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MEDICAL COMMISSION

MEDICAL ASPECTS IN MOUNTAINEERING

PROCEEDINGS of the UIAA MOUNTAIN MEDICINE CONFERENCE

PRAGUE, CZECHOSLOVAKIA, 20-22 OCTOBER 1988

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Contents

OVERUSE INJURIES IN MOUNTAINEERING

IV. PROBLEMS WITH LABORATORY ASSESSMENT OF A CLIMBERS´ TOLERANCE TO EXTREME HEIGHTS AND POSSIBILITIES OF ON-THE-SPOT TESTING OF THE CLIMBERS´PHYSIOLOGICAL FUNCTIONS

V. PREVENTION OF ACCIDENTS AND TRAINING IN TACKLING EMERGENCY SITUATIONS

WELCOME ADDRESS TO UIAA MEDICAL CONFERENCE IN PRAGUE 21. 10. 1988

Jaromír WOLF; Vice-president of the UIAA

Ladies and Gentlemen,

The first report on the influence of mountain environment on man dates back several thousands years. In Exodus, chapter 34, verse 29-30, we read about the sunburnt skin of Moses's face after having returned from the summit of Mount Sinai (about 9,000 feet), where he spoke with God.

The ingenious theoretical assumption proposed by L. G. Pugh from Medical Research Project into Effects of Altitude of Mexico City 1965 before the Olympic Games 1968, claims that the curves of maximal and submaximal work capacity intersect just at the altitude of the Everest, which suggests that that altitude corresponds to the limit of man's adaptability to lack of oxygen.

The Moses of our time however does not interview God about code of ethics for humanity, but takes a sample of the air of his lungs on the summit of Everest during the American Medical Research Expedition to Everest in October 1981. The significance of this is that the pressure of carbon dioxide in the air of the lungs is essentially the same as that in arterial blood. This in turn reflects the amount of increased breathing done by a climber under the condition of oxygen deficiency, and is a measure of the degree of acclimatization.

In the summer of 1986 nine expeditions with members from all nations converged on K2, the world's second highest mountain. Twenty-seven people climbed K2 and 13 of them died in a period of seven weeks, from June 21st to August 10th, seven of them after having reached the summit. An analysis of this terrible statistics is the subject of the communication of B. L. Holt in our conference. On the other hand that summer on K2 produced other less grim statistics: two outstanding new routes, an incredible 23 hour ascent of Abruzzi Ridge and the first woman's ascent of K2.

Nevertheless these events generated the inevitable media furore, particularly the question of why help had not been organized by other members of these expeditions.

Questions of ethics raised by such statistics are outside the consideration of our surely scientific meeting. There has nevertheless been an evolution of the relation of man to mountain during the period of thousands of years from the mysticism of the second book of Moses to scientific truth and finally back to irrationality of summer 1986 on K2.

Ladies and gentlemen, dear friends. I beg your pardon for my unusual welcome address. I have the pleasure to convey the best regards from the President of UIAA, Dr, Carlo Sganzini, to your Meeting and to wish full success to your Conference.

OPENING ADDRESS

Prof. Paul Bernett, President of the International Society for Mountain Medicine (ISMM)

Ladies and Gentlemen,

as President of the International Society of Mountain Medicine I want to give my best compliments to the participants of this Congress of the Medical Commission of the International Union of Alpinist Associations (UIAA). It is a special pleasure for me to greet Dr. Ivan Rotman, who was elected for Vice President of the ISMM in Davos this year for the coming period.

We would like very much to integrate medicine interested mountaineers in this society. This society is independent, apolitical and has only medical goals. Those goals are to create an international organization of scientific character bringing together physicians, members of paramedical professions and organizations or societies interested in mountain medicine in its widest aspects, further to encourage research, studies, discussion and publications concerning all medical aspects of mountains and to compile scientific and applied documentation.

Also doctors and interested people should be provided in a scientific approach to mountain problems and laboratory research and studies in the field should be encouraged and coordinated, too. Periodically congresses of international character must be organized. Last but not least an international review of mountain medicine will be published.

Thank you for the good organization and your great hospitality. Let me wish you a successful course of the congress.

I. ACCIDENTS AND INJURIES IN MOUNTAINEERING

EPIDEMIOLOGICAL ANALYSIS OF CLIMBERS' INJURIES BASED ON DATA FROM THE RESCUE REPORT REGISTER OF GORSKA SLUZBA SPASAVANJA (MOUNTAIN RESCUE SERVICE) OF THE MOUNTAINEERING ASSOCIATION OF SR CROATIA, YUGOSLAVIA

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Introduction

The Mountain Rescue Service of the Mountaineering Association of Socialistic Republic of Croatia, Yugoslavia, keeps a register of rescue reports on all rescues undertaken or shared in by this service. It contains about 2000 reports. The data from those reports have used to demonstrate a spectrum of climbers' injuries, the most frequent injuries, and also some relevant circumstances of climbing accidents

Material and Methods

The records dated from 1946 to 1985 have been selected for the present analysis. Rescues without injuries (capture by bad weather etc.) have been excluded, as have also rock rescues of non-climbers (suicides, falls in a difficult rocky ground etc.). Data were processed using standard statistical methods.

Result and Discussion

Among all the rescue reports registered 1946-1985, 72 cases involving injuries were found. 47 of them occurred in rock-climbing, while 25 others occurred in snow and ice conditions, including climbs in high mountains of the world. In these 72 cases a total of 123 separate injuries were recorded.

Table 1 shows that the number of injured climbers is increasing. This is a direct reflex of the increasing number of climbers and even more of the increasing number of ascents done.

Table 2 gives the anatomic distribution and frequency of the injuries caused by climbing accidents. It is obvious that the most frequent climbers' injuries are head injuries, followed by injuries of the legs and then the arm.

Table 3 offers a detailed insight into a spectrum and frequency of climbing injuries. Among the head injuries the most frequent was fracture of the basis cranii. The most common leg injuries were fractures of the lower leg. Fracture of the forearm was the most common injury of the upper extremities. One can also see some less frequent but typical injuries, like dental luxation, burns of arms caused by climbing rope etc. A rarity was a case of overnight upside-down hanging with a leg caught in a sling of rope (mentioned as a crush injury of leg) but without any serious head lesion.

Among all these 72 injured people there were 22 fatal cases. Table 4 lists the injuries which caused these deaths. The most frequent was fracture of basis cranii, followed by severe open fractures of the skull and compressions of the brain. Although single, it is worth mentioning was strangulation caused by the entangled rope and slings.

Analysis of the circumstances of fatal accidents (Table 5) shows that in most cases the victim was a solo climber. Other important circumstances were the whole roped-party falls caused by lack of belaying and also falls of the party leader.

The importance of head injuries as the most common climbers" injuries and the most frequent cause of death was the reason for an attempt of indirect evaluation of the efficacy of protective climbing aids, especially the protective helmets. Protective helmets

came into wide use in the mid-sixties in this country. So the period analysed was divided in two sub-periods: before the protective helmet (1946-1965) and after the helmet had been introduced (1966-1985).

Tables 6 and 7 show this correlation based only on rock-climbing injuries, because this type of climbing implies the use of protective aids more than do the winter climbs. It can be seen that in spite of the increase in the number of injured climbers, the number of severe head injuries and also the number of fatal cases decreased both absolutely and relatively. The differences are not statistically significant though, maybe because of the rather small number of cases. If one accepts those differences as real, they might be due to several factors: better climbing skills, improved system of running belays, and also more complete recording, resulting in a greater proportion of the less severe injuries being obtained. The time coincidence of the introduction of helmets and the drop in incidence suggests that this might be a real good consequence of the use of protective helmets.

At the end, an attempt of assessing the risk or probability of a climbing accident involving injury was made. Assuming that the number of ascents which might gravitate towards requiring rescue service was about 10 000 in the last ten years, the risk of a climbing injury turned out to be 3 per 1000 (31:10 000) and the risk of a fatal injury less than 1 per 1000 climbs.

The present analysis showed that a good deal of the severe accidents might have been prevented.

Conclusion

Analysis of climbing injuries showed that the most common climbing injuries were injuries of the head, followed by injuries of the legs and arm injuries. Basis cranii fracture is the main cause of death in climbing. Solo climbing is more dangerous than climbing in a roped party. However, a roped party without proper belaying is also dangerous. The analysed data suggest the importance and usefulness of using the protective helmet. The calculated risk, i.e. probability of a climber´s lethal injury turned to be below 1 per 1000 climbs done.

Table 1.

Injured and dead climbers

Period	Number Injured	Number dead	%
1946 – 1955	10	4	40
1956 – 1965	9	4	44
1966 – 1975	22	6	27
1976 – 1985	31	8	25

(*) hypothermia, mountain sickness etc., see Table 3

Table 2.

Anatomic distribution of injuries

Anatomic region	Number of injuries
Head	42
Legs	26
Arms	17
Spinal column	7
Shoulder girdle	4
Abdomen	4
Thorax	2
Pelvis	1
Undefined (or scattered)	9
Other (*)	12
Total	**72**

Table 3. Review of climbers´ injuries

HEAD	
Fractura basis cranii	11
Fractura cranii	5
Teeth broken	4
Compressio et contusio cerebri	3
Commotio cerebri	2
Wound of the forehead	2
Fracture of mandible	2
Ophtalmia solaris	2
Luxatio bulbi oculi	1
Amputatio of the pinna	1
Nose contusion	1
Other injuries	1
LEGS	
Fractura cruris	14
Wounds of the legs	3
Contusion of the hip	1
Fractura femoris	1
Frostbites/amputations of toes	1
Lower leg contusion	1
Fracture of foot bones	1
Heel contusion	1
Other injuries	3
(1 crush injury)	
ARMS, SHOULDER	
Fractura antebrachii	7
Shoulder contusion	3
Finger fracture	2
Burns (by rope friction)	2
Ruptura ligament acromioclav.	1
Congelatio of arm	1
Other injuries	5
SPINAL COLUMN AND PELVIS	
Spinal column contusion	5
Spinal column fracture	1
Fracture of pelvis	1
TRUNK Inner injuries	4
Wounds of the thorax	2
MULTIPLE INJURIES (UNSPECIFIED)	
Severe multiple injuries	4
Multiple contusions	4
Multiple lacerations	1
OTHER	
Hypothermia	4
Mountain sickness	3 (2 HA oedemas)
Exhaustion	2
Bleeding	1
Pneumonia	1
Strangulatio (by rope)	1
T O T A L	**123** (HA = high altitude)

Table 4. Injuries in fatal cases

Type of injury	Number
Fractura basis cranii	10
Compressio et contusio cerebri	4
Multiple severe injuries	3
Hypothermia	3
Strangulatio	1
Spinal cord break	1
Total number of deaths	**22**

Table 5. Circumstances of lethal cases

Circumstance	Number
Solo climber	9
Fall of whole roped party	4
Fall of the first climber	3
First climber pulled down by the second	1
Stone fall	1
Hypothermia	3
Unknown	1
Total number of deaths	**22**

Table 6. Rock climbing accidents before and after introduction of protective helmets

Period	Number injured	Number injured having severe head injuries	%
1946 – 1965	17	6	35
1966 – 1985	30	4	13
T o t a l	**47**	**10**	

$x^2 = 3.11$ $p < 0.05$

Table 7. Proportion of fatal injuries before and after introduction of protective helmets.

Period	Number injured	Number injured deceased	%
1946 – 1965	17	8	47
1966 – 1985	30	7	23
T o t a l	**47**	**15**	

$x^2 = 2.79$ $p < 0.05$

MOUNTAIN ACCIDENTS IN THE ENGLISH LAKE DISTRICT

M. Townend, Cockermouth, Cumbria, Great Britain

The country of Cumbria in N.W. England contains Britain´s most compact and easily accessible mountain area. Covering about 2500 square kilometres, connected by good roads to the motor way network and with good rail links, it is visited by several millions British and foreign visitors each year. It is difficult to estimate how many of these visitors walk or climb but the universal impression is that their numbers have increased steadily in recent years. The Lake District offers excellent opportunities for mountain walking and rock climbing. Less predictably because of its climate it offers in some years good winter mountaineering and ice climbing.

I have investigated all incidents dealt with by the 12 mountain rescue teams and 2 peripheral teams covering the Lake District during the 10 years from 1978 to 1987 and have also made some comparisons with 1968.

From 1978 to 1987 there was an increase of 66% in the numbers of persons rescued, an increase of 150% over the 1968 figure. Most of this increase was accounted for by an increase in the numbers of walkers rather than climber rescued.

Excluding those rescued unhurt the 1987 total of casualties showed an increase of 75% over the 10 years and 133% since 1968. Numbers of deaths fluctuated but did not show an overall increase.

As we have already seen walkers, who are greater in number than climbers, account for a much greater number of casualties. Accidents to walkers doubled in number from 1978 to 1987 and deaths amongst walkers rose by 260% over the 10 years.

Among rock climbers there was no overall increase in accidents and deaths decreased to 20% of the 1978 figure. It is difficult to draw conclusions about trends in ice climbing accidents fluctuate from year to year as regards both suitability for climbing and objective dangers.

Casualties amongst walkers on snow increased by over 40% from 1978 to 1987 and by 500% from 1968 although there was no overall increase in deaths.

Incidents between 1978 and 1987 were further analysed with reference do 4 factors which may have contributed towards causing or exacerbating them, namely the quality of clothing and footwear, the degree of experience and the quality (or indeed absence) of other necessary equipment. Unfortunately this information was not always recorded.

Standards of clothing and footwear amongst climbers on both rock and ice were highly satisfactory but amongst walkers one casualty in 8 had unsatisfactory clothing and footwear. Amongst walkers on snow 25% of casualties had inadequate footwear.

Most climbing casualties whose experience was recorded were considered to have adequate experience but about 25% of casualties amongst walkers (about 50% of those recorded) were considered insufficiently experienced. This figure rose ***to*** almost 50% (well over 50% of those recorded) for walkers on snow. The standard of equipment amongst ice climbing casualties was recorded in only 50% of cases but was considered adequate in all cases. Almost 50% of rock climbing casualties were considered to be inadequately equipped; the commonest fault was absence of a helmet, their other equipment usually being well up to standard. Considerably more than 50% of

walkers on snow were considered badly equipped, often lacking such fundamental items as ice axes and crampons.

A worrying trend in the last 10 years has been a marked increase in the number of persons rescued suffering from medical conditions, an increase of almost 600%. The biggest single increase in medical conditions has been heart disease which has increased by over 400%. Deaths from medical causes have increased over the 10 years by 1000% and cardiac deaths have probably been responsible for the whole of this increase.

It is difficult to correlate these increases on both accidents and medical incidents with the increasing numbers of participants in mountain sports as such figures are virtually impossible to obtain. All who are involved in mountain sports and mountain rescue agree, however that the number involved are steadily increasing and that this factor accounts for at least some of the increase in accidents and deaths, at least amongst walkers.

In recent years Britain has seen an increase in leisure time and an increase in awareness of the importance of physical sport in maintaining good health. Increased publicity for the sport of mountaineering, increased car ownership and improved road communications have also contributed to the increasing numbers taking in our mountains. Unfortunately many of them appear to be equipping themselves inadequately or choosing routes or weather conditions for which they have inadequate experience. What appears to be undemanding hill walk may be completely transformed by a sudden change in the weather, or on a winter day a route which was a simple walk in the summer may become a difficult and dangerous expedition with severe weather, avalanches, cornices or dangerous slopes of ice or névé?

Many walkers also miscalculate their physical fitness for the hills. An increasingly common scenario is that of the overweight and under-exercised middle-aged man, possibly also a smoker, who takes a holiday in the Lake District and feels whatever impulse it is which draws men towards mountains. He sets off full of his new-found enthusiasm and struggles breathlessly to his chosen summit, only to collapse there with acute chest pain. In about 10 such cases each year it may or may not have been his first essay into mountaineering but it will certainly be his last activity of any kind.

Climbers on the other hand appear to prepare and equip themselves well for their chosen activity. Although rock-climbing standards have risen greatly difficulty there has been no increase in the number of accidents and the number of deaths has actually fallen. This is no doubt due to the great improvements in techniques and equipment for arranging protection. It is perhaps a little worrying however that stripped tights and chalk-bag are nowadays considered more important than a helmet.

CAUSES AND STATISTICAL ANALYSIS OF ACCIDENTS IN THE AUSTRIAN ALPS

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Abstract

Since 1985 the Austrian Alpine Club has had the possibility of electronically processing the alpine accident survey of the Federal Ministry of the Interior. The present study primarily deals with a descriptive epidemiology, with occasional analytical approaches. In comparing the total numbers of the accident statistics from 1985 to 1987, fatal accidents sank from 283 to 242 while the total number of those involved in accidents rose from 2532 to 2988. We attribute this tendency to an optimization of rescue operations and emergency medical measures. In the distribution of accidents of 1987 to the various alpine areas, 59% were due to ski-slope accidents. It remains to be considered that the ski accidents registered by the Ministry of the Interior were only those allowing suspicion of negligence by others, or those which ended fatally. Under such circumstances it is understandable that 87 of 100 accidents involved collisions. The second place in the frequency distribution is held by mountain hiking accidents (23%, 697 accident victims) followed by ski touring accidents (7%, 206 victims). 4% (119 victims) were due to rock climbing accidents and 1% each have been recorded for ice climbing (27) and glacier tours (29). Paragliding accidents enter the alpine statistics for the first time in 1987, at 2% (49). "Tripping, slipping" (75) and "cardiovascular emergencies" (71) are the major causes of fatal alpine accidents (1987: 242). Following these, classified according to frequency, are avalanche fatalities (23), falls and collisions on the ski slope, and crashes with aircraft (hang-gliders, etc.). Accidents due to lack of physical condition are more typical for persons at an advanced age, while accidents due to lack of experience and training early show a lower average age on the part of the persons involved.

The head is the part of the body most liable to injury due to accidents on the ski slope and rock- and ice-climbing accidents. The lower extremities dominate for injuries during ski and glacier tours, hiking and paragliding. While the lower leg and knee are affected the most in skiing, hiking affects the ankle. Twenty-five per cent of all paragliding accident victims suffered vertebral injuries.

Hypothesis has been put forward that effective prophylactic measures should be introduced, the training and equipment of rescue personnel should be adapted, as well as that there, should be analytical approaches and experimental investigations must be the necessary consequences and continuation of the present study.

With the objective in mind of presenting an overview of Austrian alpine accidents with details especially of the various causes and the distribution of the locations of injuries, a survey was prepared in 1985 by the Austrian Alpine Club and placed at the disposal of the Federal Ministry for Domestic Affairs. The data collected by the Alpine Gendarmerie were then computer-processed by the Section for Alpine Rescue and Health of the Austrian Alpine Club.

The analysis and comparisons of the annual statistics indicate tendencies, allow conclusions as to causal connections, and hence give us the possibility of establishing prophylactic measures.

These statistics reflect only the accident data collected by the Alpine Gendarmerie: a large number of alpine accidents, primarily with slight injuries, are not included in the survey. Only fatal skiing accidents on pistes and those with suspicion of third-party negligence are included. Almost 100% of the diagnoses appearing in the survey were established by doctors.

The estimation of a yearly number of 2 to 3 million hikers and climbers in the Austrian Alps is based on documented mountain hut guest records and on computed projections.

According to data supplied by the "Austrian Curatorship for Alpine Safety" the number of persons transported by cable ways and lifts during the winter of 1983 was 453.5 million.

In the following, I should like to draw attention to, eve al results and analyses based primarily on the year 1987.

Alpine accident statistics 1986-1987

While the total number of persons involved in alpine accidents increases (2,532 – 2,859 – 2,988 persons), the number of deaths decreases (286 – 258 – 242 fatalities) – a fact which we attribute to the extremely high percentage of rescue missions with helicopter and emergency physician, the excellent training of the rescue teams and the improvement of rescue equipment.

Only 11% of those persons involved in accidents were members of alpine clubs. Mountain hut guest records show that alpine club members make up about 30% of all guests. We attribute the clearly lower percentage of involvement in accidents to "safety through training".

The distribution of 2,988 emergencies according to the various alpine activities: skiing in the piste involved 1,572 persons (59%), hiking 697 (23%), ski tours 206 (7%), rock climbing 119 (4%), paragliding 49 (2%), glacier tours 206 (1%), ice climbing 27 (1%), and other 109 (4%).

The causes of 242 fatalities in 1987.

Leading, with 31%, are accidents due to stumbling, slipping, and losing a hold - already in the second place are cardiovascular emergencies at 29%! Avalanches involved 23 persons, falls and collisions on the piste 21, crash with paraglider, etc. 16 persons.

Analytic results in individual alpine activities:

1. Hiking accidents - 1987 (697 persons: dead 96, injured 501, not injured 92, missing 8). Causes of accidents, average age, and the percentage of men involved in the accidents were as follows.

As in 1986, "stumbling" and "slipping" dominate (450 persons, 46 years old on average, 45% men). This highly frequent cause of accidents when hiking can hypothetically be seen as the result of lack of concentration and coordination due to physical and mental weariness or an underestimation of the motorial requirements of the terrain.

"Stumbling" and "slipping" represent the primary causes of accidents particularly for persons of relatively high age, in contrast, lack of experience, for example getting lost due to poor knowledge of orientation, or slipping or freezing due to insufficient clothing and equipment, is supposed as the frequent, main cause of accidents involving young persons.

(Losing one´s way: 89 persons, 37 years on average, 60% male; cardiovascular emergency: 87, 54 years, 70%; falls and crashes without details: 41; exhaustion 15, 55 years, 40%; other causes: 38)

Distribution according to the location of the injury, the lower extremity dominates with 48% of all injuries. Every fourth injured hiker suffers a head injury (25%). Thorax injuries 11% (of these: heart emergencies in 34 persons), spine 5%, upper extremity 5%, shoulder 3%, abdomen 1%, pelvis 1%.

Injuries of upper extremities: upper arm in 6 persons, elbow in 4, lower arm 7, hand (-joint) in 12 persons. Injuries of lower extremities: thigh in 12 persons, knee 39, lower leg 61, foot (-joint) in 152 persons. Polytrauma was present in 15 injured persons.

2. Rock climbing accidents (119 persons: dead 19, injured 65, not injured 35). As compared with 231 injured persons in 1985, it is unclear which factors have brought about this almost 50% decrease. We assume the following: the shifting of climbing activities from alpine terrain to well-secured routes in sport climbing areas, the improvement of personal experience, different weather conditions, etc.

The modal value of age distribution is, as in 1985, 19 years. This value – especially in this "technical" discipline – allows the assumption of lack of experience and technique at young age.

"Falls and slipping" (41 accidents), "losing a hand- or foothold" (30), and "a piton breaking loose" are the most frequent causes of accidents.

While in 1986 the lower extremity was the main location of injuries, this is taken over in 1987 by head injuries at 32% - possibly a consequence of not wearing a protective helmet. Injuries of lower extremities represented 28% of all 95 injuries, upper extremity 20%, thorax 7%, shoulder 7%, spine 4%, and pelvis 1%.

Injuries of upper extremities: upper arm in 4 persons, elbow in 3. Lower arm 2, hand in 5, finger in 3. Injuries of lower extremities: thigh in 6 persons, knee 1, lower leg 10, foot (-joint) in 7 persons. Polytrauma was present in 10 injured persons.

Fifty-four per cent of all persons injured in rock climbing accidents were climbing at degree of difficulty 3 and 4. This confirms the lack of suitable experience of primarily young climbers at mean degrees of difficulty! Eight per cent of the persons involved were injured in fixed rope routes - clearly fewer than in 1986, which is an encouraging sign of an improved sense of safety on the part of the climbers.

The extremely high percentage of helicopter rescues (86%), and of transport, of persons 87 persons injured in rock climbing demonstrates the high training standard of the alpine air rescue personnel in Austria!

3. Ski touring accidents (206 persons: dead 25, injured 127 with 141 injuries, not injured 52, missing 2).

As before, the main causes of accidents are falls (94 persons), avalanches (55), losing one´s way (18), slipping (12), cardiovascular emergency and sickness (9) etc.

The figure of 52% for injuries in the lower extremity area dominates. Head injury 17%, shoulder 13% (of these clavicle in 7 persons, thorax 8%, spine 6%, upper extremity 3%, abdomen 1%, pelvis 1%). Injuries of upper extremities: elbow in 1, lower arm in 3 persons. Injuries of lower extremities: thigh in 6 persons, knee 21, lower leg 36, foot (-joint) in 15 persons. Polytrauma was present in 4 injured persons, exhaustion in 8, and suffocation in 6 and hypothermia in 9 persons.

Distribution according to age indicates a peak between 15 and 24 years and one between 40 and 50 years. While 40% of the first group were injured due to "avalanches", this was the case with only 18% of the second group, in which more than 50% of the cases were due to "falls".

In more than 80% of the cases the avalanche was triggered as a snow slab by the skiers themselves. Here we can clearly see, on the one hand, a lack of experience, incorrect estimation of conditions or an increased readiness to take risks on the part of younger alpinists and, on the other, a lack of sport motorial capability on the part of the older skiers.

4. Glacier accidents (29 persons: dead 4, injured 24, not injured 1).

Stumbling or slipping (14 persons) and losing one's way (5), followed by falls into crevasses (4), are the major causes of accidents.

The predominant general location of injury is the lower extremity (15 persons, 65%), mainly the foot joint. Of the total of 29 persons involved in accidents, only 7 were roped up - one with a makeshift harness, six with a chest and sit harness.

5. Ice climbing accidents (27 persons: dead 3, injured 16, not injured 8).

Similar to the rock climbing accidents, here too we can note a clear drop in the figures for 1987 as compared with 41 persons involved and 9 dead in 1986.

The main causes of accidents are falls (8 accidents) and slipping (7), followed by avalanches (7) and rock- and ice fall (3).

The part of the body most usually injured is the head (5 persons, 33%). The avalanche accidents, occurring to waterfall climbers during ascent or descent, allow the assumption of poor alpine experience.

6. Skiing accidents on the piste (1,752 persons: dead 54, injured 1,053, not injured 643).

Please note once again that here only those accidents are included in the survey which were fatal or involved the suspicion of third-party negligence. For this reason it is understandable that 87% of all cases involved collisions.

Cause No. 1 of fatalities on the piste is - at 48% (25 persons) - a cardiovascular emergency as a result of poor physical condition! No fewer than 9 persons were the victims of collisions. The age frequency peak of those causing collisions lies under 20 years. Here we can assume deficient character traits, lack of responsibility and consideration, an increased readiness to take risks, a false estimation of one's own ability, and the frenzy associated with speed to be responsible. Ten persons died after a fall or crash and 8 in avalanches - mainly in unsecured areas.

As in 1986, the distribution of accidents on the piste according to the location of the injury shows the head to be the major site of 381 injuries (35%), followed by the lower extremity (304, 28%), shoulder (107, 10%, of these clavicle: 33), thorax (105, 10%, of these heart emergencies 25), upper extremity (81, 7%), spine (74, of these cervical 38), abdomen (19, 2%), pelvis (17, 2%).

Injuries of upper extremities: upper arm in 32 persons, elbow in 5, lower arm 21, hand (-joint) in 24 persons. Injuries of lower extremities: thigh in 60 persons. Knee 104, lower leg 129, foot (-joint) in 21 persons. Polytrauma was present in 15 injured persons.

7. Cardiovascular emergencies.

The development of cardiovascular fatalities during alpine activities: 74 cases of 283 deaths in 1985 (26%), 51 of 258 in 1986 (24%) and 69 of 242 in 1987 (28.5%). In spite of the priority given to providing medical information, the last three years still show an increasing tendency!

Conspicuous in the 1987 data is the group of persons between the ages of 50 and 55 as compared with the group of 60 to 65-year-olds in 1986. In the age group of 10-44 years there were 7 fatal cardiovascular emergencies, 45-49 years: 9 cases, 50-54 years: 17, 55-59 years: 5, 60-64 years: 11, 65-69 years: 10, 70-74 years: 7, and 75-79: 2 persons.

The distribution of cardiovascular fatalities with regard to the various alpine activities shows the highest incidence for hiking (30 persons) and on the ski piste (28). It is noteworthy that the number of cardiovascular fatalities in hiking dropped from 66% in 1986 to 43% in 1987, and that those on the piste increased from 20% in 1986 to 38% in 1987! The distribution of cardiovascular fatalities in 1986 and 1987 according to altitude differs only very little. The peak lies just under 2000 meters.

So as not to generally question the value of mountain climbing as a healthy exercise, it must be noted that the presence of cardiovascular risk factors can cause a cardiovascular malfunction in any activity in daily life - sports or otherwise - comparable to mountain climbing . Only increased and regular sport-medical examinations of one's health and training condition, above all from middle age onwards, can check the advance of cardiovascular fatalities in all areas of physical activity.

8. Paragliding accidents (injured 48, not injured 1, dead 0).

The lower extremity is the main location of injury (32 persons, 58%), followed by 21% with regard to injuries of the spine. Twenty-five per cent of all injured persons spinal injuries!!!

Distribution according to age with the highest incidence between 20 and 30 years indicates an increased readiness on the part of younger persons to take risks. 1988 shows a clear increase in the number of paragliding accidents - and fatalities too.

9. Accident statistics regarding children.

Of the 291 children under the age of 15 who were involved in alpine accidents° 240 - or 82% - were injured in the ski piste. 103 children under the age of 10 were involved in skiing accidents - more than 80% involved third-party negligence - of these, 82% were injured and 2 children died. 50 children were the victims of collisions on the piste. Of the 48 injured 49% suffered head injuries!

For such a statistical survey and analysis of accidents in alpine regions not to be just an end itself, the next necessary step is to work out prophylactic measures. It is the responsibility of national and international alpine organizations to provide more information than before, to awaken a stronger sense of consciousness with regard to safety and health, and to take action to prevent accidents. In the final analysis the success of our efforts will depend on the extent to which it is possible to win potential accident victims as responsible partners in trying to prevent accidents in the mountains.

(Unfortunately, it was not possible to print the tables)

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INJURIES AND SECURITY IN THE MOUNTAINS

Karol Gurský, Department of Sports Medicine P. J. Šafárik University, Prešov, ČSSR

Abstract

During the period 1980-83 we monitored injuries in the mountains of Slovakia. The shares of young people and women were determined.

During that period there were 11,807 injuries in winter and 6786 injuries in summer. Attention should be paid for the fact that the highest number of ski injuries occurs during the first five downhills. The male / female ski injury ratio between men and women was 1.7 / 1.

The highest age-specific frequency of injuries was reported for young people up to 20. The most frequent cause of death in mountain climbing was a fall (77.1%), exhaustion and snow avalanche coming next. A subjective failure or mistake was involved in 88.4% of cases.

Taking into consideration that most injuries in the mountains have subjective causes, we suggest that measures be organized at the levels of the Department of Education of the Czechoslovak Socialist Republic, the Czechoslovak Union of Physical Education, the trade unions, the Socialist Union of Youth, local national committees, recreation centres and international hotels ("interhotels").

We believe that this could decrease the rates of accidents and injuries in men, women, adolescents, and children in spite of the continuing increase in the number of mountain visitors.

During the period 1980-1982 we monitored injuries in the mountains of Slovakia. Working with statistics, age, sex, profession, training and physical activity were taken into account.

