbing technique, as opposed to increasing intensity.

Left hand of 15-year-old male climber who permanently damaged epiphyseal plate of proximal interphalageal joint of middle finger by continuing intensive finger strength exercises.

With permission from *Hochholzer and Schöffl, 2005*

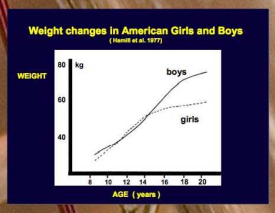
Radiographic image of same middle finger showing 15° rotation of interphalangeal joint that resulted from ulnar deviation

With permission from *Hochholzer and Schöffl, 2005*

X-ray of foot in climbing shoe while standing. Note that the forefoot does not rest on the head of the metacapalia 1 and 5 as normal but on the crimping toes.

With permission from *Schöffl and Winkelmann, 1999*

Feet of high ability climber who wore constrictive climbing shoes for 10 years from the age of 12.



An increased incidence of injuries and physeal fractures co-incides with the final growth spurt around the ages 13-17 when skeletal mass increases almost twofold and 20% of adult final stature is achieved.

CONCLUSION: Accomplished adolescent climbers can now climb identical grades and compete against elite adult climbers aged up to and >40 years. As the implications of a youngster's high-intensity sports training requiring leannes can result in more significantly altered and delayed pubertal and skeletal development, metabolic and neuroendocrine aberrations, and trigger eating disorders, this should be sensitively and regularly monitored. Training should reflect efficacious exercises for a given gender and biological age.

Photograph of competition climber by Steve Gorton.

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Climbing Capabilities and Alpine Emergencies – Minimal Requirements for the Staff Employees of Alpine Rescue Organizations

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SUMMARY

Objective: Effective and safe work during alpine rescue operations need some capabilities in rock and ice climbing (fig.1-3), but the minimal requirements were not yet investigated.

Conclusions: Advanced "alpine experience" is a "must" for any person involved in alpine rescue operations – physicians, too. In absolute extreme terrain there is no need for medical help. Here technical rescue is dominating. Therefore a compromise for minimal alpinistic requirements of medical personnel is as follows: Capability of absolute control of rock climbing UIAA III°, safe climbing (as second) IV° UIAA, absolute control of 50° in ice, safe climbing (as second) of 60°. Special alpine knowledge is a "must" for situations like avalanche rescue.

Fig.1: Site of a winch rescue operation in the „Bergler-Rinne" of Lyskamm north face at about 4,200m: 55°-60°, falling ice and poor ice conditions

MATERIAL & METHODS

A total of 2,731 alpine rescue operations of two regions (Oberwallis / Switzerland, n = 1,082; Tirol / Austria, n = 1,649) were analyzed with special regard to the type of terrain at the site of the accident (easy walking, "off-route hiking", "real alpine climbing"), climbing difficulties (rated by UIAA Scale for rocky terrain and steepness for ice / glacier), and other factors indicating the necessity of so-called "alpine experience" for rescue personnel involved.

Statistics were performed with non-parametric tests. P<0.05 was defined as significant.

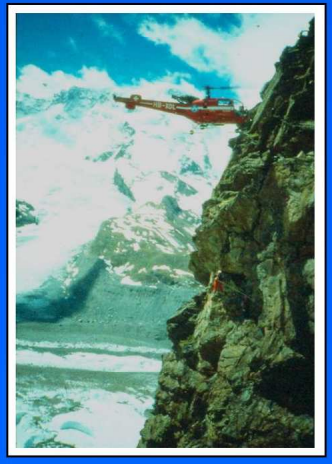

Fig.2: Winch operation with Alouette III helicopter at the south face of Riffelhorn: Direct rescue in overhanging terrain of UIAA grade V+/IV-

Fig.3: Site of a winch rescue operation in the „Schmidt-Route" of Matterhorn north face at about 4,250m: poor conditions in snow-covered rocky terrain of UIAA grade IV