From the medical point of view, attention was directed to different kinds of injuries, their frequency, laterality, topography and relevance. To evaluate the share of external aetiology, the manner of arrival into the mountains, some questions of a technical character, and the influence different climatic and meteorological situations were considered.

During the period studied, there were 11,907 injuries in winter and 6,796 injuries in summer. The highest age-specific occurrence of injuries was recorded in group 14-24 years old. During the day there were two critical periods between, 11 and 12 a.m. and from 14 to 15 p m.

Injuries in the mountains of Slovakia (1977-1982)

Year	Fatal Injuries	Heavy Injuries	Light Injuries	First aid	Searching
1977	21	800	1 312	3 014	98
1978	27	810	1 483	3 584	126
1979	34	821	1 810	3 634	106
1980	36	930	1 280	3 199	129
1981	38	794	2 384	3 456	133
1982	31	805	1 669	3 370	131
TOTAL.	187	4 960	9 938	20 257	723

Ski injuries and length of stay in the mountains

Day of stay	%
1	39 3
2.	15.3
2-5	29.8
5-10	8.9
11-14	5. 9

Character of ski injuries in women Chopok 1980-1982

Injuries	%
Distensions , Distorsions	53.4
Contusions	16.1
Fractures	13.6
Open injuries	5.1
Luxations	2.5
Other injuries	9.3

Localization of mountain injuries according to age (1980-1982)

Age	1-5	6-14	15-18	19-30	31-40	41-50	>50
Head	-	3	7	5	2	-	-
Trunk	-	-	5	20	8	11	9
Upper limbs	-	39	39	58	40	32	6
Lower limbs	34	1121	312	702	283	171	81
T o t a l	34	1153	362	785	333	215	96

In respect of the seasonal factor, the highest frequency of injuries was in January-March and July-August. It is a serious matter that the highest number of injuries in skiing took place during the first five downhills.

The proportion of ski .injuries between men and women was 1.7:1- Analysis of the reasons revealed a worse physical condition of the women, especially up to 20 years of age. Sixty per cent of the men had a fracture of a shin bone, and only 4O% of the women. Women showed higher rates of injuries of knee tendons.

During the observation period we recorded a lot of injuries in children and young people, especially fractures above the upper edge of a ski-boot. In women, almost 54% of falls were accompanied by failure of the release binding.

The most frequent cause of fatal injuries in mountain climbing was a fall (77.1%), then exhaustion and being caught in a snow avalanche. Subjective failure was present in 88.4% of the cases. It is puzzling that 59% of climbing accidents were due to unsatisfactory belaying; 13.3%, to incorrect rappelling, the next most frequent mistake was climbing with unsuitable equipment in bad weather.

The highest frequency of injuries was reported at an age up to 20 (52. 4%), then in mountaineers of 40 (25.7%) and 30 years of age (10.9%). We conclude that the main causes of injuries in the mountains are subjective.

With regard to prevention of injuries, we suggest the following measures to reduce ski accidents and injuries during alpine tourism and mountain climbing.

1. Education. Educational influence in the family, at school, in physical-training centres and sports clubs should improve the quality of physical training of sportsmen and the public generally. Emphasis should be put on theoretical knowledge of physiology, first aid, prevention of injuries, and the techniques and tactics of movement in an alpine terrain in order to reduce injuries having subjective aetiology.

2. Mass media. The press, television and radio should be made use of the anti injury prevention.

3. Distribution. Shopping centres, department stores and sporting shops should be supplied with high-quality sporting equipment, especially for children and young people.

4. Czechoslovak Union of Physical Education. The Union should exercise strict control over sporting Clubs so that they keep the safety rules and co-operate with the mountain rescue service and the State Insurance Company. The results of inspections should be reported regularly.

5. Interhotels and recreation centres of the trade union and the Socialist Union of Youth. Since many of the visitors who come to the mountainous areas of Slovakia are not organized in the Czechoslovak Union of Physical Education, it is necessary to improve services and provide training and guiding services.

6. State Insurance Company. The State Insurance Company in the Czechoslovak Socialist Republic should be engaged in the prevention of injuries according to the model of the Alpine countries

7. Mountain rescue service. International ski-signs should be installed on all skiing routes at ski centres in Slovakia, safety rules should be kept and skiers who break them should be find. Informative boards should be installed at ski-tow stations. They should emphasize the value of warming up and show some series of effective exercises.

8 Technical services. All winter centres should be equipped with the necessary mechanization to prepare pistes adequately. Skiing areas should conform to the internationally established safety rules regarding the capacity of ski-tows. In most frequently visited ski centres resting services should be built gradually. It would be possible to test there safety ski binding.

9. Register of injuries. A uniform register of injuries should be introduced in all the mountainous terrains of the Czechoslovak Socialist Republic.

10. IT SHOULD BE EMPHASIZED THAT THE MEDICALCAL ASPECT OF SPORTS IN THE MOUNTAINS IS EQUAL IN VALUE TO THE EDUCATIONAL AND TECHNICAL ASPECTS.

Taking into consideration that most- injuries in the mountains are results of subjective mistakes or failures, we suggest that the above measures should be instituted on the basis of the Department of Education of the ČSSR, the trade union, the Socialist-Union of Youth, local National Committees, recreation centres and interhotels. We believe that this would result in a decrease of accidents and injuries in men, women, and children in spite of the continuing growth of the number of mountain visitors.

FATAL ACCIDENTS IN CZECHOSLOVAK MOUNTAINEERING

I. Rotman; Medical Commission of the Czechoslovak Mountaineering Association, ČSSR

Abstract

The amount of risk in any sport is determined by the sport activity and the personality of the sportsmen. Climbing and mountaineering represent one of the most dangerous human activities. Despite some increase in the number of fatal accidents, which can he explained by the increase in the number of people at risk, the percentage of fatalities remains at the same level or has even decreased somewhat. During the last 30 years (1958-1987) there have been 265 fatal accidents among the member of the Czechoslovak Mountaineering Association or an average of 9±5 accidents (1-24 deaths) per year Recent statistics do indicate certain trends: in the period 1961-70, the rate was 2.7%; in 1971-80, 1.2%; and in 1981-87 1.1%.

PLACE OF ACCIDENTS

n = 265	
SANDSTONE AND OTHER ROCKS	25
HIGH TATRAS	152
OTHER MIDDLE MOUNTAINS	12
ALPS AND CAUCASUS	38
HIGH MOUNTAINS > 6000 M	27

MECHANISMS OF ACCIDENTS

n = 265	
FALL	158
AVALANCHE	41
EXHAUSTION	25
EARTHQUAKE	14
FALLING ROCK	10
OTHER	18
lightning	4
acute mountain sickness	4
apoplexy	1
cardiac infarction	1
unknown	8

DIAGNOSIS

n = 265		
CEREBRAL AND MULTIPLE INJURIES		83
MULTIPLE INJURIES		63
CEREBRAL INJURIES		49
HYPOTHERMIA		31
ASPHYXIA		32
OTHER		27
Lightning	4	
Acute mountain sickness	4	
Cardiac disease	2	
Hanging on rope	2	
Other und unknown	15	

C A U S E S O F M O U N T A I N E E R I N G A C C I D E N T S

ENVIRONMENTAL RISK FACTORS	PERSONAL RISK FACTORS
Rock steepness	underestimation of environmental factors
Gliding rock	loss of concentration
Friable rock	inexperience
Weather changes	overestimated abilities
Snow conditions	fatigue, inadequate training, disease
Hypoxia	inadequate equipment
Cold	technical and tactical errors
Solar radiation, etc.	faulty belay and climbing alone, etc.

The cause of each accident is compounded of many factors. Since the classification dividing the causes into different categories (related to the individual, the equipment, the environment) or into so called subjective and objective causes are often misleading, the Medical Commission has

proposed to analyse the risk factors in mountaineering (environmental and personal) and to distinguish strictly between the "mechanisms" and "causes" of accidents. In an analysis of 265 fatal accidents the "mechanisms" in the order of frequency were as follows: falls of climbers (158 cases; 59.6%), entrapment in an avalanche (41; 15.5%), exhaustion and exposure (26; 9.6%), earthquake (14; 5.3%), falling rock (10; 3.8%), and others (lightning, acute mountain sickness etc.). As far as the causes are concerned, inattention* inexperience, fatigue, overestimation of abilities, faulty belay, not wearing a helmet, climbing unroped or alone or in poor weather, inadequate equipment accounted for the majority of- accidents (217 cases, 81.9%); falling rocks, earthquake and lightning were responsible for only 34 accidents (12.8%).

It is concluded that the individual is the main factor, although the equipment and the environment may play roles of variable importance. The preventive measures are mostly of a methodological, educational and organizational character.

C O N C L U S I O N S

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AND ORGANIZATIONAL CHARACTER.

PRACTICAL ASPECTS OF MOUNTAIN AIR RESCUE

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In the Swiss Alps there are 900 to 1200 mountain accidents annually. Over 90% are handled by helicopter rescue. Efficient helicopter rescue systems (e.g. Swiss Air Rescue: rescue radio net; central alert-station, operating 24 hours; 15 ambulance helicopters reach every spot in the country within 15 minutes of flight; during day time airborne within 5, at night within 30 minutes) with trained emergency doctors allow optimal medicalized first treatment at the site of accident and fast transport to the next hospital or centre according to type of injury.

There are mainly three helicopter rescue organisation in Switzerland: Swiss Air Rescue, a specialized rescue organisation and Air Zermatt/Air Glaciers, two helicopter companies in the Valais, doing rescues besides their commercial flying work.

On the average up to 1000 persons have to be rescued out of pathless areas every year. In 50% of these cases a winch rescue is necessary. All missions are registered according to medical (NCA-Index) and topographical aspects. In 1983/84 17% of all winch rescued persons were not injured. 21% were dead or died after an unsuccessful resuscitation attempt. 19% were ambulant cases (NACA 1+2), 37% had been seriously injured (NACA 3+4), and 6% suffered life threatening injury. Over 2/3 of all rescued by winch were evacuated of accessible and 1/3 out of difficult sites of accident. 2% were extremely difficult rescues, e.g. direct face rescues from the Eiger North-face.

For difficult missions (direct face, night missions, and bad weather) the risks have to be evaluated in relation to the seriousness of the injury. Within the last 10 years REGA has lost 2 ambulance helicopters during rescue mission.

Due to rock- or icefall some rescues in dangerous areas should be done only during the early hours of the day. But often it cannot be determined in the helicopter whether a patient is still alive and here it is the crew´s or team's decision whether the mission goes on or the following morning has to be awaited. Ambulant cases can be evacuated directly by the climbing harness and the rescuer has not to leave the winch cable. This procedure, lowers the risk considerably whenever safe belays are lacking or objective dangers threaten the mission.

Direct faces rescues occasionally demand an extension of the winch cable (up to 70 m). These missions are rather delicate for the crew because of the potential swaying and the difficult judgment of distance. In exceptional cases winch rescues take place also during the night.

In difficult and extreme sites of accidents the rescue doctor has to decide whether immediate treatment at the site of accident (medication, volume substitution, and intubation) or an immediate transport of the patient should be given priority. Especially in cases of severe head-brain injury or spinal injuries immediate treatment is necessary and the patient has to be positioned carefully into the rescue net. In steep faces this often requires additional helpers for belaying and takes a lot of time.

Altogether 1.5% of all winch-rescued patients have been intubated at the site of accident and evacuated in the net under constant ventilation.

In the Swiss Alps the assignment of air rescue doctors has improved the efficiency of first treatment (volume substitution, intubation, resuscitation, hospital choice) at the site of accident even in difficult and extreme mountain areas. The result is a better survival chance in case of a mountain accident.

THE ACTIVITIES OF THE MOUNTAIN RESCUE SERVICE IN CZECHOSLOVAKIA

I. Miko; Medical Commission of the Slovak Mountain Rescue Service, Czechoslovakia

Abstract

Substantial part of the Czechoslovak territory (127,801 square km) is covered by mountains, which are extensively visited by tourists, skiers and climbers. Moderate altitudes prevail (85% from 200 to 1500 m), only 2% of the territory is above 1500 m. The ridge of the highest mountain range – the High Tatras (260 square km) – is 26.5 km long, with an altitude of 2250 m on an average and with the highest peak, Gerlach, measuring 2655 m.

The Mountain Rescue Service (MRS) in Czechoslovakia is affiliated to the Czechoslovak Union of Physical Culture (ČSTV) and is represented in the International Organization for Mountain Rescue (Internationale Kommission für alpines Rettungswesen, IKAR). The MRS totals 1939 members and is divided into 15 mountain areas, the number of physicians reaches up to 10% of the membership in some places. All the physician are volunteer MRS members.

They arrange first-aid education for all professional and volunteer MRS members (inclusive of mountain guides, avalanche specialists, and members of air rescue parties), render first aid in the mountains, and take part in education of the general public, especially on prevention of mountain accidents, taking advantage of collaboration with mass media. The Medical Commissions of the Czech and Slovak Mountain Rescue Services cooperate closely with other sport organizations, with the Medical Commissions of the Mountaineering Association, with the Mining Rescue Service of Czechoslovakia, and state health institutions.

In 1987, members of the MRS delivered 6233 lectures and talks, organized 12,296 terrain patrols and 251 search undertakings, and 1039 times rendered assistance at sports events. They worked 102,800 hours in emergency service • and treated 6123 injured persons, 2689 of them severely (with 43 deaths accidents).

LIGHTNING INJURY IN MOUNTAINEERING

E. Ehler, I. Rotman; Medical Commission of the Czech Mountaineering Association, Czechoslovakia

Abstract

The electric energy of lightning may cause thermic lesions (burns), ocular injury (impairment of vision), or an electric shock. A stroke of lightning may produce characteristic lesions of the skin, the muscle, the heart (arrhythmias), and the blood vessels (vasomotor changes). It may also affect the nervous system causing neuropathies, lightning paralysis, loss of consciousness, and/or cerebral haemorrhage with brain oedema. Biochemically, myoglobinuria with resulting renal failure, increased creatinkinase, and haemolytic jaundice may be observed. Lesions may be noted also on the EEG, ECG and computerized tomogram of the brain.

During a storm in the mountains, particularly in a mountaineering area, severe injury may be incurred indirectly as well – by a fall, from a pressure wave, or by inadequately acting in a difficult terrain.

The most important measures to prevent lightning injury are to foresee the storm and recognize the actual risk from meteorological indications, of course, every mountaineer should be familiar with weather phenomena. Appropriate action should be taken to minimize the risk of injury during the storm itself. Finally, a scheme of adequate first aid and first medical aid in the case of lightning injury is presented.

Introduction

Lightning injury (LI) is not so entirely exceptional an event in human society, as would seem from the very rare personal experience with such injured people in medical practice. Craig (4) states that in the USA 300 to 600 persons die yearly after lightning stroke and several thousand injured people survive. This number is larger than the toll of any other type of natural catastrophe including tornados. In an exposed terrain in the mountains or rocks there is a far greater chance of being struck by lightning. In spite of our considerable knowledge of the physical essence of lightning there are gaps in the knowledge of the pathophysiology of lightning-caused damage to the organism and perhaps also certain ambiguity in the development, prevention, and management of the after-effects of these injuries (8, 18). In view of there being some lack of satisfactory and complex information about LI in contemporary specialist literature and some uncertainty about this medical problem in most physicians, we shall try to review briefly the contemporary views on this problem and also to state out also a few concrete data.

Incidence of Lightning Injury in Mountaineering.

It is very difficult to ascertain definite data about the occurrence of LI. According to statements from certain areas attractive to climbers, mild injuries are not treated by local physicians or mountain visitors receive treatment in the places of their permanent residence, mostly in towns and cities. As regards injury reporting in mountaineering, mild LI are mostly not reported, in the same way as other mild injuries are not, this being largely due to inconsistence of particular committees of mountaineering sections and organizations (11, 15).

During the period of 1951-1981 3108 injuries were reported in mountaineering activity in USA and Canada; of that sum 36 (1.15 %) had been caused by lightning, but there was no fatal LI among the 178 mortal casualties (19) In 1979-1984 the German Alpine Union (Deutscher Alpenverein) reported 1112 injuries, of which 9 (0.8%) had been due to lightning (11).

In the High Tatras, the only Czechoslovak high mountains, altogether 814 fatal casualties were recorded among all visitors over a long span of time 1650-1985. Only 12 cases (1.47%) of these deaths were after lightning stroke (3, 14). Within the framework of the Czechoslovak Mountaineering Association (15), 265 mortal injuries occurred from 1956 to 1987, 4 mountaineers evidently died from lightning stroke (1.51%) and for the next 8 (3.78%) fatal LI can be presumed (3.78%).

The Origin of Lightning

The essence of the electric charge in the clouds is the build-up of static electricity due to collision of water droplets and ice particles. This gives rise to positively charged clouds with respect to the ground. When this charge exceeds 100 million V, the insulating properties of the intervening air are overstepped and a discharge of electricity occurs with electrons passing upward from the ground to neutralize the positively charged clouds. By this mechanism a stroke of lightning is produced (8, 13, 20).

From the physical point of view, lightning is characterized by a saltatory expanding discharge directed from the clouds to earth, whereby this leader stroke creates a lightning channel 3-30 mm in width. The main stroke is from the ground to the clouds, in the return direction, and is up to 100 times stronger than the leader stroke. This discharge can reach a current intensity up to 200 kA, a voltage of 100-200 MV, the duration of the discharge lasting approximately 0.1 s and the visual effect 0.6 s, with the total energy amounting up to 1000 kWhr. A lightning stroke is a discharge of explosive character and the temperature originated by it reaches up to 30,000 °C. The main stroke is followed by a few shorter and significantly weaker after discharges. Most of the lightning discharge are between clouds and maybe a quarter of them are directed towards the earth (5.8%).

Several types of lightning can be distinguished. The "cold lightnings" are discharges of short duration and without thunder. "Incendiary lightning" is characterized by relatively low current intensity and comparatively long duration. The common lightning is one of high voltage and high current strength. Among the phenomena of induction we reckon the fire of Elias, buzzing of the ice-axe, electrisation of suit, etc. Ball lightning and its variants represent, from the physical point of view, a not yet explained problem (6).

The Effects of Lightning on the Human Organism.

It is estimated, that 20-30% of the victims die and 75% survivors have some permanent sequels (4). The effects of lightning on the human organism depend especially on the mode of the stroke. A direct stroke can cause heavy sequels or death. A side stroke, splashing by lightning is an indirect stroke, with the discharge conducted to the man from the immediate neighbourhood - from a tree, from rock formation, or another man (20). Ground currents can injure to a distance of few hundred meters from the place of the discharge, by stride potential (8). Damage to the human organism can originate from the primary changes of electric energy, from secondary causes (e.g. by fall), or

following damage of suit and outfit. Abrupt lightning can injure the eyes and superficial layers of the skin (so-called flash phenomenon). When electric energy is converted to thermic, it can produce superficial and also deep burns, including internal burnings of organs and tissues. Very interesting is the "flash-over phenomenon" when, owing to well conducting surface (wet outfit, sweat-through clothes, rain) the electric current flows only around the victim's body and not through his inner organs. Diffuse skin burns are then observed but the inner organs and tissues remain undamaged. An electric shock wave originated by the passage of discharge through the victim's body can produce tympanic membrane perforation and internal contusion or perforation (1, 4, 5, 12, 20).

Secondary changes occur by fall in the exposed terrain, often direct expulsion of the body by generalized convulsion (abrupt muscular contraction, caused by the discharge), lesions of bones and muscles. Also breathing paralysis can occur (8).

Metallic parts of the outfit can occasion skin and soft tissue lesions (necklace, bracelet). Magnetization of metallic objects lasts months and years after a stroke of lightning and is important for forensic reasons.

Injuries of Particular Organs

The character of the injury depends not only on the type of the lightning and the place where it strikes, but also on the conductance of certain tissues. The best conductors are the nerves, then come vessels, muscles, skin, tendons, fat, and lastly the bones. The tissues of least resistance are regularly damaged the most. The range of injuries in various tissues and organs is wide, from mild and superficial lesions to heavy, profound "thunder strokes" with dilaceration and avulsion of organs out of the abdominal or cranial cavity (4, 20).

Skin injury is absent in only 11% of LI victims and 53% injured have multiple burn sites (4). Mild changes of skin adnexa are the least form of these injuries. “Wavy hair" after a stroke may, in particular cases, be of forensic importance. Feathering patterns, regularly cited in classic medical textbooks, are caused by coagulation of the blood in superficial layers of the skin. They are created by erythematous markings that heal without scarring. Contact burns most often occur in areas at contiguity with tight-fitting damp suit or metallic jewellery and other objects. Flash burns are brownish or erythematous areas originated by lesions of superficial skin layers by the thermal effect of lightning. White mottling is often seen peripherally secondary to intense vasoconstriction during the initial stage. Lightning-prints are crater-like defects in skin and subdermal layers reaching down to the fascia or muscle. They are caused by relatively low voltage current. The entrance point of the lightning is usually situated on the head or neck, and can also be missing. The exit point is found regularly and is created by tearing of the skin in the outward direction. It is often combined with tearing of outfit, socks and shoes, and with their baking together (2, 4, 5, 9, 10, 16, 17).

Neuropsychiatric complications of LI are very frequent. There are early and late neuropsychiatric complications that can be persistent or even permanent. During the acute stage of LI, there can occur disturbances of consciousness lasting seconds to minutes and longer psychic changes (especially confusion). Focal neurological symptoms are mostly manifested in the form of transient motor or sensory disturbances. Lightning paralysis (keraunoparalysis) is manifested by a flaccid paralysis with changes of sensory functions involving maximally the legs and lower trunk. After the initial lesions of his consciousness, the injured person is not able to get up or to move a

limb. There is no amnesia on this period and all symptoms last less than 24 hours. Lightning paralysis was first described by Charcot in 1889. Since massive accompanying vasomotor changes are present and the disturbances are reversible, significant vascular functional-changes are presumed to condition this syndrome. Epileptic seizures during acute LI are not so rare either. Vasomotor changes with cyanosis and oedema of the limbs are consequences of sudden changes of stimulative type in the autonomic nervous system. Peripheral nerves are relatively rarely injured, and so is a form of localized or generalized neuropathy (4, 8, 16).

The early neuropsychiatric complications have been most commonly ascribed to initial hypoxia, complicating cerebral oedema, direct damage to ganglionic cells by the lightning discharge, and also to possible concussion injury sustained as a result of the fall. Many authors presume abrupt cessation of cessation of metabolism in all nervous cells, which may delay the onset of degenerative processes in the brain cells in cases of ensuing anoxia and ischaemia, and explain successful delayed resuscitation (4).

As delayed neuropsychiatric complications of LI, hemiparesis, aphasia, and painful neuralgia in the extremities have been described. LI may perhaps be conducive to the inception or acceleration of chronic degenerative cerebral processes, but also illnesses such as amyotrophic lateral sclerosis or even schizophrenia. Serious progressive myelopathy with evidence of demyelination and often fatal outcome has repeatedly been described. This myelopathy sets in a few weeks after LI. Long-lasting psychical disturbances appear mostly as hysterical manifestations such as transient blindness, deafness, and loss of speech. Many victims of LI develop uncontrollable thunder and lightning phobias (8, 12).

Heart injuries can attend practically any LI, but within a distance of up to 50 meters from the place of stroke the hazard for the heart is high. Also ground currents, stride potentials, can lead to fatal heart injury. The pathophysiological processes leading to cardiovascular complications are various: anoxia caused by arrest of breathing or by initial dysrhythmia, massive catecholamine release, central nervous system stimulation, direct myocardial necrosis, or contusion (4, 5, 8).

Heart arrest is caused by sudden depolarization of the entire myocardium. Of the persons who die of LI, 75% have cardiopulmonary arrest. Unless anoxia or other complications develop, spontaneous sinus rhythm returns. Arrhythmias appear relatively less frequently, and for the discharge to hit during a vulnerable phase of heart must do so between the start of the T wave and its summit Then ventricular and rarely atrial fibrillation appears. Ischaemic-anoxic changes of the myocardium afflict exclusively the superficial layers, but never the sub endocardial. Total transmural necrosis in autopsy have been described in fatal casualties. Ischaemic-anoxic myocardial changes can lead to the development of cardiac dysfunction as late-effect. An "angina pectoris electrica" that lasts weeks to months has been described after LI. Excessive initial catecholamine release may be manifested by transient hypertension, tachycardia, and cold and cyanosed extremities The heart lesion dynamics may be appropriately monitored by electrocardiography (4, 8).

Musculoskeletal injuries may originate on the basis of the violent muscle contraction caused by the lightning discharge, as a result of severe vasoconstriction, but especially from falls and secondary injuries. Ruptures of muscles, tendons, fractures of bones, oedemas and necrosis of muscles often appear. Anaerobic clostridium infection of the necrotic muscles is but an exception.

Profound burns can lead to coagulation necrosis, up to carbonification of bones and muscles (4, 8, 18).

Eye and ear lesions produced by lightning occur in acute and late forms. At the acute phase, various disturbances of visual acuity appear, which may be caused by corneal ulceration or perforation, injuries of the retina or optic nerve. In the hearing apparatus, there are frequent ruptures of the tympanic membrane, occasionally accompanied with injuries to the ossicles and sometimes temporal bone injury or lesions in the inner ear structures: Neurosensory deafness and dizziness are frequently described. Cataract may develop relatively often as an after-effect with a few months' or even years' delay. Pathophysiologically, the development of this cataract is not yet quite clear: is it caused by the direct thermal effect or by the luminous effect, the so-called flash mechanism (4, 20).

LIs differ from high-voltage injuries in several ways. In the case of lightning, there is a direct current, although of great intensity, great energy, and short duration. Generally, it is less dangerous for the human organism than an alternating high-voltage current, which potentially produces a longer effect. LI has more frequently caused heart arrest, while high-voltage alternating current ventricular fibrillation. Also the burns in the case of LI are more superficial and -commonly smaller in extent (4, 16, 17).

Fatal casualties.

Fatal casualties amount up to 30% of the victims. The cause of death is mostly cardiac (heart arrest or arrhythmias), other causes are electric shock and brain injury. Sudden death can also occur after a “direct stroke” of lightning, with-tearing and avulsion of inner organs. Breathing paralysis can be of central nervous or peripheral origin, and thus a generalized disorder of transmission of impulses across the neuromuscular junction or a sudden metabolic disorder in muscles and can also be fatal. As brain injuries leading to death have been found at autopsy brain oedema with point haemorrhages and dispersed lesions of ganglion cells. Such changes are caused by the direct thermal effect or by metabolic disorders accompanying the passage of electric current through the brain. Passage of the current from the surface of the skull is facilitated also by transmission through the venae emissariae directly to the cerebral cortex. Late deaths caused by lightning can be secondary on myocardial lesions and also on damage of other organs - kidneys in myoglobinuria, brain in subdural haematoma, spinal column in demyelinating myelopathy (1, 4, 8, 18).

Auxiliary Investigations

Careful electrocardiogram monitoring is the most important of all auxiliary investigations. The typical changes are an ST segment depression, T wave inversion, QT prolongation, P wave changes, and arrhythmias. In rather extensive muscle injury, myoglobinaemia and myoglobinuria may appear and renal failure develop. Disintegration of muscles brings about an increased level of total creatinkinase. Intravascular haemolysis may lead to haemolytic jaundice (5, 8).

In victims with disturbed consciousness, seizures, and other cerebral symptoms, an important examination is bran CT, which can detect oedema, cerebral necrosis, haemorrhage, subdural haematoma; and electroencephalography, which is able to discover focal and diffuse changes and also specific paroxysmal changes. For persistent paresis or signs of neuropathy, an important

method is electromyography, which can evaluate the character and suggest a prognosis of the lesions (8, 18).

First-Aid Measures.

First-Aid measures after Ll have some specialities. Frequently many people are .injured and the unconscious victims ought to be resuscitated first, although they appear to be dead to the layman. This will ensure that those victims without changes of consciousness will have a good prognosis prospectively even when they have suffered severe injuries. Owing to the deceleration of degenerative charges in the brain from anoxia, the success of resuscitation appears to be frequent also after prolonged delay. Following technical rescue and securement of the victims against possible further injury (fall) in an exposed terrain; cardiopulmonary resuscitation begins. An initial stroke on the breastbone is the important measure in attempting to return the Spontaneous sinus heart rhythm in the very frequently occurring cases of commencing heart arrest. Then follow clearing of the airways, mouth-to-mouth breathing and outer heart massage. The next acts of premedical self-help and mutual help are treatment of other injuries, antishock measures, and transport of the victim (1, 4, 5).

Medical aid includes qualified help on the spot, during transport, and in the health centre. Every person injured by lightning should be monitored (ECG) and observed in an intensive care unit. Victims of LI have to be managed as patients with polytrauma, burns, and developing shock. Shock control is very important, so is hydration (especially in myoglobinuria by in the crush syndrome), administration of corticoids (in brain oedema), management of fractures and injuries of the skin and muscles (in muscle swelling also fasciotomy is necessary). Intravenous administration of beta-blockers is very effective, if there are signs of excessive catecholamine release with tachycardia, hypertension, and pallor. Epileptic seizures usually disappear soon after intravenous diazepam. Tetanus prophylaxis is necessary in all victims, but antibiotics need not be given. With delayed cataracts an expecting attitude is recommended, because relatively often the cataract resorbs spontaneously. In patients with tympanic membrane perforation, similarly, a 6 - 12 months' delay of tympanoplastic surgery is recommended, since spontaneous healing can be delayed by the hare done to vascular supply by the lightning (1, 4, 5, 8, 20).

Case Analysis.

For illustration, two characteristic case reports of LI in mountaineers are presented below.

Case 1. A 25-year-oldd construction technician, an experienced climber, was injured by a ball lightning during the last pitch of ascent in Travnik in the Julian Alps (Yugoslavia) on 26. 8. 1982. The entrance point of the lightning was behind his left ear and the exit point on his right foot. His partner immediately made all resuscitative efforts including the stroke on the sternum and outer heart massage. The initial coma lasted 30 minutes and then confusion with unrest continued for 2 hours. This injured mountaineer was hospitalized for 10 days and, in all, was disabled from work for only one month. The auxiliary investigations yielded an only positive finding in electroencephalography, where focal changes in the left fronto-parietal area with signs of increased disposition to seizures lasted for 4 months. He was medicated with diazepam, 3 times 5 mg daily, and the EEG signs entirely normalized. In the clinical picture there was only a slight sensory disturbance on the dorsal surface

of the right foot, the place of the exit point of the lightning. During the subsequent period he was very active in mountaineering. Unfortunately he died in 1988 after having conquered the Marmor pillar on Chan-Tengri (6995 m) in Tian-Shan during the descent from this mountain.

Case 2. A 30 years old designer, an active climber for a long time, was hit by lightning on the summit ridge of Lysskam in the Wallis Alps (Switzerland) in August 1973. He was the last of three climbers to have ascended the wall and the three of them were walking at some distance in between. In the thin mist the climber had been hearing the buzzing of ace-ayes for a few minutes. The discharge was so silent that the other two climbers did not notice it and were surprised, to find their partner lying on the snow and injured by lightning when they had not any thunder. The discharge passed from between the helmet and the top of the head, along the neck, trunk, and both legs to the leather boots and crampons. The injured climber had been unconscious about ten minutes and was immediately resuscitated. The he was disoriented for a short time, but there was no amnesia. Because of severe disturbance of equilibrium and the pain in his calves, he was not able of stand and walk and was therefore drawn on the snow by his partners. From emergency bivouac he was transported to Zermatt by a helicopter, He suffered severe burns of the skin, subdermal layers, superficial layers of the occipital bone, and deep burns of the left heel and dorsum of the right foot that required a few weeks´ hospitalization. After 1.5 months he was able to make only a few steps with assistance owing to persistent disturbance of equilibrium; after three months from the date of the injury he was able to run on skis (but kept falling); after 8 months he was climbing quite well although he remained very uncertain and would often fall down while walking. He began to run after 1.5 years. Nowadays he complains only of not feeling fully certain when running or walking and he is still a very active and good climber.

Prevention of Lightning Injury.

Prevention of LI requires not only qualified tour planning, but also special knowledge of meteorology and the physical relations in mountainous terrain. Before planning a tour one must pay careful attention to the weather forecast (TV, radio) and examine and follow the weather locally with respect to the possible occurrence of a thunderstorm (temperature. type of clouds, mist). The tour should to be planned so as to avoid afternoon thunderstorms as much as possible. It is necessary to start the tour early in the morning so as to return, depending on the weather, about noon from exposed terrain (4, 8).

The risk of LI increases with the presence of thunderstorm clouds (cumuli and cumulonimbi) and of "good conductors" in the close surroundings. These can be minerals (granite, crystal slate, radioactive sediments), certain trees (larch, oak, maple, beer, lime), ground water, springs, watercourses, and also moistened soil. There is lesser danger of LI while the mountains are in mist, in region of poorly conducting minerals (compact limestone. scree, grainy soil), and fir trees perhaps also attract lightning less (8).

The safest shelter in the case of a thunderstorm it a building or car. Mostly one does not have such an opportunity and so good conductors in one's surroundings should be avoided. Dangerous can be secured ascents so-called "iron routes" with steel ropes or chains, and one should avoid shelter under trees especially, fissures in rock in the vertical direction (overgrown by grass and moist), boundary lines of rocks, also in valleys and saddles. Unsuitable is shelter in a cave unless it

is roomy. Danger of being struck via round currents threatens at the entrance, the rear, or the walls of a cave. It is safer if there is a gap of not less than 1.5 meters between the roof and one's head. For the same reasons it is not safe to seek shelter under small overhangs. One should not belay in the vertical direction, especially using a wet rope. In view of possible heart complications in the case of a lightning stroke, rope belay across the chest should be avoided, but securement by means of sit-harness or rope bound around the buttocks is recommended. A longer stay in an open plain terrain can perhaps also be dangerous, because a lightning channel can develop during the storm. Nowadays the opinion prevails that it is not necessary to be devoid of metallic mountaineering sports outfit (hammer, ice-axe, screws, and chocks). The ice-axe should be positioned horizontally and, together with all other metallic equipment, kept at sufficient distance from the shelter.

In the case of acute danger of LI during a tour, one ought to try find the best shelter in the surrounding terrain. The most suitable seems to be a certain depression that is at least 2-3 meters off the wall or, in a plain area, 10-12 meters away from any conspicuous elevation. It is important to curl up in a squatting or sitting position on a dry rope, isolating mat, or rucksack affording isolation from the ground. To prevent generation of stride potentials, the legs should be kept close together, the arms close to the trunk, and hands clasped or nearly so. Because of ground currents it is forbidden to lie down on the ground. Covering with Zdiarsky's sack is suitable, but according to the newest information an aluminium foil cover so often recommended in the past can be risky in some cases.

If a storm should come during a mountaineering ascent in difficult terrain, stay on the summit or exposed ridge should be avoided. One is not recommended to stand upright. From such exposed places it is better to return to the wall. A sitting or squatting position on dry rope can also be taken on the small platform, with the feet and hands close together and no vertical belay (4, 8, 11, 14).

Conclusion.

The danger of being struck by lightning in mountainous and rocky terrain is surprisingly great. Various types of lightning and different ways in which lightning strikes have been responsible for the very multiform clinical pictures encountered in lightning-injured persons. Primary and secondary injury can be incurred. Different organs, especially the skin, heart, nervous system, muscles, bones, and sensory organs, especially the eye and the ear can be affected. Sometimes LI leads to late effects (heart dysfunction, cataracts, demyelinating and degenerative cerebrospinal disorders, “psychic changes”). In rendering first-aid the rule is to concentrate all resuscitative efforts on victims with disturbed consciousness and to use the initial stroke on the sternum to reverse heart arrest. Even resuscitation applied long after the lightning stroke has repeatedly been successful. With appropriate medical management, LI patients with polytrauma, burns, and evolving shock have been cured. Initially they should hospitalized at intensive care units and monitored electrocardiographically. Emphasis should be placed on prevention, which implies knowledge of meteorology and the physical environment and qualified planning of tours. When a man is caught up in a storm, then rational behaviour, especially search for the safest possible shelter and position is recommended.

References.

1. Apfelberger D.B., Masters R.W., Robinson, D. W.: Pathophysiology and treatment of lightning injuries J. Trauma 14: 453-460. 1974. **2.** Bartholomew C. W., Jacoby W.D., Ramchand S.C.: Cutaneous manifestation of lightning injury. Arch Dermatol 111. 1456-1458, 1975. **3.** Bohuš I.: Casualties in the High Tatras (in Slovak). Krásy Slovenska 64: 19, 1987. **4.** Craig S. R.: When lightning strikes. Postgrad Med, 79, 109-124, 1986. **5.** Cwinn A.A., Cantrill S.V.: Lightning injuries. J Emerg Med 2: 379-388. 1998. **6.** Dixon G.F.: The evaluation and management of electrical injuries. Critical Care Med 11: 384-387. 1083. **7.** Esses S. T., Peters W.J.: Electrical burns: pathophysiology and complications. Canad J Surg 24: 11-15. 1981. **8.** Flora G. (ed.): 4. Internationale Bergrettungsärzte-Tagung. München-Gräfelfing. Werk-Verlag Dr. Edmund Banaschewski. 1974. **9.** Hunt J. L., Mason A.D., Mastersen T.S., Pruitt B.A.: The pathophysiology of acute electric injuries. J Trauma 16: 35-340, 1975. **10.** Kobernick M.: Electrical injuries: pathophysiology and emergency management. Ann Emerg Med 11: 533-535, 1982. **11.** Mägdefrau H., Schubert P.: DAV-Unfallstatistik 1979-1982. In: Schubert P., Mägdefrau H. (eds.): Sicherheit im Firn und Eis. Tätigkeitsbericht 1860-1983. München, Deutscher Alpenverein, 1984. p. 27-28. **12.** Panse F.: Electrical trauma. In: Vinken P.J., Bruyn G.W.: Handbook of Clinical Neurology Vol. 23, part I. Amsterdam. , North Holland Publishing Company, 1975, p. 623-729. 1**3.** Peters W.J.: Lightning Injury. Can Med Assoc J 128: 145-150. 1983. **14.** Reitmeyer: Blitz-Unfälle in der Hohen Tatra. In: Flora G. (ed).: Internationale Bergrettungsärzte-Tagung. München-Gräfeling, Werk-Verlag Dr Edmund Edmund Banaschewski, 1974. p. 62-63. **15.** Rotman I.: Fatal Accidents in Mountaineering. In: UIAA Mountain Medicine Conference "Medical Aspects in Mountaineering" Prague 1988. **16.** Skoog, T.: Electrical injuries. J Trauma 10: 816-830. 1978. **17.** Vincenti F.C., Mochief J.A., Pruitt B.A.: Electrical injuries: a review of 6S cases. J Trauma 9: 497-507. 1950. 1**8.** Vojtišek P., Ehler, E.: Lightning injury (In Czech). Prakt. Lék (Praha) 66: 415-417, 1985. 1**9.** Williamson J.E., Reader R.: Accidents in North America Mountaineering, 1982. New York - Banff. The American Alpine Club and The Alpine Club of Canada. 1982. **20.** Youngs R. Deck J., Kwok, P., Hawke, M.: Severe sensorial hearing loss caused by lightning. Arch Neck Surg 114: 1184-1187. 1986.

MOUNTAIN ACCIDENT – SEVERE ABDOMINAL BLEEDING – FIRST AID?

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Abstract

Severe bleeding in the abdominal cavity is always a situation difficult to resolve in the mountains. The.possibility of the first aid presents the counter pressure of the abdominal wall of the compressive bandage. In the mathematic-physical model, a group of volunteers and experimental animals the efficiency and limiting factors were confirmed. For satisfactory compression 40-50 mmHg are enough, which is available even in improvised circumstances by the fixation and pressing of the soft pelot on a half of its initial height. Simultaneous bandage of lower extremities is necessary, bleeding under compression has to be carefully stopped. Prevention of the acidosis and developing of the turniquet syndrome consists in controlled interruption of the compression.

II. ACCIDENTS IN HIGH-ALTITUDE MOUNTAINEERING

DEATH DURING MOUNTAINEERING AT EXTREME ALTITUDE

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Each year the mountaineering press contains too many reports of fatalities on expeditions. Two years ago Alan Rouse and Julie Tullis died on K2 after 5 nights above 8,000 meters. We can't be sure of the precise cause of their deaths, but we do believe that at last some tragedies, like those on K2, must be avoidable.

We have attempted to identify the factors contributing to loss of life on British expedition over the past 20 years (Fig. 1.). We chose peaks over 7000 m because they were likely to have received more detailed reporting and provided a finite source of data.

Fig. 1. Deaths at high altitude. 1968-1087

83 British Expeditions
7000 nerves or above
533 Mountaineers

Fig. 2. Fatalities at extreme altitude.

23 deaths of the 41 peaks visited
1 death every five expeditions
Mortality rate: 4.3% (23/533)

During this period 533 mountaineers went on 93 such expeditions. Our analysis showed there were 23 deaths on 10 of 41 peaks visited (Fig. 2). One death every fifth expedition or 4.3% of those visiting these high mountains.

We arbitrarily divided the fatalities into those occurring below 6500 m and those above. Table 1 shows the principal cause of death as gleaned from expedition reports (1) divided into these two altitude categories. Below 6500m 7 deaths were thought to have been caused by accidents and 1 from high altitude cerebral or pulmonary oedema. Above 6500 m 9 were accidents. 3 were due to high altitude complications and three were of unknown cause. Expressed another way (Table 2) nearly all deaths below 6500m were caused by falls, rock fall or avalanche which are unfortunate accidents associated with the hazards of the terrain of the Great Ranges and probably not associated with hypoxia. At these more modest altitudes mountaineers are very aware of the problems of acclimatisation.

Table 1.

	Altitude		Total
Cause of Death	<6500m	>6500m	
Falls, rock fall, avalanche	7	9	16
Cerebral/pulmonary oedema	1	3	4
Uncertain	0	3	3
Total	8	15	23

Table 2.

	Altitude		Total
Cause of Death	<6500m	>6500m	%
Falls, rock fall, avalanche	88	60	59.6
Cerebral/pulmonary oedema	12	20	17.4
Uncertain	0	20	13. 0
Total	100	100	100. 0

In the higher category only one fifth of fatal accidents were definitely associated with altitude hypoxia. However, it seems likely that in those deaths apparently due to objective dangers there are important components of misjudgement, disorientation or exhaustion caused by severe hypoxia. The Table 1 shows that twice as many climber died above 6500m as died below, suggesting that hypoxia may have a causal role in these accidents.

It seems that mountaineers are still unaware of the danger of hypoxia at these extreme altitudes. Once they have overcome the unpleasantness of acclimatisation at lower altitudes they are still at risk from sudden onset of high altitude pulmonary oedema/high altitude cerebral oedema.

At least some of these deaths could have been prevented if early signs of cerebral or pulmonary oedema had been treated by rapid descend, the use of oxygen and dexamethasone.

Bottled oxygen would almost certainly have reduced the number of both traumatic and medical deaths but its use is limited for logistic reasons and only one individual in our study was using it.

We urge the extreme altitude mountaineers of the 1990's to take heed of these figures and reduce this unacceptable high mortality.

(1) Mountain Magazine (1968-1887) 1-118, Sheffield.

AN ANALYSIS OF THE DEATHS ON K2 IN 1986

B.L. Holt, Doctor to the British K2 Expedition 1986

Abstract

During the summer of 1986 nine different expeditions were given permission to climb K2. A total of twelve climbers including Alan Rouse, the leader of the British team, lost their lives in different accidents. An analysis of the deaths is presented by the British doctor, who has specialized in problems of hypoxia and the causes involved. When considered in conjunction with other recent Himalayan climbing accidents, certain conclusions are reached concerning high altitude deaths. In particular the problems of climbing at extreme altitude without oxygen are examined.

In the summer of 1986 no less than nine different expeditions were given permission by the Pakistan authorities to attempt K2. This put a great strain on the resources of the area and some of the later expeditions had difficulty in recruiting porters for the walk-in base camp. The result of this excessive number of expeditions led to some unfortunate incidents and at least four of those offering their services as porters perished along the way from Dassau to Concordia. The early expeditions had not only the best porters, but also reasonable clean camp sites on the trek to base camp.

The first expeditions to arrive were those of Maurice Barrard and Renato Casarotto closely followed by the British expeditions of Alan Rouse. The main base camp area on the Goodwin-Austin glacier rapidly assumed .the proportions of a small village with the arrival in early June of an American Expedition and the Italian "8,000" Expedition.

At this time the weather remained comparatively clear and the British made good progress on the long North West Ridge route, establishing an advance base and two further camps.

The first of many disasters struck on June 21st when the Americans attempting the South Pillar had two of their climbers killed in an avalanche.

The body of the expedition leader Jon Smolich was never found, but that or Alan Pennington was recovered and buried at the Gilkey Memorial above the base camp.

During this period of good weather, two Spaniards from Casarotto's team made the first ascent of the season, and were followed by all four members of Maurice Barrard's team. On the descent Maurice and Lilian Barrard fell behind and although Michael Parmentier waited for them, they never appeared at Camp IV. The weather was deteriorating at the time and high winds had sprung up. It may be that they were blown off the ridge. Lilian's body was later recovered by the Korean expedition and was buried at the Gilkey Memorial.

The Americans, after their tragic loses, abandoned the South Pillar route as did the Italians. On the 5th June six members of the Italian expedition reached the summit by the Abruzzi Ridge and were followed by two members of Herrligkoffer's International Expedition. Two members of the Polish team succeeded in reaching the summit on 8th July by a new route up the South Face. While descending the Abruzzi Ridge in bad weather Piotrowski who had lost a crampon slipped and fell to his death.

During this time the British expedition had been continually hampered by bad weather and in mid-July decided to attempt the Abruzzi Ridge instead of the intended North West Ridge.

On the 13th July Casarotto was descending the lower slopes from Camp 1 to Base Camp after reaching a point only 200 meters below the summit on the South West Ridge. He abandoned his solo attempt because of bad weather. When only about, two hours from Base Camp he fell through a snow-bridge into a crevasse. Although injured he was able to radio Base Camp for help. At first it was not thought to be too serious and a few climbers from various camps went to his assistance. At midnight a call went out for a major rescue attempt and although he was hauled from the crevasse he had obviously suffered major internal injuries and he died despite all efforts to save him.

Towards the end of July many expeditions had decided to withdraw and only the Austrian and Korean expeditions were left to make their first attempts at the summit via the Abruzzi Ridge.

The remnant of several other expeditions also made an attempt at this time. An August 3rd three members of the Korean expedition reached the summit followed closely by to Poles. Wojciech Wroz disappeared during the descent to Camp IV.

On August 4th two of the Austrian Imitzer and Bauer reached the summit closely followed by the leader of the British expedition Alan Rouse. These-three descended to Camp IV with Wolf who failed to make the summit. Diemberger and Tullis who had previously been over 8,000 m with the Italians also reached the summit late in the evening and had to bivouac on the descent to Camp IV.

The weather deteriorated rapidly and although Diemberger and Tullis made it back to Camp IV on 5th August it was impossible to descend further and everyone was trapped by a ferocious storm. It appears there was insufficient fuel to smelt snow and dehydration was a major problem, and the fact that there were insufficient tents.

Tullis who had been suffering double vision presumably as a result of cerebral oedema died during the night of 7th August. Of those trapped at Camp IV, Tullis. Imitzer, Wiener and Wolf perished, the last three during the descent which was attempted on 10th August. Rouse was incapable of moving and was left in his tent. Wolf died probably as the result of abseiling and Imitzer and Wiesser collapsed from exposure.

In all there were 13 deaths on K2 during that summer of 86. Some of these were obviously due to unavoidable accidents but certain lessons can be learnt.

Of those who were successful it is obvious that they spent relatively short time at altitude and in the cases of Rouse, Diemberger and Tullis all three had been at base camp for over two months and had been to over 7,000 m on at least one occasion. They had all three suffered considerable physical deterioration and this is very obvious from the photographs taken of Alan Rouse.

The deaths of the two Americans and Casarotto occurred at relatively low altitude and can be considered to be pure accidents that were not related in any way to altitude. The accidents of the two Poles, Piotrowski and Wroz were also accidents but altitude and fatigue were undoubtedly factors that may have caused them to lose concentration.

The deaths of the husband and wife team of Maurice and Lilian Barrard is something of a mystery because they were descending not far behind Parmentier. We know that Morice was not feeling well and had received medication, and he may have slipped and fallen, taking Lilian with him.

The deaths of Julie Tullis was almost certainly a result of cerebral hypoxia, and she had been demonstrating symptoms of this before reaching Camp IV when fuel ran out and the weather prevented any retreat.

The deaths of Imitzer and Wiesser were also due to exhaustion combined with exposure, and Wolf may have died as a result of abseiling, with which she was having difficulty. With the profusion of fixed ropes on the Abruzzi, it is surprising that more accidents did not occur, because in bad weather it was difficult to see which ropes were new and safe and which were old and rotten from previous expeditions.

In the final analysis it would seem that climbing to over 8,000 m without oxygen requires good weather and extreme fitness so that the time spent above 7,000 m is kept to an absolute minimum. After arriving at base camp there is a continual period of acclimatization about three weeks when a climber probably reaches maximum fitness. He will remain at this peak for a period of approximately another three weeks and any summit attempt should be made in this time. After about six weeks at base camp and above, a slow deterioration begins to take place and although the temptation to make a summit bid may be strong it must be realized that as time progresses it becomes potentially more dangerous. This the lesson that must be learned from the Deaths on K2.

INCIDENCE OF ACUTE MOUNTAIN SICKNESS ON THORONG-LA (5400 m), NEPAL.

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The results of an epidemiological study on Acute Mountain Sickness (AMS) are discussed. AMS was studied with the use of questionnaires in trekkers going over the Thorong pass (5400 m) on the trek around Annapurnas. These questionnaires consisted of two parts, a general part with questions on items like sex, age, weight, personal rate of ascent, knowledge about AMS and a measuring part consisting of several copies of the Environmental Statistical Questionnaire III (Sampson et al., 1983).

During a period of 8 days in November 1986 questionnaires were issued to every trekker coming through Manang (3535 m) or Muktinath (3800 m, opposite side of the pass) on their way to the pass. 500 questionnaires were issued, 371 were returned, 353 were used for analysis.

We considered trekkers with scores over 0.7 for AMS-C (cerebral score) and 0.6 for ANS-R (respiratory score) to suffer from AMS.

The overall risk of AMS was 58%. The risk of developing AMS-C was 38% and of AMS-R 54%; 38% developed both AMS-C and AMS-R. AMS was positively correlated with speed of ascent and negatively correlated with pre-trek acclimatization. Women suffered from the condition more often and developed more serious AMS than men. We found a positive association between the body mass index (weight/squared length) and AMS. We also found evidence that a good physical condition in trekkers over 35 year's age could be protective against AMS. We found no significant association between AMS and smoking habits, use of oral contraceptives, previous high altitude experience, special pre-trek training, size of trekking party, or kind of travel organization. Eighty per cent of the trekkers had good knowledge of AMS.

References

1. Shlim, D.R., Motamedi, M., Houston, R.: Trekking accidents in Nepal: A basis for advising adventurous travellers. Proceedings of the Conference on International Travel Medicine in Zurich. April 5-8. 1988. Springer Verlag, Heidelberg, in press. **2.** Milledge, J.S.: Acute mountain sickness. Thorax, 1983; 33: 641-645. **3.** Hamilton, A. J. Cymmerman, A., Black, P.: High altitude cerebral oedema. Neurosurgery 1997, 19: 841-849. **4.** Shoene, R.B., Hackett, P., Henderson. W. R., Sage, E.H., Chow, M., Roach, R.C., Mills, W.J., Martin, T.R.: High-altitude pulmonary oedema. J. Am. Med. Assoc. 1986; 255: 53-59. **5.** Sampson, J. B., Cymmerman, A., Burse, R. L., Maher, J.T., Rock, P. B.: Procedures for the measurement of acute mountain sickness. Aviat. Space Environ. Med. 1983; 54: 1063-1073. **6.** Johnson, T.S., Rock, P.B., Fulco, C.S., Trad, L.A., Spark, R.P., Maher, J.T.: Prevention of acute mountain sickness by dexamethasone. N. Engl. J. Med., 1984; 310: 683-686. **7.** Birmingham Medical Research Expeditionary Society. Mountain Sickness Study Groups. Acetazolamide in the Control of acute mountain sickness. Lancet 1981; i: 180-183. **8.** Hackett, P.H., Rennie, D.: The incidence, importance, and prophylaxis of acute mountain sickness. Lancet 1976; ii: 1149-1154**. 9.** Hackett, P.H.: Acute mountain sickness. Lancet 1077; i: 491-492. **10.** Wilkerson, J.A. (ed.): Medicine for mountaineering. 3rd edition. Seattle. The Mountaineers. 1995. **11.** Richalet, J.-P.: L'adaptation a l'altitude. La Recherché 1987; 18: 1492-1492. **12.** Scoggin, Ch., Myers, T. M., Reeves, J.T., Grover. R. F.: High-altitude pulmonary oedema in the children and young adults of Leadville, Colorado. N. Engl. J. Med. 1987; 297: 1269-1272. **13.** Dickinson. J.G.: Terminology and classification of acute mountain sickness. Br. Med. J. 1982; 285: 720-721. **14.** Richalet, J.-P., Kéromes, A., Dersch. B. et al.:

Characteristiques physiologiques des alpinistes de haute altitude. Science et Sports; 1988; 3: 147-156. 1**5.** Lobenhoffer, H.P., Zink, R.A., Brendel. W.: High-altitude pulmonary oedema: analysis of 166 cases. In: High altitude physiology and medicine. Brendel, W., Zink, R.A. (eds.) Springerverlag, New York - Heidelberg - Berlin, 1982, P. 18--32. 1**6.** Takano, N: Reflex hypoxic drive to respiration during the menstrual cycle. Resp. Physiol. 1984; 65: 229-235. **17.** Hackett. P.R., Rennie, D.: Rales, peripheral oedema, retinal haemorrhage and acute mountain sickness. Am. J. Med. 1979; 67: 214-219. 1**8.** Boyer, S. J., Blume, F. D.: Weight loss and changes in body composition at high altitude. J. appl. Physiol., 1984; 57: 1580-1585. **19.** Hackett, P.H., Rennie, D.: Avoiding acute mountain sickness. Lancet, 1979; i: 939. **20.** Micozz, M.S., Albenes, D., Jones, Y., Chumlea, W.C.: Correlations of body mass indexes with weight, stature and body composition in men and women in NHANES I and II. Am. J. Clin. Nutr, 1985; 44: 725-731.

HIGH ALTITUDE CEREBRAL OEDEMA

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Abstract

Neurological problems at altitude were recognised by the European physiologists of the 19th century and many of the features of what we would today call early Cerebral Oedema were described by Dr. Thomas Ravenhill in South America in 1913. The subject received little further attention until the later 1960's and early 70's when it became apparent that the cerebral features in severe Acute Mountain Sickness (AMS) were common, occurring either in isolation, or with High Altitude Pulmonary Oedema. The "Cerebral Forms of AMS" and "High Altitude Cerebral Oedema" were used to describe these clinical conditions.

We now recognise that Cerebral Oedema occurs in two different settings;

1) Cerebral Oedema of Acclimatisation. This is a common syndrome of headache and ataxia with a variety of neurological signs, which may progress to stupor, coma and death. It occurs during ascent from altitudes of 3000 to 5000 meters.

2) Cerebral Oedema of Extreme Altitude. This describes the sudden deterioration of brain function and appearance of Cerebral Oedema in climbers above 5500 meters who are apparently well acclimatised. It is probable that many deaths at extreme altitude have been caused, at least in part by this condition.

The neuropathology is of brain oedema, arterial and venous infarction. Changes in cerebral blood flow in response to hypoxia, polycythaemia and changes in clotting and fibrinolysis contribute to the pathophysiology.

Treatment, as with other forms of severe AMS is with descent and dexamethasone. Early recognition is important. Regular ophthalmoscopy and haematocrit measurements may help to decide which climbers may be at risk or who show early signs of oedema at extreme altitude.

Other neurological problems also occur at great height: cerebral infarction, either cortical or brain stem, and transient cerebral ischaemia are described. Classical hemicranial migraine also occurs at altitude, epilepsy may be precipitated by AMS in susceptible subjects.

This paper reviews the clinical and practical aspects of these important high altitude problems.

Introduction

The relationship between cerebral pathology and high altitude has been suspected since the nineteenth century (Professor Angelo Mosso and others) and in 1913 the British physician Dr. Thomas Ravenhill described "nervous" and "respiratory" symptoms in Acute Mountain Sickness. It is however only during the last two decades that other have emerged the clear clinical descriptions of the conditions now known as High Altitude Cerebral Oedema (HACO), or, more broadly as the Cerebral Forms of Acute Mountain Sickness. The occurrence of brain oedema and change in brain blood flow in response to hypoxia are now recognized as being of fundamental importance in our understanding of many altitude-related diseases.

Cerebral oedema at high altitude may be classified as follows:

High Altitude cerebral Oedema	a) of Acclimatisation
	b) of Extreme Altitude

We need to distinguish it from other events caused by chronic hypoxia for example stroke and psychological disturbances.

CEREBRAL OEDEMA OF ACCLIMATISATION

Clinical features

Ascent to altitudes above 3500 meters is accompanied frequently by the self-limiting illness of Acute Mountain Sickness (AMS) but in a small proportion of cases this progresses, often unpredictably towards High Altitude Pulmonary Oedema and/or Cerebral Oedema.

Cerebral Oedema is rare below 3500 meters; the patient is usually aged between 15 - 45 years and usually has some symptoms of AMS for several days before developing a severe headache with many features of an intracranial origin – it is worse on coughing, stooping and straining; the patient may have to sit up constantly to remain comfortable. Psychological changes may occur in the early stages varying from irritable and irrational behaviour to obvious delusions, hallucinations and confusion. Clouding of consciousness with somnolence, stupor and coma follows. Early clinical features are of ataxia, particularly truncal, causing a staggering gait; there is a slurring of speech and double vision. Irregular periodic respiration is usually present and may be an early finding, particularly at night. A wide variety of neurological signs may be present – papilledema, cranial nerve palsies, nystagmus, truncal and limb ataxia, pyramidal signs and neck stiffness. The development of this clinical picture may be acute, over several hours or gradual over several days. Recovery may occur at any stage but once coma ensues the mortality is over 60%s.

Cerebral oedema has serious implications and a typical case history is given below.

"A 40 year old previously fit male, flew to 2750 meters and over the next five days walked to 5200 meters. He developed severe headaches and became stuporous. 24 hours later he was in coma: There was papilledema, neck stiffness, and extensor plantar responses. He died 48 hours after the onset of the illness."

Pathology

The morbid anatomy of cases of HACO has received detailed study. Macroscopically the brain is oedematous with flattened gyri. Tonsillar herniation may be present. Histological examination shows widespread petechial haemorrhages, small intracerebral haemorrhages and sometimes cerebral venous thrombosis.

Investigation

Clinical investigation during life of cases of established cerebral oedema has added relatively little to the knowledge gained from the clinical picture and morbid anatomy. Detailed physiological studies have often been precluded by the clinical setting of as severe illness at high altitude. CT scanning has shown small or normal ventricular size with periventricular low attenuation areas characteristic of oedema. EEG slow wave changes seen in many diffuse cerebral disease also occur.

Lumbar puncture, which is usually in this condition, has shown fluid at an increased pressure. The constituents are usually normal though there may be xantochromia.

Pathophysiology

Any hypothesis explaining the development of cerebral oedema must unite the following factors:

a) clinical symptoms,

b) postmortem findings,

c) changes in cerebral blood flow in response to hypoxia,

d) time course of the condition in relation to exposure to hypoxia.

The clinical picture is consistent with the pathological findings – there is evidence of severe generalised extracellular brain oedema with haemorrhagic micro-infarction. The neurological findings are due to the combination of these pathological processes – for example the ataxia, presumably due to early tonsillar herniation, or a hemiparesis, presumably due to micro-infarction.

The elegant yet simple hypothesis of Sutton and Lassen ("AMS and HAPO have a common pathophysiological basis: both are due to increased pressure and flow in the micro-circulation, causing oedema in the brain and oedema in the lung"), does much to elucidate altitude-related disease. What their hypothesis does not explain is the time course of Cerebral Oedema (which usually develops several days after arrival at high altitude, at a time when cerebral blood flow (CBF) should be decreasing) or the appearance of brain oedema at extreme altitudes after long sojourns (see below). We need more about cerebral blood flow in sick climbers, and also detailed coagulation studies.

Treatment

The recognition of the early stages of cerebral oedema is of great importance. Irrational behaviour, severe headaches, drowsiness and unsteadiness of gait may be the only clinical features of this serious disease. Early recognition is vital and treatment is urgent, and simple, in the early-stages. Descent rapidly to low altitudes (below

3500 metres, if possible) is imperative and is frequently followed by rapid and complete clinical improvement. Oxygen may be given if available. Dexamethasone or betamethasone given orally or by injection help cerebral oedema dramatically probably by stabilising the blood brain barrier. The usual daily starting dose is dexamethasone/betamethasone 16 mg/day, decreasing as soon as the clinical situation permits. Sedative drugs should be avoided and if possible, all powerful analgesic. Sleep may be more comfortable if the subject is sitting up. Acetazolamide may help the headache of very mild cerebral oedema.

In the author's opinion, early treatment with dexamethasone should be considered in all cases of severe Acute Mountain Sickness, and this with descent to low altitude are the only important manoeuvres in the treatment of the condition.

It is tempting in the Himalayas to arrange an aerial rescue or simply to wait at high altitude to "see how things are in the morning". Frequently, between these extremes it would have been possible to carry or walk a patient five hundred metres lower rapidly, even at night or in bad weather.

It is difficult to give an accurate prognosis for treated cerebral oedema. Mild causes merge with AMS and are clearly self-limiting. Severe ataxia of gait, papilledema and clouding of consciousness are sinister findings and of published series the overall mortality when they are present is of the order of 50%.