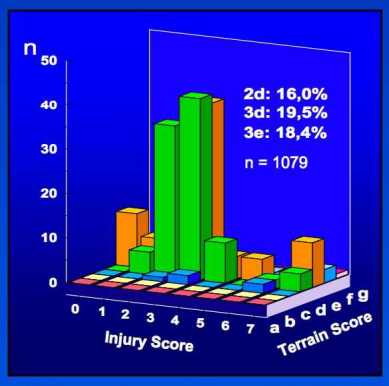

Fig.4: NACA scores of the rescue operations in the Western Alps

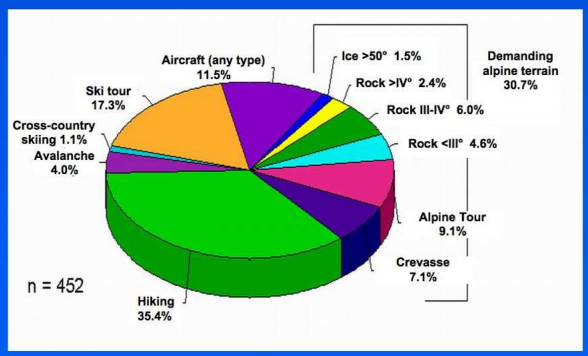

Fig.5: Relative amount of alpine sport/terrain of all rescue operations investigated

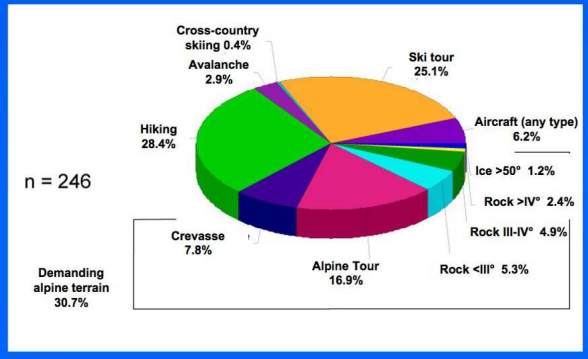

Fig.5: Relative amount of alpine sport/terrain of the rescue operations in the Western Alps

RESULTS

99.7% of the accidents could be analyzed. 62.2% of rescue operations were performed in alpine terrain of – for experienced mountaineers - moderate difficulty (NACA d, e). 5.9% took place in difficult or extreme terrain (NACA f, g).

Compared to the Western Alps there were more difficult operations in the Eastern Alps (78.2% NACA d, e and 2.2% NACA f, g in the west vs. 51.8% / 8.4% in the east), especially caused by a higher amount of rescues in difficult rocky terrain. In contrast there were more ice and alpine tour rescues in the Western Alps, also typical for the terrain.

During summertime there were significant more operations in hard terrain than in winter.
The NACA d – g classes correlate to 7.1% of accidents on steep glaciers, 9.1% high-alpine tours (ridges, walls), 4.6% rock terrain up to III° UIAA, 6,0% rock terrain UIAA III-IV°, 2.4% >IV UIAA, and 1.5% in ice steeper than 50°.

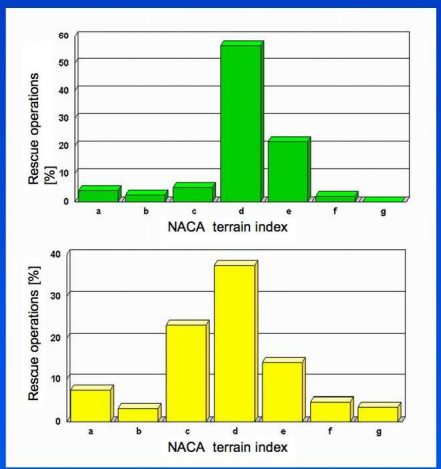

Fig.6: Comparison of terrain index in the Western (green) and Eastern Alps (yellow): The more of demanding terrain for all operations (ski slope, traffic, ocupational accidents included) in the Western
Alps is highly significant (P<0.001)

DISCUSSION

The study presented is the first systematically analysis of the alpinistic demands which must be handled during year-around alpine rescue service. The minimal requirements for the personnel are mainly a question of the security level which shall be provided: If the medical personnel is supposed to handle 90% of the operations safely – also in poor conditions – people involved must be able to climb absolute safe (leading) grade IV UIAA and ice of 50°. Of course, the knowledge of the associated alpine risks and handling rope and knots is a "must" for efficiency and safety.

In terrain harder than mentioned here there wil be no medical treatment at all and it doesn't make sense to recommend requirements, which are fulfilled only by a minority of all alpine rescue personnel. On the other hand these recommendations include any personnel, where the terrain exceeds easy hiking area (NACA c included).

For details of the data and calculations see [1] (english publication in preparation).

Acknowledgements

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