CEREBRAL OEDEMA OF EXTREME ALTITUDE

The literature of HACE indicates that the condition occurs most frequently during acclimatisation and that the usual factors predisposing to severe AMS are present – rapid ascent, strenuous exercise, intercurrent illness, disregarded of early symptoms of mild AMS and sedative drugs. There are however- instances of life threatening cerebral oedema which have occurred acutely in fit acclimatised climbers at extreme altitude.

Case 1. In 1975 during the fourth week above 7000 meters, a 29 year old Sherpa working at 7200 meters on the SW Face of Everest became drowsy and ataxic with a headache. He descended the fixed ropes face and was escorted to camp at 6200 meters on the Western Cwm. He could barely stand, he was sleepy and had irregular respiration. On neurological, examination there was no neck stiffness. Severe bilateral papilledema was present.

He descended to 5200 meters with assistance on the second day, having been treated with dexamethasone. He made a complete recovery by the fourth day.

Unknown to myself he re-ascended the Khumbu Icefall the following week and worked at over 7000 meters without further symptoms for a further 10 days!

Case 2. A previously fit 28 year old climber during the seventh week above 5000 meters was climbing (without oxygen) at 8200 meters on the north east ridge of Mount Everest in Tibet in May 1982. Whilst climbing he developed a sudden mild left hemiparesis. He managed to descend to a snow hole and to return next day to camp at 6200 meters. On examination he was of alert and free of headache. There was severe bilateral papilledema and a mild left hemiparesis. He descended to 5200 meters and thence to 3500 meters. A weak following the incident, having flown to Hong Hing, there were no abnormal signs. A CT scan was normal.

It is of interest that on a previous expedition in 1980 he had noticed bilateral blurring of vision with central scotomas for some days following a stay between 7500 and 8200 meters. Presumably he had papilledema.

Case 3. A 32 years old British doctor was climbing Broad Peak (8073 meters) in the summer of 1983. At about 7900 meters he became generally unwell, lethargic and unsteady on his feet, with a severe headache. Descent was attempted and a camp at. 7300 meters reached. His condition deteriorated and he became blind (or, at least, had a severe persistent disturbance of vision). Coma ensued. He died during the night.

Case 4. A forty-three year old British woman was trapped in a storm on K2 (8611 meters) in August 1986. On the evening of her fourth day above 8000 meters, after descending from the summit without oxygen, she became unsteady on her feet, somnolent and uncomplaining. She could see properly. She died during the fifth night. During the same storm, another male British climber died in similar circumstances in the same camp.

These case histories illustrate the development of cerebral oedema at extreme altitude. The condition appears to develop without warning after a sojourn around 8000 meters in previously fit apparently acclimatised climbers who are not using bottled oxygen. It can be rapidly fatal.

Recognition is essential and regular ophthalmoscopy is certainly worth consideration as one of the only methods of discovering early cases.

Dexamethasone should certainly be available at high camps.

A CASE OF SUCCESSFUL TREATMENT OF HYPOXIC CEREBRAL OEDEMA

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In August 1976 we were at 7000 m on the Peak of Communism. At 8 p.m. one day I was called by the chief of the Japanese team to examine and give medical aid to an ill Japanese climber.

After talking with him I got information about his condition. He was suffering from headache, general sickness, and he vomited. His condition went worse and worse. He stopped answering my questions and 2 hours he lost consciousness. He had not been treated or medically consulted before my visit. He was put into a warm sleeping bag and moved into a tent and he received hot and sweet tea. I sent an emergency report to the base camp. Before my visit the patient had had periodical hallucinations and urinated in his sleeping bag.

During my examination the patient was in a horizontal position, and developed a precoma condition. He reacted .n the ache test. He did not answer my questions correctly. He did not breathe loudly and did not cough. The number of breath movements was 28 per minute. I heard difficult breath above all pulmonary areas. His face and hand skin was of subnormal colour. The examination was carried out in the tent with a climber lamp. The temperature of his hands seemed to be lowered. The characteristics of his pulse were good, the frequency was about 88-92. I heard a slight systolic murmur at the base of the heart and an accentuated second sound above the aorta. There was no dysrhythmia. The blood pressure was near 150/100 mmHg. The pupils were dilated, the right pupil being wider. The ocular tonus was lowered. The hand muscle tonus was higher. Pathological signs of other systems were not present.

This condition was diagnosed as high-altitude disease complicated by hypoxic brain oedema. Based on the examination and diagnosis, the following treatment was started: Lasix 30 mg, Corglycon 0.5 mg, prednisolone 60 mg intravenously, aethaperasin (chlorpiprasin, neuropax) 10 mg three times daily per os.

Aethaperasin belongs to the phenothiazine group, but it differs from phenothiazins in some respects. When we administered aethaperasin we hoped for -antiadrenergic, sedative, antihypoxic, hypotensive, and antivomiting effects. After this treatment the patient's condition became better. His breath improved, the pulse rate decreased to .78-80, blood pressure decreased to 120/70 mmHg. The next day the treatment was repeated. The second night the condition did not get worse.

Next morning we began to transport the patient down. At 5900 m his condition became better, he could walk on his own with the help of two rescuers. The next day we reached the base camp at 4200 m. The last day he patient took aethaperasin only.

So far as I know aethaperasin has not been used in the treatment of brain oedema.

BRAIN DAMAGE AND HIGH ALTITUDES

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Abstract

Psychiatric, psychological and electroencephalographic research were realized among a group of 40 Polish mountain climbers in the years 1968-1976. Diagnostic investigations were repeated before, during, and after high-altitude expeditions. As a result of these long-term studies, the author describes the clinical features of a particular organic injury to the central nervous system, which developed in alpinists because of the traumatic influence of high-altitude stress. This syndrome occurred in 11 persons (25%). The following elements were essential in the development of this syndrome: the duration of stay at high altitude, the duration of practising alpinism, acute organic brain syndromes, and Cheyne-Stokes breathing in the course of mountain sickness as well as altitude deterioration.

High-altitude cerebral asthenia (HACA) occurred in three forms: characteropathic (6 persons), encephalopathic (4 persons), and neuroplegic (1 person). With the first form emotional disturbances prevail; with the second – a focal brain damage; and with the third – peripheral neurological dysfunction in the form of paresis. The course of HACA is chronic and progressive. Taking into consideration the specific causes and the characteristic clinical features of the disease, the author has introduced a name of HIGH-ALTITUDE CEREBRAL ASTHENIA (HACA). HACA constitutes a permanent effect of acute mountain sickness (AMS) and high-altitude cerebral oedema (HACE).

Introduction

Many authors and mountain-expedition doctors emphasize the incidence of various mental and neurological disturbances during and longer after high altitude expeditions. Usually these symptoms, are considered a result of the extreme physical effort and high altitude deterioration (5, 10, 11, 12).

The most dangerous complications in the course of acute mountain sickness (AMS) are high-altitude pulmonary (4, 5) and cerebral oedemas (HAPE and HACE; 1-3, 8). The psychopathological features of HACE comprise disturbances in the psychomotor drive, the emotional sphere, memory, criticism, orientation, and consciousness, with somnolence, stupor and coma. In the severe cases the predominant symptoms are generalized and/or focal brain injury with paresis, paralysis, convulsions, and disturbed consciousness up to coma.

The development of HACE is usually acute and the mortality is very, high (7, 9). In serious cases a residual cerebral –damage may remain for a long time or permanent. All these controversial data motivated formulation of the following question: Do climbs to extreme altitude cause brain damage? (13).

Material and methods

Forty Polish alpinists, the participants of high-mountain expeditions, were examined in the Department of Psychiatry in Krakow in the years 1968-1976. Experimental studies were carried out during the expeditions to Hindu Kush (1971) and to the Andes (1973 – 1974). Psychiatric examination were supplemented by psychological tests (Bender, Benton, Graham-Kendall, Couve)

and electroencephalography (EEG). All these studies were tarried .out before, during and after the expeditions. Catamnestic examinations were undertaken one year after the expedition and continued 6-8 years in selected cases.

All the alpinists were members of the Polish Alpine Club. Age: from 20 to 40 years (mean: 35). Marital status: 19 married, 16 single. 5 divorced. Education: university level – 32 persons; secondary or technical – 8 persons. Duration of alpinism: from 6 to 25 years (mean: 15 years).

Results.

1. Somatic and mental disturbances at high altitudes

a) High-altitude deterioration .and Cheyne-Stokes breathing were found at high altitude in 18 persons.

b) Psychological pattern of AMS:

The neurasthenic syndrome predominated: apathic-depressive (25 persons) or euphoric-impulsive (10 persons). Sixteen persons developed an acute organic brain syndrome. This syndrome consisted of the following symptoms: psychomotor retardation, reluctance to activity, depressed intellectual fitness, somnolence, alterations of orientation and consciousness. Disturbances of speech, episodes of psychomotor excitement, tremor and/or convulsions, ataxia, temporary paresis or paralysis of limbs were also observed.

2. Mental disturbances after the expedition

Permanent psychopathologic symptoms concerning the intellectual, emotional, and impulsive spheres were diagnosed after the expedition in 11 persons. In the intellectual sphere, decreased speed of thinking, worsened memory, reduction of interest, and difficulty of concentration were observed. Depressed mood, emotional indifference, impetuosity, a tendency to conflicts as well as to dysphoric and aggressive reactions were found in the emotional sphere. Disturbed drives consisted in a depression of sexual excitability and libido, as well as in worsened appetite.

Results of EEG recording

	n	normal	pathologic
Before expedition	35	32	3
At altitude	12	6	6
After expedition	23	11	12

D i s c u s s i o n

These investigations indicate that the harmful factors of high altitudes not only evoke different functional disturbances of the central nervous system during the stay in this environment, but also produce remote and even permanent cerebral damage.

High-altitude cerebral asthenia

High-altitude cerebral asthenia (HACA) represents a particular type of organic mental disorders which results from the long-lasting action of traumatic factors at high altitudes and is complicated by psychosomatic disturbances. This syndrome occurs in three forms: characteropathic (5 persons), encephalopathic (4 persons), and neuroplegic (1 person).

The following elements are essential in the development of HACA: duration of stay at high altitudes and duration of practising alpinism, acute organic brain syndromes and Cheyne-Stokes breathing in the course of AMS, as well as high-altitude deterioration. The most traumatic factors are low atmospheric and reduced partial oxygen pressures.

Psychopathological features

The axial symptoms of HACA are of an intellectual, emotional, and impulsive type. Additional symptoms determine the characteropathic, encephalopathic, and neuroplegic types of HACA.

The characteropathic type comprises disturbances of temperament and character. They consist in agitation, irritability, explosiveness and the tendency to drink alcohol. Focal injuries of CNS were absent. This type of HACA was diagnosed the most frequently (50%).

The encephalopathic type of HACA was distinguished by symptoms of focal injury. Asymmetry of tendon reflexes, inequality of palpebral fissures, nystagmus, disturbances of the field of vision, and focal abnormalities in the EEG record were observed. This type of HACA was established in 40% of cases.

One subject only developed the neuroplegic type with crossed paresis of right upper and left lower limbs. This paresis constituted the relict of a paralysis suffered by the alpinist at an altitude of 7700 m above sea level.

The organic nature of HACA was confirmed by the results of psychological and EEG examinations. In more than 50% of the HACA alpinists the results of psychological tests indicated organic pathology, and in 30%, they were on the borderline between norm and pathology. EEG records in this group reveal a generalized pathology in the form of flattening and dispersion of theta waves.

HACA should be differentiated from organic mental disorders of traumatic, toxic, inflammatory, or vascular aetiology. In the pathomechanism the direct effect of hypoxia must be taken into consideration, as well as the secondary disturbances in the cerebral blood flow and high altitude cerebral oedema.

There are experiences with the treatment of HACA. The prophylaxis should comprise administration of adequate preparations before the expedition, competent methods of acclimatization, as well as detailed medical examination before and after each expedition into high mountains.

It should be purposeful to perform follow-up studies in the group of alpinists with already existing organic brain injury and to check if high altitude exposure deepens the abnormalities or not. Expedition practice indicates that persons with organic brain injury are sometimes less sensitive to hypoxia and better tolerate the exposure to high altitudes. Verification of this observation would be to the point.

References

1. Clarke, Ch.: High altitude cerebral oedema. Int. J. Sports Med., 9 (1988), 170-174. **2.** Dalenz, J.R.: El edema cerebral de altura. Revista del IBBA, Bolivia, 2, 1979, 29-31. **3.** Hajdukiewicz,J., Ryn, Z.: Höhenödem. Medizinische Probleme bei Bergfahrten in grössere Höhen. 7. Internationale Bergrettungsärzte-Tagung. Innsbruck, 15. November 1980, Eigenverlag G. Fora, Innsbruck 1983, p. 88-92. **4.** Houston, C.S.: Acute pulmonary edema of high altitude. New Engl. J. Med., 289 (1960), 478-480. **5.** Houston, C. S.: Altitude illness. 1975 version. The Am. Alpine J. 20 (1975), 407-415. **6.** Houston, C.S.: High-altitude pulmonary and cerebral edema. The Am. Alpine J. 16 (1972), 93. **7.** Ryn, Z.: Edema cerebral de altura. Apuntes de Med. Deport., Barcelona, 53 (1977), 7-10. **8.** Rivolier, J., Cerretelli, P., Foray, J., Segantini, P.: High Altitude Deterioration. Karger, Basel, 1985. **9.** Ryn, Z.: Nervous system and altitude. Syndrome of high altitude asthenia. Acta Medica Polona, 20 (1979), 155--169. **10.** Ryn, Z.: Psychopathology in alpinism. Acta Medica Polona, 3 (1971), 455-459. **11.** Ryn, Z.: Psychopathology in Mountaineering. Mental disturbances under high altitude stress. Int. J. Sports Med., 9 (1988), 153-159. **12.** Ward, M.: Mountain Medicine. A clinical study of cold and high altitude. Crosby Lockwood Staples. London. 1975 **13.** West, J.B.: Do climbs to extreme altitude cause brain damage? Lancet, 2 (1985), 378-388.

SOME MEDICAL PROBLEMS CONNECTED WITH POLISH EXPEDITIONS TO THE HIMALAYAS AND KARAKORUM

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Alpinism in high mountains has under our eyes become a record-seeking sport. Expeditions to more and more difficult destination points are organized. Small groups ascend mountains of eight thousand meters. Face solo climbing is performed in the Himalayas. While climbing the highest mountains, people eliminate oxygen. It is a truism to say in our company that the risk of high-mountain climbing has increased under the new terms. The question is where “reasonable" risk ends and reckless action starts. I suppose that none of us can judge the degree of risk admissible as regards ethics. This trend in alpine sporting cannot be reversed. In my opinion, however, this element results in some “degradation" of the features of alpinism that used to be quite valuable.

Anyhow, hazard should be diminished as far as possible. One way is to explain to the mountaineers how serious the danger is from the medical point of view; another – is the presence during expeditions in the highest mountains of a physician well-trained in mountain medicine.

In the seventies, the Polish Alpinists' Association introduced a statutory regulation or obligatory participation of physicians in expedition in high mountains. This regulation is not always observed as physicians are short of time and much time is needed for such events (2-4 months) and the leaders are not interested in being inconvenienced by the less efficient climbers (as physician frequently are).

In the years 1971-1987 there were 116 Polish expeditions in the Himalayas and the Karakorum, 48 of them aiming to ascend eight-thousand-meter peaks. According to sports criteria, 40 of them should be classified as very difficult.

Nine hundred and eighty-six alpinists participated in the expeditions. There were 35 fatal casualties (3.54%). Another 96 persons (9.73%) suffered from serious, life-threatening general diseases. Summing up, 13.27% of participants either lost their life or their life was in serious danger due to disease.

It follows from the number of expeditions and deaths that every third expedition (30.2%) is subject to such an incident. The incidents which ended in death can be divided into two groups due to medical causes and because of accidents.

Table 1 presents the causes of medical deaths: high-altitude cerebral edema (HACE; 2 cases), high-altitude pulmonary edema (HAPE; 2 cases), high-altitude deterioration-exhaustion (HAS; 6 cases), pulmonary embolism (1 case), cardiac infarct (1 case), and fall as a result of extreme exhaustion (3 cases). In total, there were 15 deaths in this category and 10 of them were caused by HAS.

Fatal accidents are presented in Table 2. The causes were avalanche (8 cases), fall into a crevasse (1), fall when climbing (4), drowning (1), and unspecified death while climbing (6 cases).

According of these lists, 15 deaths resulted from high altitude that gives 1.5% of the expedition participants. This also amounts to 4.8% of the fatal casualties. Another 20 persons (2.02% of expedition participants) deceased due to non-medical reasons resulting from the specific character of the terrain and activity.

Table 1. Medical Fatal Casualties		**2. Fatal (nonmedical), Accidents**	
(116 expeditions – 986 alpinists)		(116 expeditions – 986 alpinists)	
HACE	2	Avalanche	8
HAPE	2	Fall into crevasse	1
Deterioration. Exhaustion	6	Fall down	4
Pulmonary embolism	1	Unspecified death	6
Cardiac infarct	1	(2 probably due to hypothermia)	
Fall	3	Drowning	1
(due to exhaustion)			
T o t a l	15 (1.5%)	T o t a l	20 (2%)

Talking about the 6 persons who perished while climbing, most probably their death was caused by hypothermia as it happened in very bad weather. The teams descended peaks 6800 to 7100 metres in height. In the quite easy terrain fall was rather impossible. Therefore the said accidents should possibly be included in the first group – death due to hypothermia.

In 8 accidents from the second group the following mistakes were made: face climbing in unstable weather, wrong choice of route on glacier, inappropriate belay and faulty operation of equipment.

The 15 deaths included in the first group should be discussed in more detail.

1. HACE caused death in 2 cases. It occurred after 4-5 days of climbing above 7200 m. In the case of 1 climber, the acclimatization should presumably insufficient. Medical treatment was not administered as there was no physician in the expedition.

Another climber had an initial phase of hypertension. He was taking hypotensive drugs and the expedition physician was not informed accordingly. HACE occurred after an unplanned bivouacking in 7600 m. He died during transport at a height of 7100 m. He was given "furosemid", without oxygen which was stored in camp IV at 7000 m (Tirich Mir).

2. HAPE, 2 climbers. The first case occurred after fast climbing to a height 7000 m without accurate acclimatization. The patient was not treated as there were no drugs, oxygen, or connection with the base.

The next case relates to a top-class climber. He had ascended the south-west ridge of Mt. Everest, the western face of Makalu, Dhaulagiri in winter, and Lhotse by the classic way – all without oxygen. HAPE occurred after a night spent at 7800 m, before a climb to the peak of Main Kandzendzonga. The course of the disease was acute, he was led down about 300 m and then transported to the camp III (7200 m), and given diuretic drugs. He did not get oxygen and complete treatment, as camp III was insufficient equipped. The physician was in the base camp at the moment. The patient died after 11 hours from the first symptoms of HAPE. In this case acclimatization had been proper. The climber was very active, but during approaching march and in mountains he suffered from chronic laryngitis and respiratory tract infection. He started the peak trial against physician´s opinion.

3. Another casualty was very dramatic and took place during a women's´ expedition on K2. The leading Polish woman climber suffered from **pulmonary embolism**. In camp II, at 6750 m, while

resting in the tent – she died suddenly. She was in apparent good condition, except for minor dyspepsia.

The next unexpected death happened on the west face of Makalu at a height of 6780 m. The Climber died while forcing a very difficult overhanging rock. Judging by the circumstances of his death, he had suffered from circulatory-respiratory insufficiency (cardiac infarct).

4. Deterioration-exhaustion caused death of 6 climbers. The people died as follows: the 1st of them – at a height of 7400 m after 3 bivouacs in camp IV, in a weather break; 2nd and 3rd – in a weather break while returning from Broad Peak Middle at 7800-7600 m; 4th and 5th – at 7800 m, on the way back from Masherbrum's peak, after 4 days' climbing above 7200 m and bivouacking twice outside tents; 8th – while coming down on fixed ropes after an unsuccessful trial on K2, a woman who before dying had spent 6 days bivouacking at 8100 m without food and fluid because of stormy weather.

The factor of extreme exhaustion and deterioration was also certain in two further accidents that ended in death due to a fall. The first happened to a world-famous climber and occurred on fixed ropes at 8200 m while he was descending peak K2. He had climbed for 3 days above 7400 m bivouacking twice, at 8200 and 8400 m, on the way to the peak.

Another accident was caused by a fall from an ice step due to improperly fastened crampons. It happened after a bivouac at a height of 7900 m. The accident had been preceded by a successful climb of the K2 southern face. Two persons had team-climbed in alpine style. They had spent 6 days above 7400 m. They had bivouacked outside the tent twice at heights 8300 and 7900 m without food and drink.

All of these accidents had common characteristics:

1. they occurred in climbing without oxygen,
2. had been preceded by too long stays at high altitude,
3. the climbing speed had been very slow.

Only in the cases of the last two accidents the low speed had resulted from difficulties, while in the others – from insufficient acclimatization and performance. They are examples of overestimation of one's strength and a very strong desire to ascend the peak.

In 96 cases (9.73%) disease was a life danger. However, the diseases ended happily after treatment.

Among the mentioned diseases HAS was the most frequent (Table 3) – 20 cases (2.02%). It occurred in the form of HAPE in 2 participants, HACE in 8 participants, and deterioration in 10 climbers. Including the 13 cases of HAS mentioned in group I, this makes 33 cases of HAS, i.e. 3.34% in relation to the number of expedition participants.

Analysis of the said 20 cases demonstrated that acute HAS (HAPE or HACE) in 8 of 10 cases had been caused by insufficient acclimatization, a wrong plan of climbing, or poor health condition before the casualty.

In 6 of 10 cases of deterioration (HAS), the symptoms should also be connected with insufficient performance and poor acclimatization, in 6 climbers the deterioration was serious and required intensive therapy.

In 8 of 14 cases of bronchitis and pneumonia, the patients were in quite a serious condition and intensive treatment including oxygen therapy was necessary. Six patients from this group were treated in bases at an average height of 4950 m; the remaining ones had been transported down.

Out of 11 cases of thrombophlebitis the course of disease was mild in 8 but in the remaining ones it was serious and in two cases even dramatic – pulmonary embolism.

Phlebitis was diagnosed correctly in 8 of 11 cases.

Massive digestive tract haemorrhage occurred in two cases. The first occurred to a well-known Polish climber and was very dangerous as it took place in camp II (5900 m). He had climbed Batura I in alpine style, it had been 8 days' climbing above 8000 m, including 3 unprepared bivouackings in very bad weather. He was treated locally with success. A diagnosis of duodenal ulcer was confirmed by x-ray examination after he had come back to Poland.

The other patient had consulted the expedition's physician while ascending Shisha Pangma. The weather had been bad and the base had been established very quickly. The peak had been climbed a few days later. Thus, the physicians had been very busy, being moreover sick himself due to insufficient acclimatization. The haemorrhage occurred on the way back to Kathmandu in the bus.

Table 3. Medical Problems in Polish Expeditions (116 expeditions - 986 alpinists)

HACE	2		
HAPE	8	20 (2.02%)	
Deterioration. Exhaustion	10		
Thrombophlebitis	9		
Pulmonary embolism	2	11 (1.11%)	
Bronchopneumonia, Pneumonia	14		1.41%
Sinusitis	10		
Curling's ulcer	2		
Throat infection	8		
Frostbite	13		1.31%
Bone fractures, opened	2		
Bone fractures, not opened	4		
Spine fractures	1		
Thorax contusions	5		
Head injuries	6		
T o t a l	96	9.7%	

These incidents had not been preceded by any gastric disorders before or during the expedition. Since the haemorrhage occurred after strong physical and psychic stress, Curling's ulcer was diagnosed.

Four of the 13 frostbites encountered were extensive and involved toes or- fingers. Despite treatment, amputation of whole fingers/toes or their parts had to be performed. The remaining cases were treated successfully.

In one case the hand was frostbitten to the IInd/IIIrd degree in the course of deterioration after descending Dhaulagiri. The treatment was insufficient as the physician had no authority. It resulted in the amputation of 8 fingers on both hands.

In 2 of 4 cases of comminutive fracture in a leg, an open reduction of fractured bone fragments and osteosynthesis was made in the base camp. The other fractures were treated conservatively and they healed without complications. One case, however, needed a reconstructive operation after the return to Poland.

I would like to point out that more than a half of the diseases and accidents described herein would have been a real life danger without medical assistance. This relates particularly to HAS, pneumonia, and pulmonary embolism, as well as the digestive-tract haemorrhage.

These facts prove once more the significance of the physician's presence during expedition to high mountains. Therefore, the trend of undertaking small, unaided expeditions that set out without a physician and oxygen, although quite "pure" from the point of view of sportsmanship, is considered by me to be very dangerous.

A NEW ETIOPATNOGENIC AND CLINICAL-DEVELOPMENTAL CLASSIFICATION or LOCALIZED INJURIES DUE TO THE ACTION OF COLD

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Abstract

Lesions caused by the local action of cold have traditionally been classified in degrees of intensity. The attempt to relate the extent of tissue damage in the depth of the lesions with their posterior evolutionary course has led some authors to make diagnostic-developmental classifications. We propose a classification which considers not only these but also etiopathogenetic aspects.

In our casuistic material of 97 patients with localized lesions due to the effect of cold we assessed and correlated the etiological, pathogenic, clinical and developmental aspects. These factors show that at very low temperatures and in a dry atmosphere, necrotic lesions, predominantly cryogenic, are produced with little vasomotor component and few trophic or functional sequels, except for potential amputation in some cases.

With values above 0 °C, even if very cold, and in a humid atmosphere and under long exposure, mainly deep vasomotor lesions appear, leaving serious functional and trophic sequels. Between these two extremes, there is a series of intermediate mixed lesions.

A CASE OF ACUTE EROSIVE GASTRITIS WITH SHOCK AND SEVERE ANAEMIA DURING GASHERBRUM I AND II EXPEDITION

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We report the case of a climber suffering from hematemesis and melena during Gasherbrum I and II expedition.

He was a 38 years old, previously healthy man; two years before he reached the height of 8000 m on K2 without any problem; there was no anamnestic history of peptic ulcer, gastritis, epigastralgia or bleeding. Before leaving for Pakistan, physical examination and biochemistry were normal. During climbing he spent 4 days at 7400 m because of climbing difficulties and storm, poorly fed and hydrated; coming back to base camp at 5000 m he was in quite a bad condition; he was dehydrated, had lost weight, had grade II frostbite on 1st toe of the left foot and 2nd finger of the left hand.

He was rehydrated with saline solution und urged to begin slowly normal feeding; he did not completely comply with this advice and also drank some alcoholic drinks.

After two days he started vomiting and after some hours suffered hematemesis and melena. The physical examination was normal except for epigastric pain and mild tachycardia (100 beats/min). He began a therapy with ranidine 300 mg i. v. daily and iced drinks with antacids and antihaemorhagics. Despite this treatment on 2nd and 3rd day he suffered from hematemesis and melena with a hypovolemic shock; he was treated with macromolecular solution and then a perfusion of saline and glucose solution. On 5th day he was evacuated by helicopter, taken to Rawalpinidi and admitted to the military hospital. Hemoglobin was 30 g/l, red cell count 900,000; prothrombin time, urea, nitrogen and electrolytes were normal. He was treated with 4 red cell units; the hemoglobin value rose to 70 g/l.

He underwent a gastroscopy on 6th day; the findings were normal oesophagus and pale but normal gastric and duodenal mucosa. One month later he was again subjected to gastroscopy in Italy: he displayed a macroscopically and histologically normal gastric mucosa. This finding supports the diagnosis of erosive gastritis.

Gastric problems are common during high altitude climbing. They include mild symptoms as dyspepsia, nausea, epigastric discomfort but also severe epigastralgia and vomiting (1,4). Furthermore the incidence of gastric ulcers and haemorrhage deriving from such ulcers is greater at high altitude than at sea level, both in natives and residents (1,2,4). Several factors may induce such pathology: stress, unbalanced diet, hypoxia, use of drugs (as acetylsalicylic acid). This case certainly has a multifactorial aetiology.

Therefore we point out the importance of avoiding every condition inducing increased acid secretion and gastric lesions during high-altitude climbing. We suggest that climbers with history of peptic ulcera or gastritis or climbers who develop severe stomach ache use antacids or H2 receptors blockers.

III. OVERUSE INJURIES IN MOUNTAINEERS

SOME OVERUSE SYNDROMES AMONG MOUNTAINEERS

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At the Orthopaedic Hospital of the Medical University in Warsaw, in the years 1978 – 1988, 58 cases were treated because of overuse syndromes in motor organs, due to the practised mountaineering, rock climbing or trekking. The syndromes always occurred after sudden overexertion that had not preceded by rational training.

Overuse of limbs develops as a result of mechanic factors acting for a long time – microtraumas. They lead to the excessive functional and mechanical resistance of muscles, ligaments, tendons, or bones.

Overuse changes have been described by several synonyms: trauma chronicum, hyperponosis, overuse, surcharge, and they have been the subject of methodical scientific research of Le Cove, Deutschlander, Devas, Rutishauser, Schneider and others.

Overuse syndromes develop as a result of pressure and distension forces. Development of bone lesions is interpreted as a change of spatial system of osseous apatite crystal, crystals loosening, extension of intermolecular distance. Soft tissue changes and their pathogenesis are not well known. According to King and Lawton, soft tissue strength in comparison with the bone is more subject to change in dependence on temperature and the water content.

The following agents are stimulative for the development of the overuse syndrome: exhaustion, metabolism disorders, and lactacidaemia. Exhaustion results in disturbance of muscles contractility and blood vessels adaptation. Joint stabilization and the coordination of muscle functioning are worsened. This results in traumas within tendons and adjacent bone tissue – tendons attachments rupture. Exhaustion also causes the vasospasms resulting in tissue anoxia.

The following parts are the most susceptible to the overuse syndromes:

a) the collum of 2nd and 3rd metatarsal bone,
b) the site of Achilles tendon attachment to the calcaneal tuber,
c) the tibial tuberosity in the place of attachment of the patellar ligaments,
d) the proximal tibial metaphysis,
e) bases of the vertebral arches of the lumbar spine.

The localization of lesions treated at the Hospital is presented in the table 1.

1) Overuse of the iliac crest posterior segment – 3 cases. It was related to the attachment of middle gluteal muscle.

2) Sacroiliac joint. The pain occurred on active extension in the prone position. This relates to 8 patients after forced march plus heavy loads lifting (expedition in the Himalayas).

3) Vertebral arches L/5 – L/4 were subject to overuse in 9 cases. This syndrome was characterized by low back pains and lumbar spinalgia of ligamentous character. This lesions occurred in similar circumstances as in the previous group.

4) Trapezius muscle. The pain was localized within superior angle of the scapula in the case of three mountaineers intensively training modern rock climbing.

5) Shoulder. In 5 cases omalgia occurred after exhausting climbing of big mountain faces in the Alps. One mountaineer, when climbing the Tatra Mountains, with a strong static shoulder tonus, incurred

shoulder subluxation which resulted in chronic pains. Surgical examination showed partial rupture of the ring of rotators, which was corrected with McLaughlin method.

6) Biceps muscle. In three mountain climbers chronic inflammation of the long head tendon of the biceps muscle was treated. In one case there was idiopathic tendon rupture that needed surgical treatment, the other ones were treated conservatively.

7) Metatarsalgia syndrome. Quite a numerous group suffered from the metatarsalgia syndrome, with periostal reaction within colla of the 2nd and 3rd metatarsal bone in 5 cases and fatigue fracture in 2 cases. The syndrome developed by forced march with heavy rucksacks in difficult mountainous terrain, usually in improper shoes; or after training races and marching. Both cases of fatigue fracture were treated surgically by Beck´s method and plaster dressing, the remaining cases were treated conservatively by immobilization in P.O.P.

8) Accessory navicular bone and reduced plantar arch. In 4 mountaineers with accessory navicular bone and reduced longitudinal plantar arch there was chronic tissue inflammation of this region (attachment of posterior tibial muscle tendon and accessory navicular bone).

9) Knee joint. In 6 cases there were pains in the knee joint and these were located within patellar tendon, or Hoffa's body. In all cases the patients were members of an alpine expedition. Two climbers, world leaders in the sport, suffered from acute pains after they had descend from the top of Everest.

10) Achilles tendon. Ten patients experienced pain in the Achilles tendon attachment to the calcaneal tuber. In three cases the pains were preceded by intensive climbing in crampons on big faces (the Alps, the Himalayas).

In case of 7 mountaineers the pains were not directly connected with climbing but developed after improper training (races) or long marches (trekking). In 2 patients idiopathic rupture of the Achilles tendon occurred during training. Surgical treatment was performed (Bunnel suture). In both cases the rupture was localized near the tendon attachment to the bone.

In the cases treated surgically biopsy specimens were examined histopathologically. The following histopathological changes were found:

1. in muscles: Focal degenerative changes, namely necrosis of muscle fibres or granular degeneration, fragmentation, and calcification. Part of the fibres presented considerable hypertrophy.

2. Within the fascia: The following trait was symptomatic – very rich vascular system and proliferation of mesenchymal cells around vessels, in some places there was indistinctness of contours and fragmentation of collagen fibres, and there were calcification focuses as well as hyperplasia of connective tissue rich in cells.

3. Within tendon attachments: Necrosis, degradation, and calcification of collagen.

4. Blood vessels: Blood vessels in the intertrabecular spaces had considerably thickened walls and narrowed vascular lumen.

5. Bone: Bone tissue taken from fatigue fracture sites presented typical picture of necrotic bone, surrounded by connective tissue undergoing metaplasia in cartilage and bone tissue.

In the case of all patients (except six) conservative treatment was applied, viz.:

1) temporary restriction of movements and training,
2) immobilization in plaster cast in the case of metatarsalgia with overuse changes in metatarsal bone,
3) irradiation with solux lamp, application of DD current, iontophoresis with xylocain and calcium or iodine applied alternatively within 2 – 4 weeks,
4) DKF and ultrasounds.

Such medicines as Voltaren, Butipirazol, Felden, Indocid etc. were considered as adjuvant treatment to physiotherapy.

Depomedrol or Celeston injections were made only in cases resistant to physiotherapy and only in the regions of the bursa and tendon attachments, never intratendinously and never intra-articularly. All patients were completely cured within 2–4 months.

Conclusions

1. While practising various forms of mountaineering and during intensive training, climbers have their bones and joints system exposed to considerable static and dynamic overuse. Various overuse syndromes can develop in cases of individual susceptibility and in the presence of additional harmful agents.
2. The following conditions are considered harmful: fall of temperature, exhaustion, lactacidaemia, metabolism disorders, unreasonable training, insufficient training drill, improper shoes.
3. In most cases the overuse syndrome can be treated conservatively and the treatment is based on the relative or absolute immobilization and physiotherapy.
4. There are different localizations of the overuse syndrome depending on the form of the mountaineering. In the case of rock climbers, the upper limb (shoulder) is often involved. In cases of trekking or marching during expedition or snow-ice climbing, the lumbar spine (lower segment), knee and foot are especially exposed to overuse

Table: Overuse syndromes in mountaineers.

No	**Localization**	**Number of cases**	**Circumstances**
1	Iliac crest	3	Trekking, races
2	Sacroiliac joint	8	Trekking, load lifting, expedition
3	Vertebral arches L5-L4	9	Expedition, trekking, load lifting
4	Trapezius muscle	3	Modern rock climbing
5	External rotator ring	5	Modern rock climbing
6	Biceps muscle tendon	3	Forced training, modern rock climbing
7	Head and collum of the 2nd or 3rd metatarsal bone	7	Intensive march and race, trekking
8	Tuberculum of navicular bone	4	Trekking
9	Patellar tendon, Hoffa´s body	6	Expedition. Trekking
10	Calcaneal tuber	10	Snow-ice climbing

PATTERNS OF SOFT TISSUE INJURY IN EXTREME ROCK CLIMBERS

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The British mountaineering Council were becoming increasingly concerned at the apparent increase in injuries among extreme rock climbers, particularly those injuries associated with training. A survey was conducted to identify the problem areas, so that suitable training schedules could be advised to attempt to prevent these problems.

A questionnaires was devised and circulated and a total of 67 were completed returned by climbers, all of whom were climbing at least UIAA grade VII. The questionnaire was supplemented by examination in as many cases as possible. Only 11 climbers reported no injury problems and a total of 115 injuries were reported as in table 1.

Fifty per cent of the injuries had occurred during training.

There were only a few lower limb injuries, with adductor strains being the commonest. There was one case of patella tendinitis.

Eighty-nine per cent of the reported injuries affected the upper limb. In the shoulder some sort of rotator cuff tear was the commonest problem a two cases of "impingement syndrome" were reported.

Of the elbow problems reported "anterior elbow pain" was the commonest. This appears to be brachial tendinitis or "climbers elbow" and is due to repetitive strain with the forearm pronated and semi-flexed.

Fifty per cent of the upper limb injuries affected the hand and wrist with the proximal interphalangeal joints of the middle and ring fingers being the most frequent site. Many of these problems appeared to be flexor digitorum superficialis tenoperiostitis or "climbers finger". This is due to the configuration of the fingers used by the vast majority of climbers on small holds, with the PIP joints flexed and the DIP joints extended, putting the tendon of flexor digitorum profundus at a mechanical disadvantage, and therefore putting more strain on FDS tendon.

Another apparently unique injury affecting climbers is avulsion of the A2 pulley from its attachment to the proximal phalanx, causing bow stringing of the flexor tendons.

Table 1. Injuries by region.

LOWER LIMB	12			
UPPER LIMB				
SHOULDER	16	HAND		
ELBOW			PIP JOINT	31
MED. EPICONDYLE	5		1st MCP JOINT	12
LAT. EPICONDYLE	4		WRIST	9
ANTERIOR	10		MISCELLANEOUS	15
TOTAL			115	

HEALTH COMPLAINTS AND FINGER DEFORMITIES IN CZECROSLOVAK SPORT CLIMBERS

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Overuse injuries in the sport climbing result from an imbalance between the load and the tissue tolerance to this load. It is already well established that the prevalence of these injuries in sport climbers' fingers is very high. Especially finger tendons and joints seem to be damaged.

Subject of study: anthropometric parameters, professional and sports activities, modes of training, localization of health complaints, objective signs of finger damage, identification of predisposing factors in 103 representative climbers taking part in extreme climbing competitions in 1987 – 1988.

Methods: In 1987 – 1988, 103 climbers (23.5±5.2 years old men surmounting climbing difficulty-grade 8 (UIAA) on an average, free climb from 6 to 10^{-}) were interrogated using a modified anamnestic questionnaire (Bartschi, Radlinger) and subjected to physical orthopaedic examination of the hands.

Results:

1. Health complaints in upper extremities

YES: 84 (81.6%) NO: 19 (18.4%)

2. Localization of health complaints

	rights	lefts
Shoulder	8	7
Elbow	5	7
Forearm	16	14
Wrist	13	15
Fingers	41	47
T o t a l	83	90

3. Long-lasting pain in fingers

	rights	lefts
Thumb	1	1
Index finger	12	6
Middle finger	33	33
Ring finger	20	27
Little finger	3	3
T o t a l	69	70

4. Finger deformities

(F.Swellings=Fusiform Swellings, Flexion D.=Flexion Deformities)

	Both Hands					*Right Hand*					*Left Hand*				
Finger	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
Nodes	0	8	10	3	5	0	4	6	1	4	0	4	4	2	1
F.Swellings	1	12	42	28	2	1	6	22	13	0	0	6	20	15	2
Flexion D.	14	13	31	16	24	3	6	18	9	13	8	7	13	9	11

Only 19 out of 103 climbers. (18.4%) had no long-lasting complaints in the upper extremities and/or finger deformities. Fifty-eight suffered from long-lasting pain in fingers; fusiform swellings, nodes and flexion deformities of finger joints were present in 61 out of 84 climbers (72.6%). Ten climbers complained of long-lasting pain in the shoulders, 8 in the elbows, 25 in the forearms, and 21 in the wrists.

Eighteen climbers had already been examined in 1987 and the repeated examination in 1988 showed a deterioration of finger damage in 13 (72.2%) of them.

The most affected were the 3rd and the 4th finger, especially the proximal interphalangeal joint of the 3rd finger.

The results support the continued use of these investigation method not only to assess subjective symptomatology and development of pathological changes in climbers´ fingers due to overloading but also to find out what factors predispose and predetermine the damage, particularly attention being paid to the structure, frequency, and intensity of training, genetic and other factors. A study using the Czechoslovak computer program GUHA was carried out for this purpose.

5. Deformities of finger joints.

(MCP=metacarpophalangeal joints, PIP=proximal interphalangeal joints, DIP=distal interphalangeal joints)

Joints	*M C P*					*P I P*					*D I P*				
Finger	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
Nodes	0	1	0	0	0	0	2	4	1	0	0	5	6	2	5
F.Swellings	1	0	0	1	0	0	11	39	25	2	0	1	3	2	0
Flexion D.	5	0	0	0	0	0	9	29	17	19	7	4	2	1	5

6. Some factors involved in the etiopathogenesis of overuse injuries.

CLIMBERS		pain and/or deformities	without symptoms	P
AGE	Years	24.1 ± 5.3	20.5 ± 3.8	0.01
PERFORMANCE	UIAAmax	8 ± 0.8	7^{-} ± 0.8	0.01
SUMMER CLIMBING	Days a week	3.1 ± 1.4	3.5 ±1.6	n.s.
WINTER CLIMBING	Days a week	1.2 ± 0.9	1.5 ± 1.3	n.s.
SPECIALIZED TRAINING	Days a week	3.1 ± 1.6	2.0 ± 1.6	0.05

Conclusions:

1. The prevalence of overuse injuries of the hand in sport climbers is extremely high.
2. Uncontrolled and unqualified training does not raise climbing performance, on the contrary, it leads to finger damage and finger deformities. Any joint which has been subjected to constant strenuous usage is apt to develop degenerative (osteoarthritic) changes.
3. There are certainly also other factors than training, especially genetic ones, that predispose to high climbing performance or that are responsible for the susceptibility to damage resulting from chronic overloading in extremely difficult climbing. More detailed studies on the predisposing factors are required.
4. Prevention is of paramount importance to sport climbers. This especially concerns the structure, frequency, and intensity of training.

References.

1. Bertschi, D.: Theoretische und empirische Untersuchungen zu sportartspezifischen Finger- und Unterarmverletzungen bei Sportkletterern. Diplomarbeit. Bern, Dezember 1986. **2.** Rotman, I., Staněk, M., Skřička, T., Veselý, P., Hylmarová, J., Bušík, J.: Overuse Injuries of the Hand in Czechoslovak Sport Climbers. International Symposium “Mountain Medicine – Safety in Alpinism”, 14-17 September 1988, Convention Center Davos, Switzerland.

OSTEOARTHROSIS IN CLIMBERS´ FINGERS

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One of the most worrying questions about the injuries that a modern, hard climbers suffer from, is whether the tremendous forces the fingers are subjected to, predispose to premature degenerative changes in the finger joints. This paper reports the current result of an ongoing study designed to answer this question.

So far 20 climbers have volunteered to have their hands X-rayed. The entry requirement for the study is to have been climbing UIAA grade IX^{-} for a minimum of 5 years or to have been climbing VI^{+} for at least 20 years.

The X-rays are matched for age and occupation with X-rays taken of the hands for minor traumas at a hospital casualty department and analysed by a consultant radiologist and myself.

Changes appear in the joints at around thirty years of age, with small osteophytes and soft tissue swelling around the proximal interphalangeal joints, and cortical thickening of the phalanges being seen. Changes seem to be progressive with increasing age, with the full radiological picture of osteoarthrosis present in both subjects over forty years of age (both non manual workers).

While firm conclusions cannot be made while the numbers of subjects are still small, the worrying aspect of this study is that the older climbers in the series have not been climbing anywhere near the standards of difficulty the young climbers of today are achieving.

It is intended to continue with this study and further results will be published when available.

ETIOPATHOGENESIS OF OVERUSE INJURIES OF THE HAND IN EXTREME ROCK CLIMBERS

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Abstract

An attempt was made to analyse data on overuse injuries of the hand in 100 Czechoslovak sport climbers taking part in extreme climbing competitions in 1987 (Rotman et al, Davos 1988; see also poster of this Conference – Staněk et al.: Health complaints and finger deformities in Czechoslovak sport climbers) The GUHA[(1)] method – Package of Programmes for Exploratory Data Analysis, Programme "assoc" was used.

The GUHA programme is an original Czechoslovak approach to uncovering all possible interrelationships in a set of data and defining all significant correlations. GUHA was used with the hope to provide an insight into all possible factors related to the etiopathogenesis of the overuse injuries of the hand. The data collected and used as variables (antecedents and succedents) describe anthropometric parameters, professional and sport activities, modes of training, localization of health complaints, and objective signs of finger damage, e.g. finger deformities, particularly nodes, fusiform swellings, and flexion deformities affecting finger joints in extreme climbers.

The results of this approach will be reported and discussed.

[(1)]Hájek, P. Havránek, T.: Mechanizing hypothesis formation – mathematical foundations for a general theory, Springer Verlag, Heidelberg 1978.

Introduction

The adverse effects of chronic overloading upon sport climber's upper extremities, especially finger tendons and finger joints are already described by many authors (Tab. 1).

Table 1. Literature describing finger injuries in climbers.

CLARKE	1984	England
BARTSCHI & RADLINBER	1986	Switzerland
BURTSCHER & JENNY	1986	Austria
KRAUSE & REIF & FELDMEIER	1986	Germany
LEAL & RANE & HERRERO	1986	Spain
ROTMAN & PELIKÁN	1986	Czechoslovakia
BOLLEN	1988	England
ROTMAN & STANĚK & VESELÝ	1988	Czechoslovakia

Methods

Date on overuse injuries of the hand in 100 Czechoslovak sport climbers taking part in extreme climbing competitions and examined in 1987 were analysed first by means of classical statistical methods. Then an attempt was made to analyse these data applying the Package of Programmes for Exploratory Data Analysis (GUHA) to the evaluation of the data collected and used as variables

– antecedents and succedents – in regard to presumable role of the antecedents as causes of the overuse injuries, factors involved in the etiopathogenesis respectively (Table 2, Table 3)

Table 2. Variables recorded in 100 sports climbers

A N T E C E D E N T S	S U C C E D E N T S
SEX	LOCALIZATION OF LONGLASTING PAIN
AGE	– SHOULDER
BODY HEIGHT	– ELBOW
BODY WEIGHT	– FOREARM
BROCA INDEX	– WRIST
OCCUPATION	RIGHT HAND
OTHER WORK AND SPORT ACTIVITIES	1st – 5th FINGER
	– FINGERS
DURATION OF CLIMBING ACTIVITY	LEFT HAND
CLIMBING DIFFICULTY GRADE REACHED	1st - 5th FINGER
SUMMER AND WINTER TRAINING	LOCALIZATIONKINDS OF DEFORMITIES
STRUCTURE OF TRAINING	
	RIGHT HAND LEFT HAND
COURSE OF THE TREATMENT	
	FINGER Ist – 5th
MANNER OF GRIP	
	JOINTS – METACARPOPHALANGEAL
PREVIOUS FROSTBITES	– INTERPHALANGEAL – PROXIMAL
	– DISTAL
	FUSIFORM SWELLINGS, NODES, FLEXION DEFORMITIES

Table 3. Data processing

MODIFIED ANAMNESTIC QUESTIONNAIRE[(1)] & PHYSICAL ORTHOPAEDIC EXAMINATION

CLASSICAL STATISTICS	COMPUTER PROCESSING
MEAN VALUES	
STANDARD DEVIATION	d-BASE III+
TESTS OF MEAN VALUES DIFFERENCE	⇓
CORRELATION ANALYSIS	BIOMEDICAL DATA PROCESSING
	⇓
	G U H A
	PROGRAMME “ASSOC”

In 100 climbers there were 191 variables recorded and consequently 19,100 data collected. Therefore only a very small part and some examples of results can be presented.

Results

Some of results obtained using classical statistical methods are shown in Tab. 4 and Tab. 5. Only 24 out of 100 climbers had no complaints in the upper extremities, 69% complained long-lasting pain, 51% in fingers only. Fusiform swellings, nodes and flexion deformities of finger joints were present in 44%. The most affected were the 3rd and the 4th finger, especially the proximal

interphalangeal joint of the 3rd finger. However both parameters – pain and/or deformities – were observed in 52 out of 69 climbers (75%) surmounting climbing difficulty-grade from 7^+ to 10^- (UIAA).

Table 4. Characteristics of 100 climbers.

MALE : FEMALE	84 : 16	
AGE <years>	23.6 ± 5.1	range: 15 – 38
BODY HEIGHT <cm>	175.4 ± 7.9	154 – 194
BODY WEIGHT <kg>	66.6 ± 9.3	40 – 89
BROCA index	88.2 ± 7.3	72 – 110
UIAA max	8^- ± 1.0	4^+ to 10^-

LONGLASTING PAIN in UPPER EXTREMITIES 69%
in FINGERS ONLY 51%
FINGER DEFORMITIES 44%
PAIN and/or DEFORMITIES in 52 out of 69 climbers (75%)
surmounting climbing difficulty grade (UIAAmax)
from 7^+ to 10^-

The climbers with painful fingers and/or finger deformities were slightly older, climbed less frequently, but practised specialized strength training more frequently than climbers without these symptoms and decreased or stopped climbing during their health complaints less frequently.

GUHA method evaluates the significance of hypotheses about association between two logical expressions – antecedent and succedent, each of them having in general the form of logical conjunction.

Table 5. Presumable factors involved in the etiopathogenesis.

CLIMBERS		pain and/or deformities	without symptoms	P
AGE	Years	23.9 ± 5.1	20.9 ± 3.5	0.05
PERFORMANCE	UIAAmax	8 ± 0.8	8^- ± 0.9	n.s.
SUMMER CLIMBING	Days a week	3.0 ± 1.6	3.5 ±1.5	n.s.
WINTER CLIMBING	Days a week	1.2 ± 0.9	1.8 ± 1.3	0.05
SPECIALIZED TRAINING	Days a week	2.8 ± 1.8	1.4 ± 1.1	0.01

Table 6. G U H A – PROGRAMME "ASSOC" (Language: Fortran IV<H>)

S E A R C H F O R P O S I T I V E A S S O C I A T I O N S
B E T W E E N D E R I V E D T W O – V A L U E D
Q U A N T I T I E S

FOUR-FOLD CONTINGENCY TABLE

	S1	S0
A1	A	B
A0	C	D

e.g. is the number of objects satisfying antecedent <A>
and not satisfying succedent <S>

Table 7. Hypothesis 1:

NO WINTER CLIMBING 1 DAY A WEEK AND LESS FREQUENTLY <----------> FROSTBITE

	S1	**S0**	
A1	15	26	41
A0	13	46	59
	28	72	100

Hypothesis 2:

WINTER CLIMBING 1 DAY OR 2 DAYS A WEEK ←----------> FROSTBITE

	S1	S0	
A1	14	17	31
A0	14	55	59
	28	72	100

Hypothesis 3:

WINTER CLIMBING 3 DAY A WEEK AND MORE OFTEN <----------> FROSTBITE

	S1	S0	
A1	27	63	90
A0	1	9	10
	28	72	100

To become acquainted with results obtained by means of the programme GUHA – "ASSOC", the relationship between training frequency in winter and frostbite incidence in fingers can be studied (Table 7). There were three hypotheses printed showing significant positive association between winter climbing frequency one or two days a week and frostbite incidence in these climbers (hypothesis 2). The hypothesis 2 states: there are 31 climbers climbing one or two days a week in winter, 14 of them have suffered from frostbites and 17 climbers not. On the other side, there are 69 climbers who do winter climbing either more or less frequently but the incidence of frostbite in their past history is twice smaller: only 14 of 69 have suffered from frostbites. Hypotheses 1 and 2 state that there is significant frostbite incidence when the climber do not winter climbing both once a week and less frequently or three days a week and more often, respectively.

G U H A R E S U L T S

BESIDES CONFIRMING SOME NOTORIOUSLY KNOWN TRUTHS LIKE CLIMBERS
WHO
– ARE OLDER & HEAVY
> HAVE TROUBLES
– ARE OLDER & CLIMB HARD & TRAIN HARD
SHOWED RATHER INTERESTING NONTRIVIAL AND STIMULATING ASSOCIATIONS,
E.G. THAT CLIMBERS WHO ARE
– OLDER & CLIMB MODERATELY IN WINTER & DON'T CLIMB ABOVE 9^- UIAA
– OLDER & CLIMB FREQUENTLY IN SUMMER & TRAIN HARD
DO NOT HAVE SUBJECTIVE TROUBLES (P A I N)
BUT DO HAVE OBJECTIVE FINDINGS AT MEDICAL EXAMINATION
WHAT DOES THIS MEAN?
DISSIMULATION or INBORN ANATOMY or SMORTCOMINGS IN EXAMINATION?

Summary

1. The reported results of an investigation of Czechoslovak sport climbers conform to data in the literature, showing that the prevalence of overuse injuries of the hand in sport climbers is extremely high.

2. Any joint which has been subjected to constant strenuous usage is apt to develop degenerative (osteoarthritic) changes.

3. Using the GUHA programme for the statistical analysis of data gathered about climbers and their overuse injuries has revealed a necessity of restructuring data collection and redefining both antecedents and succedents. This together with new data could ensure exploitation of the full potential of GUHA. Up to the present, the use of GUHA has confirmed a preliminary statistical evaluation of the data and has provided some insight into the problems studied that would otherwise not have been obtained. GUHA will therefore guide us in future work.

4. The present style of uncontrolled and unqualified training does not lead to a rise in climbing performance; on the contrary, it leads to finger injuries and finger deformities.

5. There are certainly also other factors than training, especially genetic ones, that determine a climber's biotype and thus predispose him/her to high climbing performance or that are responsible for susceptibility to damage resulting from chronic overloading in extremely difficult climbing.

6. More detailed studies on the role of biotype and other predisposing factors are required.

7. Because of very difficult treatment of finger overuse injuries, prevention is of paramount importance to sport climbers. This especially concerns the structure, frequency, and intensity of training.

8. Prevention has at least two facets:

a) on the climber's side

– education in self-knowledge,

– education and training in self-control,

– creation of a system of training respecting the climber's individual potential and including adaptation of the climber's life style to the purpose.

b) on the health-care side

– development and verification of criteria for biotypology of climbers,

– development of a new training-system scheme

– organization adequate education and training courses.

Conclusions

1. Current results indicate close association between a climber's top performance, absence of overuse injuries, and "optimal biotype".

2. Further research is needed to define the "optimal biotype" for top sport climbing.

3. A system of education and training for sport climbers based on the above guidelines should be developed.

References

1. Bertschi, D.: Theoretische und empirische Untersuchung zu sportartspezifischen Finger- und Unterarmverletzungen bei Sportkletterern. Diplomarbeit. Bern, Dezember 1986. **2.** Bollen, S.: Personal communication, 1988. **3.** Burtscher, M., Jenny, E.: Most common complaints and injuries in free-climbers conditioned by training. Congress of the Med1eal Commission of the UIAA, 24.-25.10.1986, Munich (Häufigste trainingebedingte Beschwerden und Verletzungen bei Sportkletterern. Praktische Sport-Traumatologie und Sportmedizin, 1987, 2: 15-21. **4.** Clarke, Ch.: Summary of Rock Climbing Injuries. UIAA Mountain Medicine Data Centre, London 1984. **5.** Hájek, S., Havránek, T.: Mechanizing hypothesis formation – mathematical foundations for a general theory, Springer Verlag Heidelberg 1978. **6.** Krause, R., Reif, G., Feldmeier, Ch.: Overuse syndrome and injuries of the hand and the forearms in free climbing. Congress of the Medical Commission of the UIAA, 24-25.10.1986, Munich. (Überlastungssyndrome und Verletzungen der Hand und des Unterarmes beim Sportklettern. Praktische Sport-Traumatologie und Sportmedizin (München), 1987, 2: 10-14. **7.** Leal, C., Rane, A., Herrero, R.: Sociology, Training Time and Finger Injuries in Free Climbing. Congress of the Medical Commission of the UIAA, 24-25.10.1986, Munich (Soziologie, Trainingszeit und Fingerverletzungen beim Sportklettern. Praktische Sport-Traumatologie und Sportmedizin (München), 1987, 2: 44-47. **8.** Rotman, I., Pelikán, J.: Überlastungssyndrome der Hand bei tschechoslowakischen Spitzen-kletterern. Kongress der Medizinischen Kommission der UIAA in München, 3.-5.10.1986, Praktische Sport-Traumatologie und Sportmedizin (München), 1987, 2: 41-43. **9.** Rotman, I., Staněk, M., Skřička, T., Veselý, P., Hylmarová, J., Bušík, J.: Overuse Injuries of the Hand in Czechoslovak Sport Climbers. International Symposium “Mountain Medicine – Safety in Alpinism”, 14-17 September 1988, Convention Center Davos, Switzerland. **10.** Staněk, M., Rotman, I., Skřička, T., Veselý, P., Hylmarová, J., Bušík, J., Říhová, J., Novotný, M., Třináctá, M.: Health Complaints and Finger Deformities in Czechoslovak Sport Climbers. UIAA Mountain Medicine Conference “Medical Aspects in Mountaineering”, Praha 21.10.1988.

CLIMBER'S SPECIFIC TRAUMATIC PATHOLOGY DUE TO SPORT GEAR

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Abstract

The practice of mountaineering as a sport is associated with an important pathology of traumatic origin, enhanced lately by some new complaints, some of them typical of other sports. Of all the possible features, there exists a group of peculiar characteristics which generally appear in climbers.

From a casuistry collected by our group, the following problems related with the traumatological field are analysed: ankle fractures; tenosynovitis in the fingers of the extreme climber and other lesions due to climbing gear, among which those caused by harnesses and grips during glacier progression are prominent (Thomas Morton metatarsalgia).

In this series of complaints a cause-effect relation is seen indicating the significance of a correct preventive attitude as a means of avoiding or minimizing the lesions described.

IV. PROBLEMS WITH LABORATORY ASSESSMENT OF A CLIMBERS´ TOLERANCE TO EXTREME HEIGHTS AND POSSIBILITIES OF ON-THE-SPOT TESTING OF THE CLIMBERS´ PHYSIOLOGICAL FUNCTIONS

INDIVIDUAL RESISTANCE TO HYPOXIA

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Abstract

The aim of the present research was to investigate some mechanisms of individual resistance and working capacity at high altitude.

The results of experiments performed with rats in hypobaric chambers indicated that testing the capacity for maximal load (running) under aerobic conditions does not satisfactorily reflect individual resistance to high altitude; neither does selection under hypoxic conditions.

The mechanism of adaptation to high altitude was determined experimentally; it conditions economical consumption of oxygen and activity of oxygen transport and helps order to be maintained in the movement of blood cells in the arterioles and capillaries. The importance of the functional state of the erythron and distribution of erythrocytes according to their size and resistance was established. Activation of biochemical processes, especially of the anaerobic fractions of lactodehydrogenase, also supports resistance.

During the examination of mountaineers in the hypobaric chamber, an increase in the capacity of the antioxidant system caused increased resistance to high altitude. Thus, systemic, tissue, biochemical and especially regulatory, anti-stress mechanisms largely determine individual resistance to hypoxia at high altitude.

Since the animal organism becomes complicated in the process of evolution, its sensitivity to hypoxia and its oxygen uptake increase simultaneously (N. N. Sirotinin, 1952, 1971, 1981).

The effect of oxygen deficiency in the air at high altitude begins at 100 mm Hg for frogs, 200 mm Hg for rabbits, 250 mm Hg for dogs, 270 mm Hg for rats, 300 mm Hg for monkeys and at 350 mm Hg for human beings (M. S. Mani, 1980).

While the lower animals compensate the oxygen deficiency during elevation by respiration in general, the higher animals and man use the cardiovascular system (N. N. Sirotinin, 1965). However its compensatory capacity at extreme heights is limited. The respiratory, cardiovascular and blood systems guarantee mass transfer of blood gases (A. Z. Kolchinskaya, 1969, 1983, Ch. Houston, 198l, 1966, R. M. Froese and S. S. Spriet, 1961).

The sensitivity of the respiratory and cardiovascular systems to hypoxia and carbon dioxide concentration are related to individual peculiarities of the human organism. These properties and the level of oxygen uptake by a tissue at rest and during maximal exercises are genetically determined.

Table 1. Individual resistance to hypoxia.

ECONOMICAL BASAL LEVEL AND MAXIMAL OXYGEN UPTAKE	SENSITIVITY TO HYPOXIA AND CARBON DIOXIDE	STRESS-LIMITED FACTORS ANTIOXIDANTS ANTIRADICAL SYSTEM
OXYGEN UPTAKE – MASS TRANSFER 1:2	NEUROENDOCRINE REGULATION	GABA OPIATES AICOSONOIDS
POLYCYTHAEMIA	AGE	
INCREASE IN THE CONTENT OF HAEMOGLOBIN	INDIVIDUAL CHARACTER PREVIOUS EXPERIENCE	PROTEOLYTIC ACTIVITY
HEMATOCRIT, VISCOSITY AND IN THE RATE OF COAGULATION	RATE OF ASCENT ALTITUDE LEVEL OF ACTIVITY	ACTIVITY OF BREATHING ENZYMES OF KREBS CYCLE
INTENSIFICATION OF AEROBIC MECHANISMS	TIMELY CHANGE IN REGULATORY MECHANISMS KEEPING HOMEOSTASIS	METABOLIC ACTIVITY OF PURINES
HIGHER UTILIZATION OF OXYGEN BY LOW PO_2	STRESS MECHANISMS: RELEASING FACTOR, ACTH CATECHOLAMINES,	GENERAL METABOLIC ACTIVITY AND NUTRITIONAL STATE
REGIONAL BLOOD FLOW	GLUCOCORTICOID HORMONES INSULIN, TESTOSTERON	INTENSIFICATION OF AEROBIC AND ANAEROBIC
INCREASE OF TISSUE AND CELL RESSITANCE	ALDOSTERON, LIPID PEROXIDATION	GLYCOLYSIS ACTIVE TRANSPORT OF CALCIUM IONE THROUGH THE CELL MEMBRANE

Hunt states that the capacity to ascend to elevations of 6000 m on the Himalaya varies greatly between individuals; some men do not seem to be able to go above 6450 m and, probably, only exceptional individuals (Messner) are able to go above 8230 m without the use of oxygen.

Let me demonstrate the scheme of individual resistance to extreme degrees of hypoxia (Table 1).

In our Laboratory of High Mountain Physiology we have obtained some experimental material on noninbreed mice, Wistar rats (high and low resistance to hypoxia), as well as on dogs. We have also examined volunteers (tourists and climbers) in the process of their adaptation to the Elbrus heights. We have taken experimental animals at heights of 9,000 – 12,000 m using altitude chambers or making them breathe a 10% mixture of oxygen with nitrogen. Volunteers ascended to heights of 6000 – 7500 m. We have loaded rats on a treadmill or subjected them to a swimming test. Volunteers have performed physical exercises on a bicycle ergometer according to the recommendations of the World Health Organization (three-step test). The following parameters were studied: change in oxygen uptake, PO_2, regional blood flow, morphological and histochemical indices of consumption of glucose by erythrocytes and its retaining in blood, temperature-dependent resistance of erythrocytes and its retention in the blood, temperature-dependent

resistance of erythrocytes (by our method), intensity of peroxidation of blood lipids by the content of malonic dialdehyde in blood and thymus cells; the content of lactate and pyruvate, activity of lactate dehydrogenase (LDH), the content of its izoenzymes in blood; the content of LDH granules in lymphocytes in peripheral blood lymphocytes. Erosion incidence on the mucosa of the stomach and weight of thymus, spleen and lymph nodes were recorded. Special attention was paid to the reaction of low hypersensitivity and to the survival of animals during elevation.

Our observation showed that rats adapted and trained in treadmill did not manifest their resistance to acute hypoxia at height of 11,000 – 12,000 m.

Thus, during elevation at the above mentioned heights 46.7% of test rats died, while only 16.7% did so in the control groups. During the subsequent swimming tests the rats survived in a chamber could hold for 1.5 h, whereas the control rats did so for 2.5 h. This was evidence that the aerobic productivity was higher in the control group. Administration of haloascorbin and glutamic acid in combination with Hippophae rhamnoides to test group animals of the test group increased the time of swimming up to 2.1 h. We failed to enhance the resistance of animals to hypoxia by applying ionol, an artificial antioxidant, as a stress-limiting factor. The subcutaneous injection of 0.1 ml of 0.001% dose of histamine with 0.1 mg of serotonin during respiration by 10% mixture of oxygen with nitrogen led to a decrease in oxygen uptake. This effect was not produced in animals of the control group.

Studies on 27 female mice have shown that at a height of 9000 m 4 out of them died, whereas all males stayed alive.

It is interesting to note that under acute hypoxia removal of stress reaction by administration of drugs or by desensitization did not reduce animal death. In this case the animals died from cardiac insufficiency. In our opinion which coincides with the standpoint of Mani (1980) the physiological fit leads to the heart block. As for the old rats which were in the control groups of animals (middle age) up to 30% died. And, vice versa, at heights of 11,000 – 12,000 m the death rate was considerable among old animals (85%).

Studies on the working capacity of people have shown that it decreases in most of people at extreme heights. This correlates with a decrease in the content of malonic dialdehyde, and the counts of lymphocytes, monocytes and eosinophils in the blood. We consider a decrease in the maximal oxygen uptake in climbers at extreme heights to be a result of metabolic changes to a lower, economic level.

The neuroendocrine regulatory mechanisms play an important role in support of the homeostatic equilibrium at high altitudes. Individual resistance to hypoxia is also determined by nonspecific tissue and cell resistance.

Thus individual resistance consists of genetically determined mechanisms and those acquired during ontogenesis.

Table 2. Characteristics of different degree of hypoxia in animals and human beings.

COMPENSATORY, MODERATE HYPOXIA CAUSING THE ACTIVATION REACTION	AVERAGE DEGREE, NONCOMPENSATORY HYPOXIA CAUSING REACTION OF HIGHER ACTIVATION	ACUTE, NONCOMPENSATORY HYPOXIA CAUSING STRESS REACTION
INCREASE OF CATECHOLAMINES	INCREASE OF GLUCOCORTICOIDS	A SHARP INCREASE OF GLUCOCORTICOIDS
DECREASE OF BASAL LEVEL OF INSULIN AND INSIGNIFICANT RISE OF CORTISOL CONTENT	MODERATE INCREASE OF HISTAMIN AND SEROTONIN LOWERING OF THE OXYGEN UPTAKE	DECREASE OF ALDOSTERONE, TESTOSTERONE AND ASCORBATE
INCREASE OF TESTOSTERONE AND ALDOSTERONE	ACTIVE PROLIFERATION OF BONE MARROW AND LYMPHATIC CELLS	CONSIDERABLE INCREASE OF HISTAMINE AND SEROTONIN
ACTIVATION OF RADICAL FORMATION (O_2,ROOH,H_2O_2)	MODERATE INCREASE OF RADICAL (O_2,ROOH,H_2O_2)	
ACTIVATION OF AEROBIC PROCESSES AND AEROBIC PRODUCTIVITY	ACTIVATION OF ANTIOXIDANTS AND ANTIRADICAL SYSTEMS (REDUCED GLUTHATIONE)	DECREASE OF THE LEVEL OF ANTIRADICAL AND ANTIOXIDANT PROTECTION
INCREASE OF PYRUVATE	SH-GROUPS, CATALASE PEROXIDASE AND SUPEROXIDE DISMUTASE,	DECREASE OF THE ACTIVITY OF BREATHING ENZYMES AND CONJUGATION OF BREATHING WITH PHOSPHORYLATION
INCREASE OF ATP CONTENT	GLUTHATIONE REDUCTASE	
INCREASE OF THE NAD/NADH RATIO	DECREASE OF THE NAD/NADH RATIO	DECREASE OF THE NAD/NADH RATIO
ACTIVATION OF AEROBIC GLYCOLYSIS AND AEROBIC FRACTIONS OF LDH		DECREASE OF ENERGY PRODUCTION
INCREASE OF THE NUMBER OF RECEPTORS		ACTIVATION OF PROTEOLYTIC ENZYMES
INCREASE OF THE NUMBER OF LYMPHOCYTES, MONOCYTES, EOSINOPHILS	INCREASE OF THE NUMBER OF LYMPHOCYTES, MONOCYTES, EOSINOPHILS	
INCREAE OF HEMOGLOBIN	INCREASE OF ALPHA AND CORTISOL RECEPTORS	
INCREASE OF Camp	INCREASE OF cAMP	

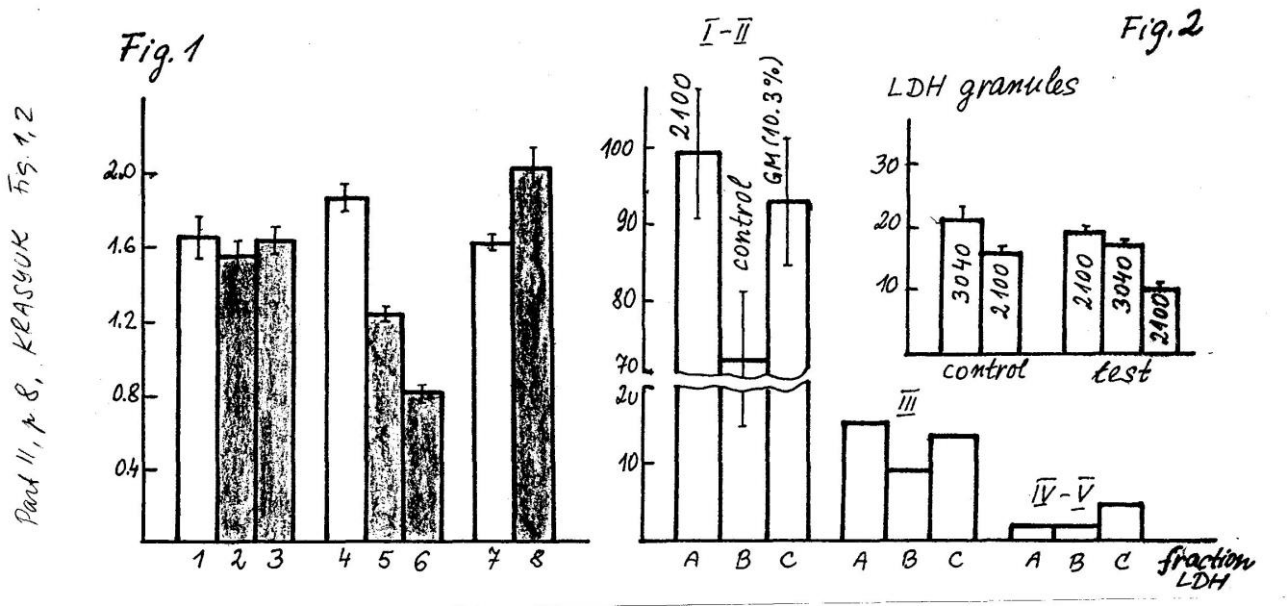

Fig. 1. Change in the oxygen uptake in ml per 100 g of weight for 1 minute in rats and mice (according to Kalabukhov). 1-6 rats; 7-8 mice; 1,4,7 - initial level of oxygen uptake; 2,6 - 10 min and 20 min after administration of serotonin against a background of hypoxia created by breathing 11% oxygen and nitrogen; 7 - mice (100 g/min); 8 - oxygen uptake by mice after breathing hypoxic mixture.

Fig. 2. Izoenzymes of LDH under hypoxia in people (change in the number of LDH granules in rats at heights of 3040 and 2100 m).

References

1. Sirotinin$_r$ N. N.: Effect of hypoxia on animal organism. In Oxygen therapy and oxygen deficiency. Kiev, 1952. P. 148-163. **2.** Sirotinin, N. N.: On acclimatization and training of sportsmen under conditions of high mountains. In: Acclimatization and training of sportsmen under conditions of alpine areas. Alma-Ata, 1965. P. 46-51. **3.** Sirotinin, N. N.: Regulacja dikhania i fizicheskie prisposoblenia dikhatelnoi funkcii pri gipoksii. Fiziol. Zhurn. SSSR, 57* 1971, 12: 1788-1792. **4.** Sirotinin, N. N.: Evolution of resistivity and reactivity of organism. M., Medicine, 1981. 234 p. **5.** Mani, M. S.: Man in highland ecosystem; effects of exposure to high altitude. Ecol. Highlands, 1980. P. 177-209. **6.** Houston, Ch. S.: Going higher. The story of man and altitude. Boston, Toronto, 1987. 324 p. **7.** Kolchniskaya, A. Z., Mischenko, V. S., Gunadi, B. K., Stepanov, Zu. V.: On regulation of oxygen regimens of organism under conditions of muscular activity of different age people. In: Motor activity and Ageing. K. Medgiz., 1969. P. 146-164. **8.** Kolchniskaya, A. Z.: Secondary tissue hypoxia. K., Naukova Dumka, 1983. 254 p.

PECULIARITIES OF THERMOREGULATION IN THE MOUNTAINS

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Abstract

Maintenance of temperature homeostasis is of crucial importance for climbers who do intensive physical work under conditions of low temperature.

Our measurements of organismic thermogenesis under conditions of hypoxia (P. V. Beloshitskii, 1979, 1982) showed that at altitude of 5500 m the amount of effective heat was 43% less than at an altitude of 2100 m. It was also established that there was a change in the chemical structure of animal thermogenesis under extreme conditions, and a hypothesis concerning the growing role of a “heat free-radical boiler” was forwarded P. V. Beloshitskii, 1982).

The problem of thermoregulation change as a part of the adaptation to hypoxia is of special interest. It was shown (P. V. Beloshitskii at al., 1987) that adaptation to hypoxia increased the capacity of the heart muscle, while adaptation to hypoxia combined with low temperature decreased it.

Our study of hypoxia genesis under hypothermia (P. V. Beloshitskii, 1982) showed that under hypothermia up to 22 °C the tissue demand for oxygen was not limited by its prolonged supply, but histotoxic hypoxia developed gradually. These studies made it possible to develop methods for post hypothermal normalization of vital activity. The method of cross blood circulation turned out to be the most effective: it allowed normalization of the vital activity after 17.5 hours long hypothermia at 22 °C.

Experiments on volunteers subjected to the influence of "high altitude" (7500 n) and low temperature (-55 °C) for one hour were also performed. The limits of bodily temperature decrease and changes of minute ventilation were determined, the parts of the body at greatest risk of frostbite were established etc. (P. V. Beloshitskii et al., 1984),

The measures against hypoxia-and-low temperature complex, are both medical (selection, adaptation, hardening, prophylaxis, diet, posthypothermal normalization of vital activity) and technical (clothes with variable heat-preserving properties, heated means of transport, heat monitoring, inhaled-air warming, etc.).

The problem of maintaining temperature homeostasis is crucial for mountain climbers exerting who do intensive physical effort under conditions of low temperature and hypoxia. Now, the question arises: how does the temperature state of organism change during ascent, as air rarefies while its temperature decreases, etc.? The organism releases more heat by conduction and less by convection and irradiation. There is also a significant increase in heat loss through respiratory tract, mainly due to evaporation. Mathews (7) estimates the respiratory heat loss at 15 – 25% of the total heat loss. Kendror (15) estimates it at 25 – 30%, and Tikhomirov (19) thinks it may be as much as 50%.

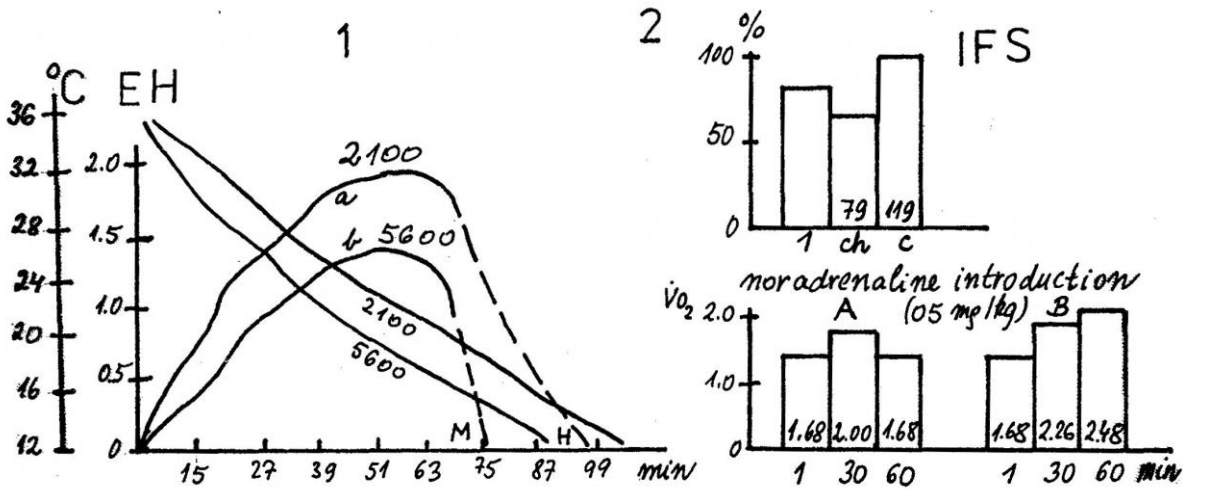

Fig. 1. Effective heat (EH, relative units) and rectal temperature in fixed rats cooled at 0 °C at the "altitudes" of 2100 and 5600 m. Designations: SOaH - EH at the "altitude" of 2100 m, SObM - EH at the altitude of "5600" m.

Fig. 2. Influence of combined adaptation to high-altitude hypoxia and cold on contractibility of the heart and its reactivity to adrenaline. Designations: A – adapted to high-altitude hypoxia, B – adapted to high-altitude hypoxia and cold; 1 – initial values; IFS – intensity of the functioning of structures (with an increase of HR to 430 under effect of electrostimulation) – a product of the pressure developed by the ventricle weight unit per heart rate, mm Hg/mg.min; ch – cold + height; c – cold. VO_2 [ml·min^{-1}·100 g^{-1}].

The peculiarities of organismic thermoregulation in the mountains also include the possibility of an eventual conflict between the central and local reactions, “clashes” between separate physiological systems. For instance, intensive work at high altitude causes a sharp increase of ventilation. At the same time, the aperture of the respiratory tract narrows in the cold owing to reflex action, and airway resistance substantially increases.

There are some other thermoregulation problems in the mountains. It was Blatteis, Gilbert, and Lutjerer (7–14) who established that metabolic reactions are weaker as a result of cold. According to Bazhenov (1), hypoxia substantially reduce the heat effect on muscular activity.

We have conducted a research aimed at measuring thermogenesis under conditions of hypoxia. For this purpose we developed a method for measuring effective heat and critical temperature of thermogenesis. Effective heat is that part of heat produced by the organism which is used for heating the body of a cooled animal. And critical temperature is the rectal temperature at which thermogenesis of the organism ceases. It was found (Fig. 1) that at “altitude” od 5500 m effective heat is 43% less than at an “altitude” od 2100 m, while critical temperature increases from 12.9±0,3 °C to 14.8±0,7 °C (3,5,16).

It was shown that simultaneously with the thermogenesis decrease in animals under extreme conditions, the chemical structure of thermogenesis changes as well. In this connection we put forward a hypothesis concerning the growing role of the “heat free radical boiler” (2,6).

Of peculiar interest is the problem of the thermogenesis change as a part of the adaptation to hypoxia. We have established (20) that adaptation to hypoxia increases the efficiency of the cardiac muscle, whereas adaptation to hypoxia plus cold decrease it (Fig. 2). Besides, animals which have

been adapted to the combined influence of hypoxia and cold respond to adrenalin by a rise of the temperature and oxygen uptake.

We have also carried out experiments aimed at elucidation of hypoxia genesis under hypothermia. It has been established (2) that under hypothermia up to 22 °C, tissues demand for oxygen is not limited by its supply for a long time, but histotoxic hypoxia develops gradually. The results of our study (4) have enabled development the methods for posthypothermal normalization of the vital activity. The method of cross blood circulation has proved to be the most effective. It has permitted the vital activity to be normalized 17.5 h after hypothermia at 22±1 °C.

Finally, we have also performed experiments on volunteers (Fig. 3) subjected to the combined influence of "altitude" (7500 m) and cold (-50 °C) for 1 hour (18). The degree of temperature fall was established, the quantity of heat loss on a square unit of the naked body surfaces was measured, and it was shown that ventilation grows under the influence of cold and high altitude. The parts of the body most exposed to the danger of getting frostbitten were as follows: cheeks, chin, nose, shoulders, the major pectoral muscle, knee joints, fingers and toes, this was established by thermovision.

The results obtained permitted us to outline a set of measures that should be complex and include both medical means (selection, adaptation, tempering, prophylaxis, posthypothermal normalization of the vital activity) and technical devices (such as clothes with variable heat-preserving properties, means of transport provided with heating, constant-check-up of heat content, individual means of warming inspired air, etc.).

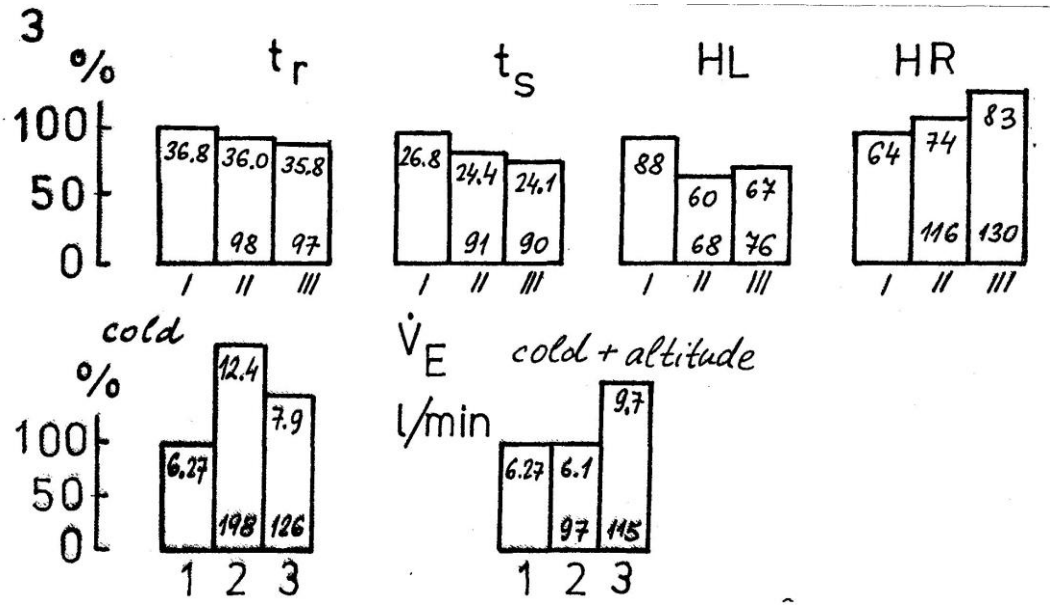

Fig. 3. Combined action of low temperature (-50 °C) and hypoxia (7500 m) on the organism. Designation: tr – rectal temperature; te – averaged skin temperature; HL – heat loss, w.m 2 ; HR – heart rate; 1, I – initial values; II – after the action of cold, III – after the action of cold and altitude; 2 – 20 min after action; 3 – after leaving the chamber.

References

1. Bazhenov, J. I.: Termoregulacia pri adaptatsii k gipoksii. Leningrad, Nauka, 1986. 126 p. **2.** Beloshitskii, P. V.: Transport i utilizaciya kisloroda pri dlitelnoj gipotermii. Avtoref. diss. dokt. med. nauk. Kiev, 1982. 44 p. **3.** Beloshitskii, P. V**.,** Petunin, J., Jakut, L.: Teploprodukcia organisma pri

okhlazhdenii v usloviach kislorodnoj nedostatotchnosti. In: Fiziologia extremalnych sostoyanii i individualnaya zashchita cheloveka. Moskva, 1982. P. 59-60. **4.** Beloshitskii, P.V.: Efektivnost metodov postgipotermitcheskoi normalizatsii zhiznedeyatelnosti. In: Tezisy dokladov 2. Vsesoiuznoi konferentsii po kriobiologii i kriomedicine. Kharkov, 1984, t. 2, p. 129. **5.** Beloshitskii, P.V.: Termoregulacija pri zanjatijach alpinizmom. In: Tezisi dokladov 1 Vsesojuznoj konferencii "Termoregulatsiya i sport". Moskva, 1986. P. 19-20. **6.** Beloshitskii, P. V.: K gipoteze o roli "svobodnoradikalnogo kotla" v protsezikh teploobrazovaniya. In: Vneshniye teoreticheskie i prakticheskie problemy termoregulatsii. Minsk, 1986. P. 41. **7.** Blatteis, C. M.: Hypoxia and the metabolic response to cold in newborn rabbits. J. Physiol., 172, 1964, 358-368. **8.** Blatteis, C. M.: Thermogenic processes during cold in hypoxia. Fed. Proc., 25, 1966, 1271-1279. **9.** Blatteis, C. M.: Thermoregulatory heat production during hypoxia. In: Influence of cold on metabolic regulation. Ed. E. M. Zipf. Issue, 1969, p. 11-16. **10.** Blatteis, C. M.: Shivering and nonshivering thermogenesis during hypoxia. In: Proc. Intern. Symp. Environmental Physiology, Bioenergetics. Ed. R. Smith. Bethesda, 1972, p. 151-160. **11.** Blatteis, C. M., Gilbert, T. M.: Hypoxia and shivering thermogenesis in cold acclimatized miniature pigs. J. appl. Physiol., 36, 1974, 4: 453-456. **12.** Blatteis, C. M., Lutherer, L. O.: Cold-induced thermogenesis in dogs: its reduction by moderate hypoxia. J. appl. Physiol., 35, 1973, 5: 608-612. **13.** Blatteis, C. M., Lutherer, L. O.: Reduction by moderate hypoxia over calorigenic action of catecholamines in dogs. J. appl. Physiol., 36, 1974, 3: 337-339. **14.** Blatteis, C. M., Lutherer, L. Q.: Effect of altitude exposure on thermoregulatory response of man to cold. J. appl. Physiol., 41, 1976, 6: 848-858. **15.** Kandror, I. S.: Ocherki po fiziologii i gigiene cheloveka na Krainom Severe. Moskva, Medicine, 1986. 280 p. **16.** Ljashko, L. I., Beloshitskii, P. V., Petunin, J. I., Jakut, L. I.: Otsenka teploproduktsii v usloviyakh izmenonoi gazovoi sredy. In: Matematicheskije problemy v biologii. Kiev, Nauk. dumka, 1983, p. 74-87. **17.** Matthews, B.: Loss of heat at high altitude. J. Physiol. (London), 1932=1933, vo. 77, 1-4, p. 28-29. **18.** Sutkovoj, D. A., Beloshitskii, P. V., B1lik, I. I., Katkov, A. J.: Perenosimost chelovekom ostroi gipoksii pri vozdeistvii na organizm visokikh i nizkikh temparatur. Deponirovana v VNII medicini i mediko-tekhnitcheskoi informacii MZ SSSR, 1984, seria D-7693. **19.** Tichmirov, I. **I.:** Otcherki po fiziologii cheloveka eketremalnykh usloviyakh. Moskva, Medicina, 1965. **20.** Ugoiev, L. M., Biber, L. M., Drozhdin, O. L., Beloshitskii, P. V.$_v$ Kapelko, V. I.: Vliyanie sotchetanoi adaptatsii k vysokonoi gipoksii i kholodu na sokratitelnuyu funkciyu serca i jego adrenoreaktivnost. In: Aktualnyie problemi obshchej patologii i patologicheskoi fiziologii. Moskva, 1978, p. 37-40.

FUNCTIONAL BODY CHANGES IN THE "SHUTTLING SYNFROME" AT MODERATE ALTITUDE

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Industrial development of mountain territories during the last decade has been characterized by mass utilization of work regimes in which groups of workers periodically migrate over a wide vertical and horizontal range (transit work), subsequently returning to their place of permanent residence.

Since accuracy in predicting functional body capacities and working capacity depends to a great extent upon a whole complex of natural and industrial environmental factors, we have attempted to classify transit work at altitudes as a new medicobiological and social phenomenon. Transit work at altitudes may differ in duration, range of vertical migration, and extent of horizontal dislocations. The transit-work cycle may be pulsatile, short-term, or long-term. Under the pulsatile transit-work regime, the change in altitude occurs daily or many times a day. This regime is mostly characteristic of drivers and subjects performing work of a special type. Under short-term regime, a change in altitude occurs after 3, 7, 15 or 30 days of work. It should be noted that such a working regime is currently the one most used by and covers practically all the professions of miners and builders. In the long-term working regime the change in altitude occurs after one or two months of work. This type of working regime is probably the most widely used by workers of permanently operating high-altitude power plants and mining enterprises. Besides the duration of transit-work, of importance in the organization of work at altitude are the altitude zone within which the subject is transferred. From this point of view the zone from 0 to 1500 m is regarding as low-altitude work, up to 2500 m as moderate-altitude work, and above 2500 m as high-altitude work, with the range of vertical dislocation in any of the three zones being not less than 1000 m. In this respect it is understandable that during the initial periods of adaptation dislocation in the moderate-zone (from 8000 to 2500 m) may prove to be more strenuous than in the high-altitude zone (from 3000 to 4000 m).

In this context of special interest is the pulsatile regime of work referred to as a "shuttling" regime, in our case represented by groups undertaking daily vertical migration from 460 to 1760 m above sea level with a 30-km horizontal displacement. Subjects who have worked in such a regime for three years or more usually complain of rapid fatigue, inertia, headaches, sleep disturbances and decreased working capacity. Of importance is the fact that ordinary medical examinations, even those involving functional diagnostic methods, have failed to reveal any clinical changes in any functional systems.

As shown by complex physiological studies involving investigation of biological rhythms, the cardiovascular, respiratory, thermoregulatory and several other systems, practically every functional parameter was within the normal clinical range. However, the functional reserve of certain systems was decreased. Thus, comparison of data obtained in Group II with those in a group of subjects living permanently at low altitude (700 m) revealed significant difference in respiratory parameters, blood oxygen saturation and haemodynamics (Table 1).

As regard respiratory function, it was found that pulmonary ventilation at rest in Group II was 38% higher than in the controls while maximal ventilation was decreased by 25%.

As to haemodynamics, a higher cardiac output was matched by peripheral flow resistance 23% higher than in controls. Exercise testing (tests with breath holding and rebreathing) revealed a lesser mobilization of the oxygen transport system. Thus, initial arterial oxygen saturation values were 3% lower in Group II and saturation recovery time was consistently increased during breath holding.

Since hitherto most investigators have been of the opinion that, together with energy expenditure, the heart rate remains one of the most informative values in assessing the level of strain during work, we analysed the biorhythmologic status of statistical indices of the cardiac rhythm and its spectral and autocorrelation components. Thus, acrophases of the heart rate and the tension index fell at 7 p.m.; acrophases of the index for sympathetic and parasympathetic activity regulation also fell at evening hours. When the same parameters were analysed in permanent sea-level residents, the acrophases were found to occur during daylight hours (3 p.m.) rather than in the evening, i. e., during active wakefulness. Spectral cardiac-rhythm analysis performed on a biorhythmologic basis revealed a clear-cut 14-hour periodicity of the activity of the autonomous and central regulatory circuits. Acrophases of central regulatory circuit activity fell at 2 a.m. Therefore, it may be assumed that one of the most adverse factors during a shuttling regime at altitude is not the daily ascent but rather daily descent, the periodicity of this process giving rise to changes in parasympathetic and sympathetic activity. This effect causes shifting of the acrophase of the autonomic regulatory circuit and the tension index to evening or event night-time hours. In all probability these processes are the cause of sleep disturbances and of the numerous complaints in Group II.

Since system stability during adaptation to a combination of adverse natural and industrial factors is in many respects determined by interfunctional relations, we studied their structure with the aid of multifactorial correlation analysis. Thus, out of the physiological parameters analysed in a group of subjects living permanently at 1750 m above sea level and undergoing the effects of a shuttling regime, nine parameters proved to form a single correlation coefficients in the pleiad. Apparently, the structure of the main pleiad is determined by the necessary minimal correlation of functions that ensures optimal adaptability. The appearance of the additional pleiad probably reflects mobilization of reserve mechanisms by the body and increased biosocial cost of the state of relative adaptation.

Thus, all the physiological studies performed indicate that the shuttling regime is stressful, are the combined functional changes occurring in the body under the influence of daily vertical migrations have been defined by us as the “shuttling syndrome”. The latter manifests itself to various degrees in the overall structure of functional states in the subjects studied; thus, in Group II, 35% the subjects had high level of functional reserves and their adaptation was satisfactory, 31% had low reserve levels and were in a pronounced state of stress, while 10% had evident signs of predisease or disease states.

Table 1. Parameters of respiratory function, oxyhaemometry and haemodynamics in subjects working under a regime of daily ascents to altitude.

Parameters / Groups	C	I	II
	n = 16	n = 8	n = 24
Minute ventilation [l]	5.5 ± 0.8	6.0 ± 0.7	9.0 ± 0.1*
Vital capacity, predicted [l]	5.2 ± 0.1	5.1 ± 0.1	5.1 ± 0.1
Vital capacity, actual [l]	4.7 ± 0.2	4.6 ± 0.1	3.4 ± 0.3*
VCpredict/VCact [%]	90.3	89.9	66.8
Macimal ventilation, predicted [l/min]	120.5 ± 4.0	120.0 ± 3.6	125.5 ±8.2
Maximal ventilation, actual [l/min]	119.0 ± 3.6	110.3 ± 8.0	90.1 ±3.0*
MVpredict/MVact [%]	99.0	91.6	72.0
Respiratory reserve [%]	21.1 ± 0.8	18.3 ± 2.5	10.0 ± 0.9*
Arterial O_2 saturation, initial [%]	96.5 ± 0.5	95.9 ± 0.5	94.4 ±0.6*
Arterial O_2 saturation, minimal [%]+	82.0 ± 1.6	78.8 ± 1.5	78.0± 2.6
SaO_2 recovery time [s]	10.2± 0.8	9.2 ± 3.2	14.0 ± 1.2*
Heart rate [beats/min]	60.0 ± 2.0	62.0 ± 2.5	84.0 ± 1.7
Stroke volume [ml]	74.0 ± 2.0	72 ± 4.5	88.0 ± 2.0*
Cardiac output [l/min]	4.4 ± 0.1	4.8 ± 0.2	5.6 ± 0.1*

+ after breath holding * significantly different from controls
C: controls (permament low-altitude residents)
Group I: subjects living for 3 to 5 years at 1750 m above sea-level
Group II: subjects daily ascending to 1750 m over a period of 3 to 5 years

In summarizing it must be emphasized that the organization of work at altitude requires detailed complex investigation of all the currently available regimes in order todevelop scientifically valid recommendations as to the selection of subjects and the prediction of their functional states.

Thus, the pulsatile work regime at altitude results in a shuttling syndrome that is a new medicobiological phenomenon involving discordance of physiological functional reserves and changes in the biorhythmologic status on a background of general body stress.

DETERMINANTS OF ACCLIMATIZATION AND PERFORMANCE IN MGM-ALTITUDE EXPEDITONS

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Abstract

Performance at high altitude was evaluated in 174 alpinists (136 men and 38 women) participating in a high altitude expedition. The maximal altitude reached (MaxAlt) during the expedition or maximal altitude ever reached by a particular subject (MaxAlt*) served as indices of performance. VO_2max and ventilatory (HVR) and heart rate (HR) responses to hypoxia ($F1O_2$=0.115) at 50% VO_2max were determinated before the expedition. Symptoms of acute mountain sickness (AMS), assessed by means of a clinical score, and climbing profile were recorded during the expedition.

MaxAlt and MaxAlt* were related to VO_2max but not to HVR or HR. Occurrence of AMS was related to HVR and HR but not to VO_2max. Subjects suffering from AMS have a spontaneous ventilatory pattern with higher frequency and lower tidal volume than nonsusceptible subjects. Occurrence of AMS is higher below 18 and above 50 yrs. The minimum number of days necessary to reach a given altitude was determinated as a function of the susceptibility to AMS and VO_2max.

Acclimatization to high altitude proceeds in 4 phases. Phase 1 (0-6 h): no or few signs of AMS; phase 2 (6h-1 week): acclimatization, max. signs of AMS; phase 3 (1-3 weeks): max. performance period; phase 4 (>3 weeks): degradation period. HVR and HR are determinants of phase 2, VO_2max is a determinant of phase 3. Climbing Everest without oxygen seems possible with low HVR but unlikely with low VO_2max.

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EXPERT EVALUATION OF "ALTITUDE" TOLERANCE IN CANDIDATES FOR SOVIET EXPEDITION "EVEREST - 82"

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Abstract

Medical selection of 24 elite mountaineers aged 25-47 years included stepwise "lifts" in decompression chamber and breathing 9.5-10% oxygen gas mixture with graded work on bicycle ergometer to evaluate individual tolerance and work capacity under acute hypoxia and reveal hidden illnesses. Besides, a hyperventilation 3 min-test was given to determine resistance to hypocapnia. Higher acute hypoxia and exercise tolerances were established in mountaineers as compared with control subjects. A relatively high sensitivity of CNS for acute hypoxia was observed in two candidates. Changes testifying to the presence of latent cardiovascular system diseases were found in two other persons who were dismissed from further training. However, performance of workload eliminated bradycardia and normalized lowered blood pressure caused by breathing hypoxic gas mixture in two more climbers with reduced resistance for acute oxygen deficiency this allowing their recommendation that they be kept among team members. Tolerance for hypocapnia in was also increased in the mountaineers. Higher voluntary hyperventilation at altitude provides higher percentage of SaO_2 in climbers and is one of the reasons of their better tolerance of acute hypoxia. The tests used permitted evaluation individual adaptation reserves and revealed abnormal reactions.

Introduction

Everest (8848 m) is the highest mountain on Earth and its ascent has remained a much cherished but unrealized dream for generations of mountaineers throughout the world. Norton and Sommerwell reached on it an altitude of nearly 8600 m already in 1924, however, the summit itself was eventually climbed only in 1953. The first of the three main difficulties encountered on Everest (altitude, weather and technical obstacles) is related with considerably lowered PO_2 in the rarefied air. The barometric pressure on the very top of Everest is 253 mmHg (30).

It is noteworthy that the first case of death of men from acute oxygen deficiency at high altitude happened to the aeronauts of the French balloon "Zenith" in 1875. During their flight they ascended to an altitude of 8600 m and stayed on it for less than two hours. Thus the crew did not even reach the height of Mt. Everest but not having been preliminary adapted to the lack of oxygen its members turned out not to be able to tolerate the considerable degree of hypoxia. This example is yet another testimony to the great importance of preliminary adaptation to high altitude.

As is known from mountaineering practice and high-altitude physiology experiments, the main biological effect during high altitude climbing is evoked by the lowered atmospheric pressure and consequent diminished PO_2 in the air leading to eventual development of oxygen deficiency in the organism. It makes one believe that in order to increase the safety of ascents it is expedient to take for the sake of prophylactics during preparatory stage of high-altitude expeditions a number of interrelated measures: to eliminate persons with decreased tolerance for hypoxia, in the first place those who are suffering from various latent diseases; to work out possibly the most rational

acclimatization regime, i. e. to elaborate a schedule for work and rest while laying out the route and putting up high altitude camps, and, finally, top foresee the wise use of oxygen during assault.

In this article we intend to dwell only upon the first question, i. e. selection of candidates for the first Soviet expedition to Mt. Everest in 1982. Undoubtedly, the level of working capacity and the way one feels at great altitudes are the best evidence of mountaineer´s individual tolerance for oxygen deficiency and other factors of high-altitude environment (9,10,12,15 etc.). This can be testified by the results of scientific observations at high-altitude stations or during expeditions. An alternative variant is the evaluation of a climber's state by his teammates or by himself under such conditions. However, one should treat such data with certain caution because mountaineers are not always able to estimate correctly their condition during ascents owing to the development of euphoria or, on the contrary, the blunting of the CNS "control system" during hypoxia. It is also possible that for personal reasons they may want to conceal their true state from other members, doctor or team leader. All this naturally implies that climber´s state should be tested to obtain objective data during simulation of high-altitude conditions in laboratories. This has been done from remote time since Paul Bert (6) with the help of air rarefaction in the decompression chamber. However, the considerable shortcoming of this method in the majority of works known to us was that the rarefaction of atmosphere – "lifting to altitude" - was rapid and the duration of one's stay in it was relatively short which does not correspond to the real conditions during mountain climbing. This was understood by an explorer and mountaineer Ch. Houston who together with R. Riley conducted in 1947 a special experiment called "Operation Everest". Four volunteer test persons lived for 35 days in the decompression chamber in which the atmospheric pressure was being lowered daily thus imitating a slow ascent; during the last day the final summit was modelled. It is important to note that the investigators themselves did not suffer from hypoxia and the experimental conditions were strictly controlled, which is not possible during high altitude expeditions (11). However, even in this unique experiment, as in all others, the imitation was not absolutely adequate because other unavoidable "sputniks" of high-altitude ascents were absent: low ambient temperature and its sharp diurnal changes, intensive solar radiation, wind, as well as a complex of factors connected with difficult mountain terrain which entails risk for life and certain psychoemotional tension.

In spite of the aforesaid considerable shortcomings, the method of "lifts" in the decompression chamber for predicting individual resistance against high-altitude hypoxia gives certain benefits. Decompression tests are conducted in strictly controlled and reproducible conditions and therefore they are widely used in expertize of persons who can experience oxygen deficiency due to professional duties. This method was used for instance during selection of candidates for the Italian expedition to K2 (8611 m), the second world's highest summit, in 1954. Many years' experience in aviation and space-exploration medicine shows that "lifts" in various regimes to 5000 – 7000 m "altitudes" can be and has been helpful in a number of cases in revealing some latent diseases, in the first place of nervous and cardiovascular systems (4,5,13,14,17,20,24,29 etc.). One should also bear in mind that such "lifts" can reveal persons with highly inferior or highly superior sensitivity to the lack of oxygen. Here we should like to mention once more that our personal experience shows that in certain cases persons who demonstrate lowered "altitude" tolerance in decompression chambers can display high tolerance and working capacity under the

real conditions of slow ascents in the mountains during which acclimatization develops. It happens first of all with people who show precollapsoid reactions – bradycardia and blood pressure fall – during rapid decompression "lifts". For instance, one of our subjects, a Master of Sport of the USSR in mountaineering, lost consciousness during a decompression chamber test at an "altitude" of 6000 m as a result of bradycardia-syncope. A month later he was nevertheless allowed to participate in a high-altitude expedition, reached the top of Khan-Tengri peak (6995 m), showed, in the opinion of other participants, high working capacity, and was feeling well (19). It is known from the literature that there exist and are being used in practice several methods for testing oxygen deficiency tolerance:

- "lifts" in decompression chambers with various regimes, intermittent or continuous, to determine "altitude ceiling";
- "lifts" in decompression chambers to great "altitude", usually 7500 m, with a sharp cut of oxygen supply, to evaluate "time reserve";
- rebreathing method or respiration test;
- breathing gas mixtures with lowered oxygen content at rest or during simultaneous performance of workloads;
- breathing gas mixtures with total oxygen absence, for instance, a test on breathing pure nitrogen, to reveal tolerance for a super acute form of hypoxia;
- a functional test with voluntary breath holding, etc.

To prognosticate one's tolerance for hypoxia and working capacity level under mountaineering conditions, some authors suggest to take into account the maximal values of a number of physiological parameters serving as limiting factors, e.g. "a standard athlete" for middle-altitude competitions (16), and "a conventional mountaineer" for high altitudes (26); other authors attribute leading importance to a certain complex of, or even separate physiological reactions – ECG, EEG, tissue PO_2 level, etc. (5,7,14,15,21,23,27, etc.); there are still others who recommend to make use of special nomograms or formulas (2,3).

Our many years´ experience of hypoxia simulation under laboratory conditions testifies that stepwise "lifts" in decompression chambers and breathing gas mixtures with lowered oxygen content in combination with stepwise increase of physical loads are the most informative methods for the purpose. In our material we shall represent the experimental data obtained in mountaineers with the help of these methods. The testing was done in order to work out recommendations for the selection of the most perspective candidates for the first Soviet expedition to Mt. Everest on the basis of evaluation of their individual tolerance for acute hypoxia and their ability to carry out physical work under oxygen deficiency. It was preceded by a thorough medical examination which revealed persons with deviations and disturbances in their health. Therefore some of them were excluded from further training (7 persons) as not affording much prospect; others were given recommendations to undergo medical treatment, for instance, sanation of their oral and nasopharyngeal cavities etc. So, practically only candidates in good health were allowed to be tested.

Methods

Following methods have been used:

1. "Lifts°" in the decompression chamber.

"Lifts" were carried out without additional oxygen supply at a rate of 20 m/s up to a 5000 m "altitude" – 1st 15-minute pause. Further "lifts" were carried out with 10-minute pauses at each 1000 m level until the onset of reactions which testified to the development of deep hypoxia state requiring the cessation of further "ascent" and use of oxygen mask. The main indications for doing so were the development of clonic seizures of separate muscle groups and sharp retardation accompanied by a loss of capability to solve elementary arithmetic tasks (addition of simple numbers) as well as appearance of bradycardia, sharp changes in arterial blood pressure, and domination of slow waves within the range of theta and delta rhythms on the EEG tracings. During these tests, simultaneously with medical observation, we recorded ECG, EEG, pneumogram, lung ventilation, arterial blood pressure, pulse rate, oxygen uptake, tissue PO_2 level in arm, and checked capability to fulfil psychological tests.

2. Combined functional tests: hypoxia plus physical load.

A tested person in a sitting position on a bicycle ergometer had to breathe gas mixture containing 9.5–10% oxygen equivalent to the altitude of the expedition Base Camp (5300–5400 m). Ten minutes after the commencement of breathing this gas mixture a mountaineer began to carry out on bicycle ergometer, for 3 minutes, the load being 300, 600, 900 and 1200 kpm/min. The test was stopped either after the subject had fulfilled all the work imposed, or when he refused to continue doing it, or owing to medical indications. Before and during the test in the process of 10-minute restoration, the following parameters were recorded: ECG in the Nehb three leads system, EEG in frontooccipital, temporal and parietal leads, rate of respiratory movements and, amplitude, PAO_2, $PACO_2$, VO_2, minute volume, SaO_2 and arterial blood pressure (Fig. 1).

3. Functional test for forced voluntary hyperventilation.

This test was conducted before a stepwise "lift" in decompression chamber to evaluate a subject´s individual tolerance to hypocapnia. Mountaineers were instructed to breathe for three minutes as deeply and frequently as possible (but not more than 25 breaths/min}. The test tolerance was evaluated in terms of both the subject´s general condition and EEG, respiration and ECG data. Hyperventilation was stopped before time upon development of domination of high-amplitude slow waves in the EEG and marked worsening of the subject´s general state.

Results and Discussion

As in previous studies (1_v18,22,28 etc.), it was found that resistance to acute hypoxia in 24 mountaineers under basal conditions, i. e. before going to the mountains, showed wide individual variations but in general was higher than in nonmountaineers. Only two candidates could not stay at 8000-m "altitude", one of them showed polytope extrasystolia on the ECG and the other one evinced sharp retardation and drowsiness turning into sleep. Four subjects could stay at a 9000-m "altitude" for less than three minutes due to pronounced disturbances in CNS activity, development of retardation, loss of capability to solve arithmetic tasks, appearance of cramps and jerks in separate muscle groups. Five persons stayed at this "altitude" for more than 5 minutes. Nine

subjects managed to stay throughout the test period, i. e. 10 minutes, at a 9000-m "altitude" and three persons at 10,000-m "altitude".

In evaluating these data one should note that the values of "altitude ceiling" obtained by us are somewhat higher than the data reported in the literature. This can be explained not only by most of our subjects belonging to the elite of high-altitude mountaineers but also possibly by the pecu1arities in the method of conducting the decompression test: the addition of single-digit numbers was done orally at the experimentator's commands given in a loud voice, which most probably produced mobilizing or in some cases "awakening" effects on those tested persons who had already fallen into retarded state and had thus nearly lost mental working capacity. In this respect, dynamic observations of the subjects´ condition during the process of "lifting" were of some importance. Many of them started to make mistakes in arithmetic tests beginning from 7000–8000-m "altitude", some displayed episodes of retardedness and drowsiness, whereas two, on the contrary, episodically lapsed into the state of euphoria. It is noteworthy that during the period of deterioration, development of retardation and appearance on EEG a great number of theta and delta waves of increased amplitude, the experimenter´s mobilizing commands led to disappearance of slow waves and appearance of desynchronization on EEG and temporary improvement in the subjects´ state.

Two persons had a low threshold (6000 m) for the appearance of high-altitude theta waves on EEG and one of them showed an episode of discharge activity. Another subject displayed a considerable increase in systolic blood pressure, from an initial 155 to 199-220 mmHg, with a considerable decrease in diastolic blood pressure, therefore his further "lifting" was stopped and he underwent a special additional examination which discovered that he had a chronic cardiac disease – mitral valve prolapse; therefore he was eliminated from further training.

Respiratory reactions during decompression tests were of considerable interest. Breathing frequency and minute volume increased considerably in the majority of the tested persons at 7,000 – 10,000 m "altitudes". For instance, before "lift" the respiratory rate in subject E-f was 6–8 breaths/min, whereas at 9000-m "altitude" it increased sharply to 24-30 breaths/min. Changes in breathing frequency seen in subject Sh. had a wavy pattern: before a "lift", 8–12 breaths/min, at 6000–7000-m "altitudes" it decreased to 6 breaths/min with an increase in minute volume, and at 9000-m "altitude" it sharply and unevenly increased up to 30 breaths/min. Such a dramatic increase in the respiratory rate was found in 19 out of 24 subjects.

These observations allowed us to witness again, as before (19,20), that at a certain time mountaineers start to hyperventilate voluntarily in order to increase their "altitude ceiling". In this connection we should like to draw attention to the results of 3-minute hyperventilation functional test. When it is done under normoxia conditions mountaineers display a higher resistance to hypocapnia in comparison with nonmountaineers: 60% of the control-group subjects show in the 2^{nd}–3^{rd} minutes of such a test the high-amplitude theta and delta activity (8), in many cases it has a paroxysmal character.

Only six out of 22 mountaineers displayed during the hyperventilation test theta and delta waves of increased amplitude on the EEG and only in two of them this activity was of a paroxysmal character; in four mountaineers it was expressed episodically and after cessation of the test it

quickly disappeared in 30–40 seconds. The rest of the mountaineers showed, during hyperventilation, only an increase in the alpha-rhythm – an increase in the number and amplitude of alpha waves – and some of them showed a decrease in frequency and disorganization in the structure of alpha waves. Thus, the use of hyperventilation test made it possible to establish that the majority of mountaineers possess a higher resistance to hypocapnia than healthy nonmountaineers.

The test for breathing gas mixture in combination with physical work revealed individual variations among mountaineers already at rest. Two of them had deviations from the accepted norm on the ECG initial tracings, especially marked in the ECG from B., who later reached the top of Everest without oxygen making use of it only at night to normalize sleep and improve recovery. He showed bradycardia at rest before the test – 37 beats/min with an unstable, sinus rhythm, displacement of pacemaker from sinus knot to lower cardiac sections. However, from the very first minutes after the start of breathing gas mixture we could observe the restoration (normalization) of sinus rhythm, the ECG reached the norm limits and remained so throughout the test. Subject M., who also reached the top of Mt. Everest using oxygen set, had lowered T waves on the initial ECG and during the work performance beginning from 600-900 kpm/min loads, the horizontal displacement of ST segment was more than 1 mm below the isoline.

A somewhat lowered tolerance for hypoxia while breathing gas mixture was seen in mountaineers E-v and T-ch (both of them made an ascent of Everest at night using oxygen), who displayed bradycardia in the 8^{th}–9^{th} minutes of the test against a background of decrease in arterial blood pressure.

In order to correct such a reaction, these subjects were offered to start pedalling the bicycle ergometer ahead of time, which led to an increase in the heart rate and blood pressure. It is noteworthy that both of these mountaineers reported improvement of their general state upon completion of the physical work. After the end of the experiment the subject T-ch wrote: "At the onset of the test I felt nauseated and drowsy at rest. After I started to work my state improved and I felt good until the end of it".

The initial EEG tracings before this test were within the norm limits in all subjects except one (Boyh-f). After the commencement of hypoxic gas mixture breathing the majority of the tested persons demonstrated only an increase of alpha-rhythm: an increase of the alpha index and alpha waves amplitude. Subject Bozh-f showed short-term bilateral discharges of theta waves of increased amplitude.

The respiratory reactions and oxygen consumption in mountaineers differed in some ways from well-known and formerly described patterns in persons without previous high altitude experience. These differences consisted first of all in the fact that hypoxic gas mixture breathing evoked in the majority of the tested climbers an increase in oxygen consumption, considerable increase in minute volume and decrease in respiratory rate.

The management of stepwise workloads on the bicycle ergometer accompanied by hypoxic gas mixture breathing enabled us to classify all the mountaineers in four groups. The 1st group consisted of 11 persons with high working capacity under hypoxic conditions who managed to cope with all the work loads; the 2nd group included five persons who coped with the test in a satisfactory

way having fulfilled the work up to 900kpm/min and 50% of 1200 kpm/min; the 3rd group were four persons who showed lowered working capacity, i. e. they could manage only the 900 kpm/min work load and one of them was requested to stop the test because of development "ischaemic" changes in his ECG. The 4th group comprised two subjects who could not manage the 900 kpm/min work load; one of them was O-ko, who refused to tackle the 900 kpm/min work load.

On the whole, the working capacity of mountaineers who performed physical work while breathing gas mixture with a lowered oxygen content turned out to be higher than that of nonmountaineers.

Conclusion

1. The use of the **hypoxic test**, stepwise "lifts" in decompression chamber and breathing gas mixture with lowered oxygen content combined with exposure to work enabled us:

a) to evaluate individual tolerance for acute hypoxic exposure in all the candidates for the expedition;

b) to discover in two candidates changes falling below the norm limits (polytope ventricular extrasystolia, sharp increase in systolic blood pressure with considerable decrease in diastolic pressure) which testified to the presence of latent cardiovascular disease which led to their dismissal in time from further training for the expedition;

c) to reveal persons with considerably sensitivity of the CNS for acute hypoxia evidenced by the appearance on the EEG during "lifting" to relatively low "altitudes" of about 5000–6000 m episodes of paroxysmal slow activity; as a result, three of the four persons were eliminated from further training;

d) to make the interesting observation that the performance of physical work led to normalization of circulatory functions and top increase of resistance against hypoxia in two persons with the lowered tolerance for this factor;

e) to rank all the candidates in accordance with their ability to perform physical work under oxygen deficiency (for the time of testing).

2. **Decompression tests** confirmed previously data about enhanced tolerance for acute hypoxia in mountaineers. These tests have made it clear that the mechanism of this phenomenon is connected to a certain degree with peculiarities of respiratory control – voluntary hyperventilation starting at high altitudes in order to preserve of brain circulation on high level

3. **The voluntary hyperventilation test** made it possible to determine individual, and on the whole increased tolerance of mountaineers for acute hypocapnia, which has some significance regarding the mechanism responsible for the increased resistance for hypoxia as well.

On the basis of the results of this work and literary data one can conclude that, at present, there exists no single test or index in terms of which a mountaineer´s high-altitude tolerance could be evaluated under laboratory conditions sufficiently to allow prediction of his oxygen deficiency tolerance in the mountains. Evidently, when selecting candidates for high-altitude expedition, it is expedient to make use of a complex of physiological tests, among them slow and stepwise "lifts" in decompression chamber and hypoxic gas mixture breathing in combination with exposure to physical workloads and a voluntary hyperventilation test. The information obtained with the help of such tests has turned out to be useful in the complex of rational selection criteria and methods, and for one thing it contributed to the success of the expedition during which 11 Soviet climbers

reached the top of Mt. Everest under very unfavourable weather conditions by a pioneer route up the South-West buttress.

(Unfortunately it was not possible to print the tables and figures)

References

1. Agadzhanyan, N. A., Mirrakhimov, M. M.: Gory i rezistentnosti organizma. Moskva, Nauka, 1970. 183 p. **2.** Aidaraliev, A. A., Maksimov, A. L.: Perenosimosti fizicheskikh nagruzok v vysokogorie pri razlichnoi inidividualnoi ustoichivosti k gipoksii. In: Specialnaya i klinicheskaya fiziologiya gipoksicheskikh sostoynii. Tez. dokl., ch. 3. Kiev, Naukova dumka, 1979, p. 100-103. **3.** Aidaraliev, A. A., Maksimov, A. L.: Opredelenie urovnya fizicheskoi rabotosposobnosti cheloveka v usloviyakh vysokogorya (Metodicheskie rekomendatsii). Moskva, Minzdrav SSSR, 1980. 9 p. **4.** Armstrong, H. G.: Principles and Practice of Aviation Medicine (2nd ed.). Baltimore, Williams and Wilkins, 1943. **5.** Asyamolova, N. M.: Opyt ispolzovaniya elektroencefalograficheskogo metoda pri provedenii razlichnykh gipoksicheskikh funkcionalnykh prob. Avtoref. Kand. diss. Moskva, 1969. **6.** Bert, P.: La pression barometrique. Recherches de physiologie experimentelle. Paris, G. Masson, 1878. **7.** Chapdarova, R. N.: Osobennosti kislorodnogo rezhima organizma pri adaptasii k krainim stepenyam gipoksii. Avtoref. kand. diss. Moskva, 1982. **8.** Gazenko, O. G., Malkin, V. B., Gora, E. P.: Individualnye osobennosti reaktsii dykhaniya pri proizvolnoi giperventilyatsii. Fiziologiya cheloveka, 7, 1981◦1: 98-105. **9.** Gippenreiter, E. B.: IzucheniJe dinamiki razvitiya adaptatsii i sostoyanie rabotosposobnosti cheloveka v procese trenirovki v gornykh usloviyakh. Kand. diss. Moskva, 1968. **10.** Houston, C. S.: Going High. The Story of Man and Altitude. Published by C. Houston and the American Alpine Club. 1980. **11.** Houston, C. S., Riley, R. L.: Respiratory and circulatory changes during acclimatization to high altitude. Amer. J. Physiol., 149, 1947, 565-588. **12.** Hunt, J.: The Ascent of Everest. London, Hodder and Stoughton, 1953, 300 p. **13.** lvanov, D. I.: Ispolzovanie barokamery vo vrachebnoletnoi ekspertize. Voen-med. Zhurn., 1948, 10: 52–54. **14.** Kovalenko, E. A., Chernakov, I. N.: Kislorod tkanei pri ekstremalnykh faktorakh poleta. Problemy kosmicheskikh poletov, t. 21. Moskva, Nauka, 1972. 263 p. **15.** Kolchinskaya, A. Z., Dudarev, V. P., Misura, A. G. et al.: Objektivnaya kharakteristika gipoksicheskikh sostoyanii. In: Specialnaya i klinicheskaya fiziologiya gipoksicheskikh sostoyanii. Tez. dokl., ch. 1. Kiev, Naukova dumka, 1979. P. 16-20. **16.** Kreuzer, F.: Transfer of oxygen in moderate hypoxia at rest and at severe exercise. Schweiz. Ztschr. Sportmed., 1966, 1-3: 7–15. **17.** Malkin, V. B.: Elektroencefalogramma pri ostroi gipoksicheskoi gipoksii. In: Aviatsionaya medicina. Moskva, 1963. P. 348-352. **18.** Malkin, V. B., Yukhnovski, G. D., Markarin, S. S.: Vliyanie adaptatsii k vysokogoriyu na ustoichvost cheloveka k ostroi gipoksii, vysokoi temperature i vestibularnym razdrazheniyam. Problemy kosmicheskoi biologii t. 8. Moskva, Nauka, 1968. P. 57-65. **19.** Malkin, V. B., Asyamolova, N. M., Kochetov, A. K.: Osobennosti razvitiya adaptatsionnogo sindroma k ostroi gipoksii u alpinistov. Problemy kosmicheskoi biologii, t. 8. Moskva, Nauka, 1968. P. 48-57. **20.** Malkin, V. B., Gippenreiter, E. B.: Ostraya i khronicheskaya gipoksiya. Problemy kosmicheskoi biologii, t. 35. Moskva, Nauka, 1977. 319 p. **21.** Ning, H.-H., Huang, S.-Y., Gung,. M.-C., Shi, C.-Y., Hu, S.-T.: Predicting mountaineering performance at great altitude. In: High altitude physiology and medicine, edited by W. Brendel and R. A. Zink. Springer-Verlag, New York, 1962. P. 278-293. **22.** Opitz, E.: Über akute Hypoxie. Ergebn. Physiol., 44, 1941, 315. **23.** Plakhatnjuk, V. I.: Reaktsii serdechno-sosudistoi sistemy cheloveka pri gipoksicheskoi funktsionalnoi probe v barokamere i ikh ekspertnaya otsenka. Avtoref. kand. diss. Moskva, 1975. **24.** Plakhatnjuk, V. I.: Otsenka i ekspertnoe

znachenie gipoksicheskoi funktsionalnoi proby. In: Spetsialnaja klinicheskaya fiziologiya gipoksicheskikh sostoyanii. Tez. dokl. ch. 2. Kiev, Naukova dumka, 1979. P. 234-238. **25.** Pugh, G., Ward, M.: Physiology and medicine. Appendix VII. In: J. Hunt: The ascent of Everest. London, Hodder and Stoughton, 1953. P. 270-279. **26.** Rass, E.: Zum Leistungeprofil de Bergsteiger. Symposium für Bergmedizin. Ergänzungsband. München 15-16 October 1962. P. 73-82. **27.** Rung, G. R.: Dinamika adaptivnykh reakcij i sostoyanie rabotosposobnosti alpinistov na bolshikh vysotakh. Avtoref. kand. diss. Cheljabinsk, 1973. **28.** Sirotinin, N. N.: Vliyanie akklimatizatsii k vysokogornomu klimatu na adaptatsiyu k ponizhennomu atmosfernomu davleniyu v usloviyakh barokamery. Arch. patol. anat. i patol. fiziol., 6, 1940 1-2: 35. **29.** Vyadro M. D.: K voprosu o patogeneze i ekspertnoi ocenke gipoksicheskikh kollapsov u lentogo sostava. Voen-med. zhurnal, 1958, 3: 60-64. **30.** West, J. B., Lahiri, S., Maret, K. H. et al.: Barometric pressure at extreme altitudes on Mt. Everest: physiological significance. J. appl. Physiol.: Respirat. Environ. Exercise Physiol., 54, 1983, 5: 1188-1194.

HIGH-ALTITUDE EXPEDITIONS WITH AND WITHOUT A DOCTOR: POSSIBILITIES FOR TESTING PHYSIOLOGICAL FUNCTIONS AND MEDICAL ASSESSMENT ON THE SPOT

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Abstract

The authors have supervised medically 10 expeditions to high altitudes. In 6 of them they took an active part as mountain doctors. In another 3, they supervised the medical aspectside but the on-the-spot control and assessment were entrusted to a mountaineer who was not a doctor. The last of the expeditions involved the medical study of a survival experiment, with a climber who stayed in solitude for 66 days on the summit of Aconcagua contacting with the medical team periodically by radio.

The results show that even when there had been careful training in medical experience at high altitude, both the control of physiological functions and medical assistance were very deficient in all those cases in which there was no doctor on the spot.

EFFECT OF ACUTE HYPOXIA ON HORMONAL RESPONSE TO EXERCISE

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Abstract

The effect of acute hypoxia on exercise-induced hormonal responses was studied in a hypobaric chamber. Six healthy volunteers were subjected to graded exercise under normoxia (NO) and hypoxic (HO) conditions. Spirometry data and plasma levels of epinephrine, norepinephrine, cortisol, growth hormone, glucose, pyruvate, lactate and fatty acids were measured at rest and different grades of exercise.

No significant changes for rest values of hormones and substrates were found. Exercise-induced catecholamine responses were significantly increased at HO, while no significant differences were found for other hormones. The exercise-induced increase of fatty acids was higher at HO. The respiration ratio was lower at HO.

These data confirm that there is a shift toward augmented lipid utilization under an exercise load and this shift in energy substrate metabolism could be controlled by a higher catecholamine response to exercise in hypoxia.

Introduction

The metabolism of energy substrates during exercise and their availability to the exercising muscle are subject to hormonal regulation. Hypoxia – being ad additional stressor – interacts with the exercise-induced hormonal response and is expected to alter its character. The aim of this study was to evaluate the effect of acute hypoxia on the exercise-induced response to sympatoadrenal and pituitary-adrenocortical system during submaximal and maximal exercises. Levels of energy substrates were evaluated, too.

Methods

The subjects were six active sportsmen aged 25.3 ± 4.7 years. Their average weight was 80.8 ± 11.2 kg, height 179 ± 5.7 cm, index of Broca 108 ± 16.9% of ideal weight. The subjects were examined on two occasions: first in the laboratory under normoxia conditions, one week later they were tested in a hypobaric chamber.

The model of the exercise on a bicycle ergometer was following: two submaximal exercises with loads of 2 W/kg and 3 W/kg of weight and, after a rest period, a test “ad vita maxima” was performed. Cardiorespiratory parameters were measured during all tests. Blood samples were withdrawn from an inserted intravenous catheter in a sitting position. The basal sample was obtained at a 0.5 hour´s interval following catheter insertion, subsequent samples were (annotation 2 in the graphs), at the end of the maximal test (3), and at the 10^{th} and 30^{th} minute after the end of the exercise.

Blood was analysed for epinephrine (A), norepinephrine (NA) and dopamine (D) by modified radioenzymatic methods using tritium S-adenosyl-methionine kit Catechola (UVVR, CSSR). Growth hormone (GH) and cortisol (KOR) levels were analysed using RIA methods (CM-Cort, France, or GH kit, Poland). Glycaemia, free fatty acids (FFA), lactate and pyruvate were determined as well.

Statistical evaluation was done using the Wilcoxon test for paired samples.

Results

Table 1 presents the per cent changes of cardiorespiratory parameters in hypoxia compared with normoxia.

[% = 100 – value (hypoxia / value (normoxia)

Table 1. Per cent changes of cardiorespiratory parameters in hypoxia as compared with normoxia. % SUBMAX=per cent (see the text for the formula) change at submaximal exercise (3 W/kg). % MAX=per cent change at maximal exercise. f_H=HEART RATE, VO_2=oxygen consumption, V_E= ventilation per minute, TIME=time before exhaustion in maximal test.

	f_H	VO_2	V_E	TIME
% SUBMAX]	+ 6.9	– 9.8	+ 16.7	–
% MAX	+ 1.6	– 13.0	+ 4.4	– 6.7

Figure 1 show the plasma levels of A, NA and D at the basal condition (0) and at the end of exposure to maximal load (3) in normoxia and hypoxic conditions. The levels were significantly higher for A and NA in the submaximal test. A trend towards higher levels of NA was found in hypoxia, though the figures were not significant due to a high scatter of individual values.

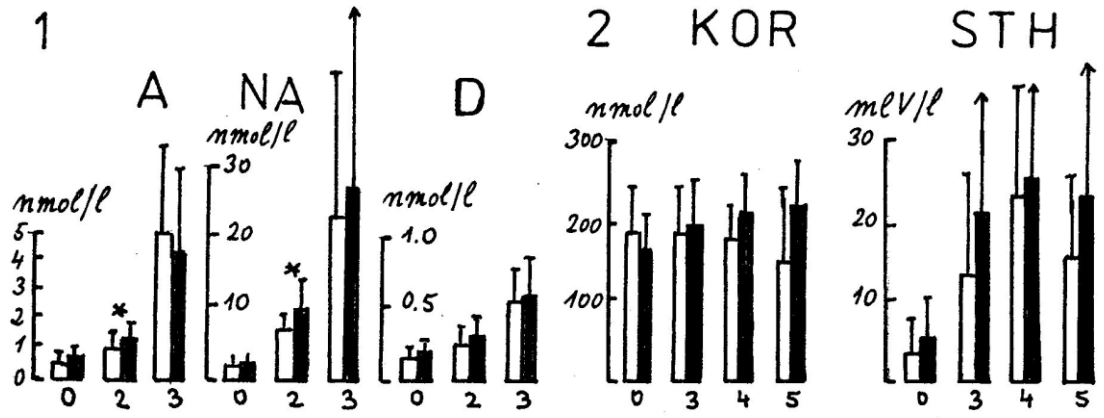

Fig. 1. **Plasma levels of epinephrine (A), norepinephrine (NA) and dopamine (D) at basal state (0), submaximal exercise involving 3 W/kg weight (2) and at end of maximal exercise (3).** Comparison of normoxic (□) and hypoxic (■) conditions.

Fig. 2. **Plasma levels of cortisol (KOR) and growth hormone (STH) at basal state (0), end of maximal test (3), 10th (4) and 30th (5) minute after the end of the test.** Comparison of normoxia (□) and hypoxia (■).

Figure 2 presents the cortisol (KOR) and growth-hormone (STH) levels at the basal state, the end of the maximal test (3), and the 10th (4) and 30th (5) minute following the end of the maximal test. Although there is a trend toward higher values in hypoxia for all the time intervals for growth hormone and for the 10th and 30th minute for cortisol levels, the differences are not statistically significant due to high interindividual fluctuation.

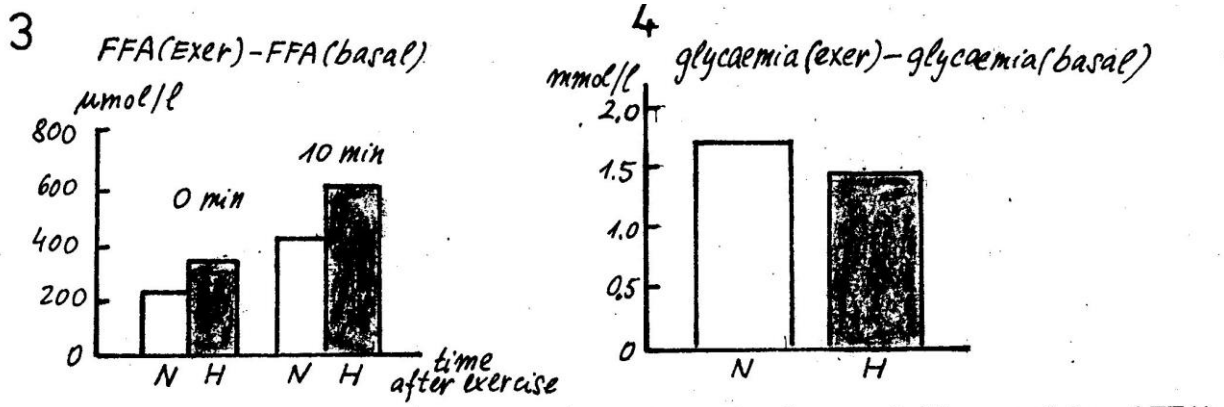

Fig. 3. Increments in plasma levels of free fatty acids (FFA) (FFAactual - FFAbasal) at the end of the maximal test (0 min) and at the 10th minute (10) after its end. Comparison of hypoxia and normoxia.

Fig. 4. Increment of glycaemia at the end of the maximal test. Comparison of hypoxia and normoxia.

Figures 3 and **4** represent the increase of FFA and glycaemia during the maximal test (i.e. maximal-basal values). There is no significant difference in glycaemia increase. A clear trend toward higher increments of FFA is obvious at the end of maximal exercise and at the 10th minute after its end, but the differences are not significant owing to interindividual variation.

Discussion

The results suggest a higher sympatoadrenal response to physical exercise under hypoxic conditions as compared with normoxia. Thus the stress of hypoxia is superimposed on the effect of exercise. That an evidently higher catecholamine response was not observable in the maximal test was due to the shorter duration of the maximal test in hypoxia (as presented in Table 1), the magnitude of the response being a function of the duration of exercise.

A trend towards a higher response to exercise in hypoxia can be distinguished for cortisol and growth hormone as well, though it is not statistical significant.

The higher response to exercise in hypoxia found for the “stress” hormones is very probably one of the regulatory factors ensuring s higher proportion of fat utilization (vs. carbohydrates) at exercise under hypoxia as reported by previous authors (Sutton 1983, Guilland 1985, Gilland 1984). In our study this was documented by the higher FFA increments at the end of the maximal test in hypoxia (in spite of the shorter duration of the test), while glycaemia did not show a different response. The respiratory ratio is not a relevant marker of substrate utilization in hypoxia as it is influenced by the hyperventilation inherent in hypoxia.

The induced metabolic shift leading to a higher proportion of fat utilization cannot be considered advantageous under conditions of reduced partial oxygen pressure in the inspired air, take into account the lower energy production per 1 litre of oxygen during fat utilization as compared with carbohydrates. High-carbohydrate diet partially reversed this negative effect of hypoxia on energy substrate metabolism and is thus to be recommended during stays at the higher altitudes.

References

1. Guilland, J. C. et al.: Evaluation of sympatoadrenal activity, adrenocortical function and androgenic status during a Himalayan expedition. Eur. J. Appl. Physiol., 52: 152–162, 1984. **2.** Guilland, J. C. et al.: Nutritional alterations at high altitude in man. Eur. J. Appl. Physiol., 54: 517–523, 1985. **3.** Sutton, J. P.: Hormonal response to exercise at sea level and at altitude. In: Hypoxia, Exercise and Altitude. Ed. J. R. Sutton, C. S. Houston. New York, Allan R. Liss 1983. **4.** Sutton, J. R., Jones, N. L.: Exercise at altitude. Am. Rev. Physiol., 45: 427–437, 1983.

CHANGES OF SELECTED PHYSIOLOGICAL FUNCTIONS IN SAGARMATRA '84 EXPEDITION MEMBERS UNDER MODELLED CONDITIONS IN PRESSURE CHAMBER

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We examined 13 men: 8 mountaineers who planned to ascend Mount Everest and five research workers (geographers) who planned ascent to the maximal altitude of 5000 m in the Himalaya mountains in 1984. We performed the basic clinical examination, including electrocardiography and ergometric examination, under the normal atmospheric pressure. A scheme of examination in the modelled conditions in a pressure chamber was proposed (up to an altitude of 7000 m). This scheme was verified experimentally. We ascertained the influence of hypobaric-hypoxic conditions (at rest and in combination with a physical load on a bicycle ergometer) on selected physiological functions and on some indices of psychic and biochemical functions of the probands. On the basis of our examination the functional efficiency of the probands was judged. The results were delivered to the Medical Commission of the Czechoslovak Mountaineering Association and were used as the basis for the selection of team members for the Mount Everest summit.

In 1984 our mountaineers prepared for the expedition to Himalaya mountains. The aim of the expedition was to reach the highest peak in the world - Mount Everest, The second aim of the expedition was the ecological and geographic research in Himalayas mountains (research part of the expedition).

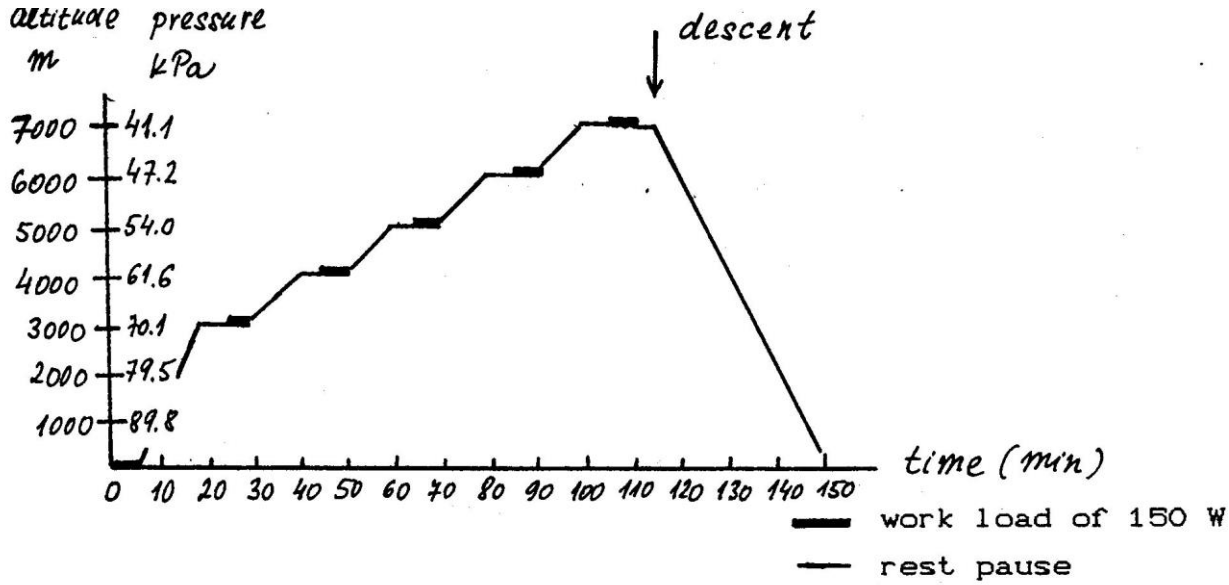
Methods

We examined 13 men: eight mountaineers who intended to be members of the summit team and five research workers, who planned to ascent to the maximal altitude of 5000 m. The mean age of mountaineers was 38 years; the research workers, 44 years. We carried out the anthropometric and a basic clinical examination, including electrocardiography (ECG) and an ergometric examination under normal atmospheric pressure. We proposed and experimentally we certified the scheme for examining the probands in the pressure chamber at the Research Institute of Preventive Medicine in Bratislava. Figure 1 shows the proposal of the examination under modelled hypobaric conditions.

The physical load in hypobaric hypoxia was modelled on a bicycle ergometer (150 W; approximately 2 W for 1 kg of the proband´s weight). Five-minutes working cycles alternated with 15-minutes resting pauses. During these pauses the atmospheric pressure in pressure chamber was continually decreased – in 10 minutes the decrease was equivalent to 1000-m altitude. After that followed 5 minutes of acclimatization and 5 minutes work on the bicycle ergometer.

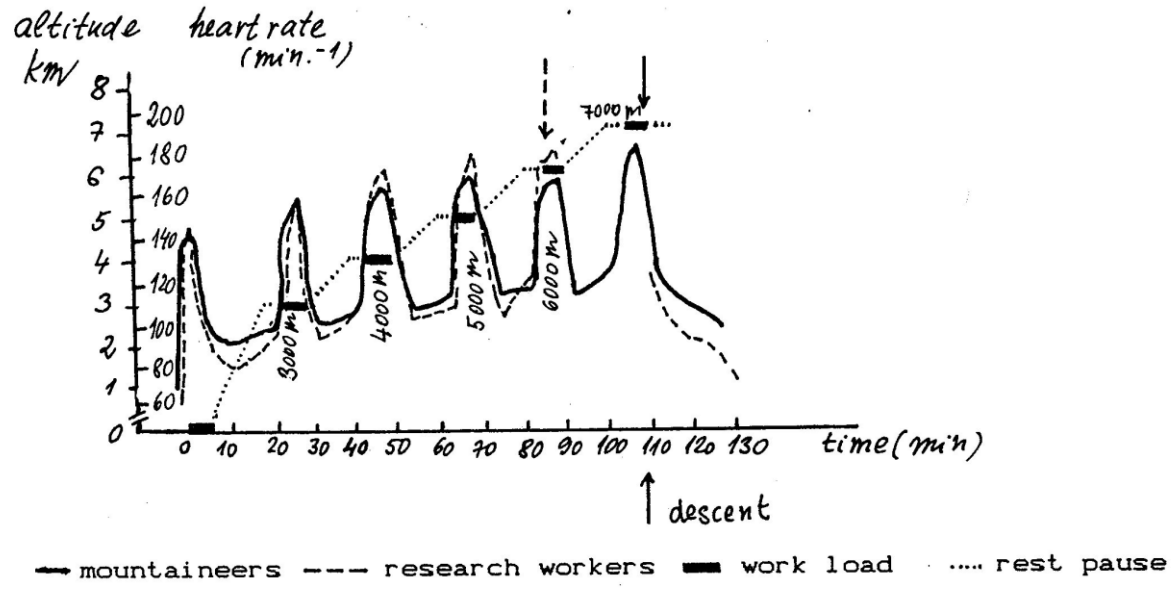
Probands cycled under this scheme till exhaustion (in terms of adverse subjective feelings, dyspnoea, pain in muscles of the low extremities, very high heart rate or blood pressure values, specific changes on ECG, etc.}. The maximal modelled altitude at which the mountaineers were able to work was 70000 m (41.1 kPa), research workers, 4000–6000 m (61.6-47.3 kPa).

Figure 1. Modelled altitude and pressure in the chamber.



During the experiments we investigated the influence of hypobaric-hypoxic conditions (at rest and in the combination with the physical load) on different physiological, psychological and biochemical indices. Many of them were valuable for our experiments: heart rate, ECG, blood pressure, psychological performance tests, subjective evaluation of experimental situation, some biochemical indices (indices of acidobase, creatinine, transaminases), etc. In this paper we present the changes of some physiological parameters.

Figure 2. Modelled altitude and heart rate (min^{-1}).

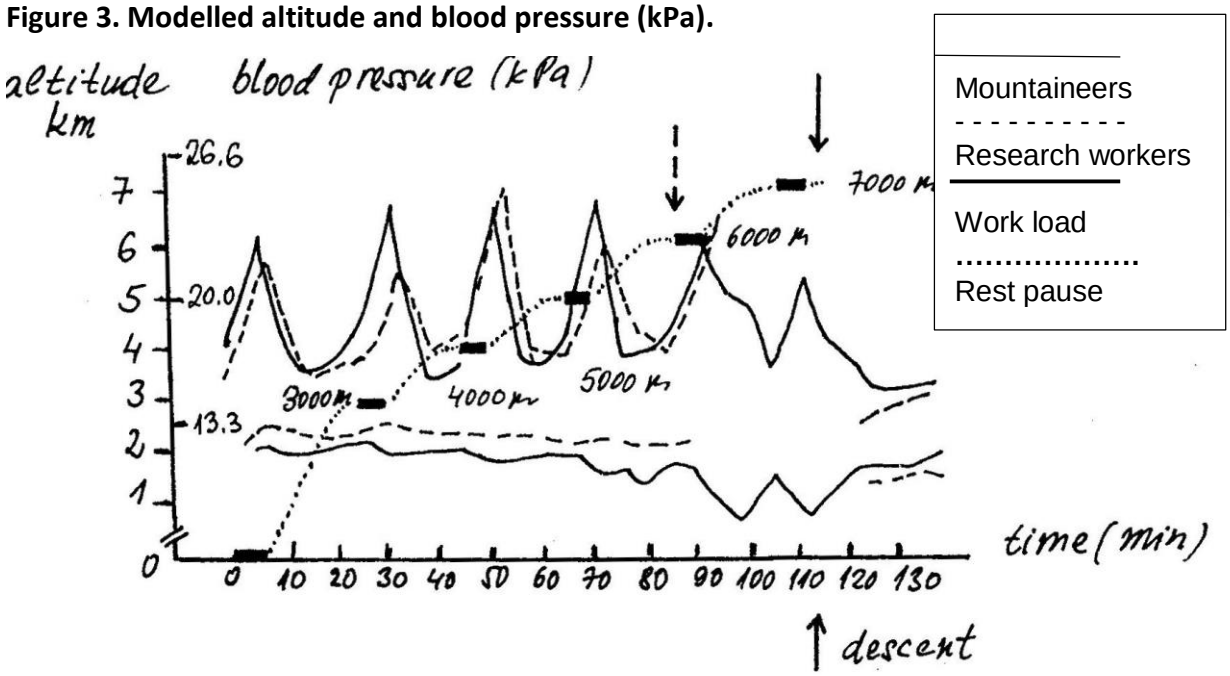


Results

Figure 2 illustrates changes of the heart rate of mountaineers and research workers during repeated work in the modelled hypobaria at the level of 3000-7000 m. The heart rates of scientific workers were usually higher than in the mountaineers, but not significantly. The immediate post work heart increased linearly with altitude. During the rest phases the heart rate decreased quickly but not to the level of rest values after work under normobaric conditions. The increments of heart rate at rest phases at the individual altitudes also displayed linear trend.

Figure 3 shows changes in blood pressure under the same hypobaric condition. During work, the systolic blood pressure (Bps) expressively increased, the diastolic blood pressure (BPd) did not change unequivocally. At work, values of BPs were usually lower at research workers. BPd were lower in mountaineers throughout the whole experiment. At rest after work under hypobaria, BPs values returned to the basic values equal to those after work under normobaric conditions.

Figure 3. Modelled altitude and blood pressure (kPa).



During ergometric tests under normal atmospheric pressure there were no pathological changes on the ECG records. Particular attention was paid to the evaluation of ECG records during the work in hypobaric conditions, namely in the highest altitude at which the proband was able to work. In the last phase of work we found an elevation of the ST segment about 0.1 mV in the V1 lead in three probands. During the acclimatization period and at work at the 5000-m level the depression of the ST segment was about 0.3 mV in the V5 lead, which was evaluated as an ischaemic reaction. When atmospheric pressure being increased we did not find these changes.

Discussion and Conclusion

On the basis of our examination under normobaric and hypobaric conditions, we determined a higher efficiency of mountaineers in comparison with research workers. Mountaineers reached higher performance under normobaric conditions, they were able to stay for longer time under pronounced hypobaria, and they were able to work at the higher modelled altitudes.

We observed that ECG monitoring, detailed analysis of ECG records, evaluation of heart rate and blood pressure measurements are very important for the judgment of mountaineers´ efficiency when studied under modelled hypobaric conditions. If pathological changes appear on ECG records during work under acute hypobaria, it is necessary to dismiss the proband from participation in the expedition.

Our Individual evaluation of the probands we delivered to the Czechoslovak Union of Physical Education and it was used as a basis for the selection of top team members for the climb to the Mount Everest summit.

THE MEDICAL MOUNTAINEERING EXPEDITION PAMIR 1988

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The Medical Mountaineering expedition Pamir 1988, organized by the Regional Hospital Banska Bystrica and Climbing Club Biotika Slovenská Lupča took place from the 3rd July to 3rd August 1988 in the Alayska Valley of the Pamir Mountains.

The research team consisted of five doctors (2 intensivists, 1 anaesthesiologist, 1 otorhinolaryngologist, 1 surgeon) and 1 technician. They proceeded in close cooperation with 15 Czechoslovak and 20 Soviet climbers from Cimkent.

The main aims of the expedition were:

1. to examine the possibilities of laboratory work under base camp conditions as well as of manipulation and transport of blood samples in high mountains;
2. to investigate the role of hypocapnia in the etiopathogenesis of high-altitude disease and to study the possibilities and effects of artificial carbon dioxide intake.

There were also secondary research programs including:

1. Ophthalmologic examination of the retina and taking audiograms before and after climbs to high altitudes.
2. Daily completion of psychological questionnaires and overall psychological examination before and after the expedition.
3. Measurement of various biochemical parameters, ECG records, determination of Ruffier´s test at various altitudes and various stages of acclimatization.

Our principal idea was: low PCO_2 is as dangerous for climbers at high altitude as low $P0_2$.

There exist three harmful effects of hypocapnia on the organism:

1. A well-known ventilatory dysregulation with development of periodical breathing and hypoxia especially during sleep.
2. Respiratory alkalosis with its effects on the calcium metabolism, bicarbonate depletion and a shift of the haemoglobin dissociation curve to the left – this shift may be of advantage to the climber, but also a danger of forced hypoxia is possible.
3. The third effect of hypocapnia is acute vasoconstriction and thus hypoperfusion and hypoxia, mainly cerebral and cardiac. This danger occurs in situation when acceleration of the climbers' performance is needed, when a sudden drop of PCO_2 may take place. Repeated hypoperfusion and reperfusion of the tissue may hypothetically cause a change in oxygen metabolism and development of oxygen radicals.

The main experiment was placed between two camps at heights of 4200 and 4800 m above sea level. Twenty-three climbers made the trips between the camps twice. Between these climbs they rested one day at the base camp. One trip to the higher camp was with artificial intake of CO_2 through specially constructed system.

We looked for difference between “carbon dioxide” group and “control” group in the levels of blood gases, blood pH, concentrations of lactate, uric acid, minerals, ECG records, Ruffier’s tests, capability of mental concentration, and the subjective state of the climbers.

We found statistically significant lower pH and higher PO_2 and a less significant lower of lactate concentration in the "CO_2" group.

Also interesting was the effect of the CO_2 intake to relationship between PO_2 and PCO_2. The curve in the “CO_2 group” changed to a horizontal one and relationship disappeared.

Our work demonstrated that artificial intake of CO_2 can improve the oxygenation of tissues of climbers at high altitudes, bringing about a rise of PO_2 in arterial blood, probably as a result of improved alveolar ventilation, and lowered pH, and so optimization of the utilization of oxygen in peripheral tissues.

On the basis of our results we can say that the hidden rationale for acclimatization is to a great extent to accustom the organism to hypocapnia. In other words, the lower is the PCO_2 level that can be tolerated by the climber, the higher he can climb.

Has artificial CO_2 intake a practical consequence? In order to answer this question and some others, the experiment would have to be moved to higher altitudes. We are accordingly endeavouring to organize a medical expedition to the Himalayas in 1989.

RESULTS OF CONTINUOUS SURVEILLANCE OF HEALTH, TRAINING CONDITION, SPORT-MOTOR CHARACTERISCS, AND ACCLIMATIZATION TO ALTITUDE IN MOUNTAIN GUIDES OF THE AUSTRIAN ARMY

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Abstract

In order to supply a continual training programme for mountain guides of the Austrian Army and to evaluate their health, training standard, cardiovascular efficiency, acclimatization to altitude, and sport-motor characteristics, we investigated 141 mountain guides of the Army at an altitude of 2315 m.

Pathological results mainly hypertension, were obtained in 24% of the cases. From our investigations we concluded that the cardiovascular efficiency of the Army members was 125% in comparison to 115% in other mountain climbers. The maximal absolute watt efficiency/kg body weight was over 4 watt in 13%, between 3.6 and 4 watt in 30%, between 3 and 3.5 watt in 40%, and below 3 watt in 17% of the men.

According to sport-medical standards, a 4-watt efficiency should be obtained in mountain climbers, which seems a rather high. In order to approach this requirement, a more intensive training programme ought to be implemented.

Introduction

In order to regularly check on the state of health and altitude-dependent physical performance of army personnel on continuous duty as mountaineering instructors, alpine-medical examinations have been carried out since 1983 during the early advance training courses for the alpine instructor cadre at the training centre of the Austrian Alpine Club at the Rudolfshütte, a place at an altitude of 7,596 feet (2,315 m) in the Hohen Tauern mountain range. The examinations are performed in states of both rest and stress under hypoxic conditions at average altitudes between 5,248 and 9,304 feet (1,600–3,000 m).

Objectives

Our objectives were the following:

- Determination of the general state of health
- Assessment of the cardiovascular and respiratory system
- Assessment of training condition and acclimatization to altitude.

From an alpine and sport-medical viewpoint, these characteristics are of prime significance for the classification of mountaineering into the group of endurance sports for the assessment of the physical performance of army mountain guides.

Table 1. Pathological cardiovascular and respiratory findings.

	Military mountain guides	Civilian climbers
No. of persons examined	n = 141	n = 39
No. with pathological findings	34 (24.1%)	16 (38.5%)
Pathological findings	n = 34	n = 16
Hypertension	23 (67.6%)	10 (62.5%)
Ventricular extrasystolia	4 (11.6%)	3 (18.8%)
Pathological ST-depression	1 (2.9%)	1 (6.3%)
Right bundle-branch block	1 (2.9%)	–
Obstructive ventilation	5 (14.7%)	2 (18.6%)
Average age	35	49

Method

- Bicycle ergometry: initially at 25 watts, with the load then increasing by 25 W every 2 minutes until discontinuation due to objectively or subjectively limiting symptoms.
- Training condition and acclimatization to altitude were assessed primarily according to registered performance and the heart rate in a state of rest, exertion, and in the recovery phase.
- Small spirometry with evaluation of pulmonary function, the parameters being vital capacity, one-second capacity, and peak flow.
- Sport-motorial tests for determination of a characteristic profile. These assessed power, swiftness, endurance, suppleness and balance.

Results

Assessment of the cardiovascular and respiratory state of health of 141 test persons showed 34 (24%) with pathological findings or findings requiring further clarification. An exact breakdown in comparison with the results of a group of older – on the average – civilian climbers tested under the same conditions is presented in Table 1.

The registered physical performance as related to age and body surface area, in comparison with the expected norm, was an average of 124.7% for the Army guides as compared with only 115.5% for the civilian group.

The attained absolute watt-efficiency per kilogram of body weight was in the military group, over 4 W in 15 persons (13%), for 35 (30%), between 3.6. and 4 W in 35 (30%), between 3 and 3.5 W in 47 (40%), and under 3 W in only 20 persons (17%) (Table 2).

Table 2. Proportionate breakdown of watt-efficiency/kg BW (n = 117).

< 3.0	W	20	(17%)
3.0 – 3.5	W	47	(40%)
3.5 – 4.0	W	35	(30%)
> 4.0	W	15	(13%)

Table 3. Age-related watt-efficiency/kg BW, watt-efficiency < 3.0/kg BW

Age	n	Average watt-Efficiency	Sport-med. norm.	Individual watt-eff. < 3.0/kg BW	
20 – 29	37	3.6 W	3.0 W	1	(2.7%)
30 – 39	40	3.5 W	2.7 W	3	(7.5%)
40 – 49	29	3.2 W	2.4 W	9	(31.0%)
50 –59	11	2.8 W	2.1 W	7	(53.5%)
T o t al	117			20	(17.0%)

A breakdown of the watt-efficiency per kg of body weight with regard to age groups as well as the percentage of the age groups whose performance was under 3 W are shown in Table 3. An assessment of the performance for the military instructors can be seen in Table 4a. The training condition was determined according to ergometric performance, pulse rate during exertion and recovery pulse rate (Table 4b).

For the evaluation of those motorial characteristics recognized as being relevant for mountaineering performance, the following tests, selected by sport-scientists, were used: pull-ups, side-straddles, leg lifts forward, trunk-bending forwards, dips on parallel bars, standing on both legs on a rolling board, hanging from both arms, hanging from one arm only, and a one-bent-arm hang. Compared with the group of free cIimbers, the military group showed a significantly higher level of general motorial endurance. Acclimatization to average altitudes, estimated according to the pulse rate at rest and during the recovery phase (Table 5), was ascertained for all test persons.

Table 4a. Assessment of performance for military alpine duty.

Performance (W/kg body wt.)	Assessment
< 3.0	insufficient
3.0 – 3.5	sufficient
3.6 – 4.0	very good
> 4.0	excellent

Table 4b. Training condition.

Pulse during recovery	Training condition	n = 117	
< 100/min	excellent	35	(29.9%)
100 – 105/min	very good	28	(23.9%)
105 – 115/min	good	22	(27.4%)
115 – 120/min	satisfactory	10	(8.5%)
> 121/min	unsatisfactory	12	(10.0%)

Table 5. Assessment of acclimatization and training condition.

Pulse rate	Acclimatization	Training condition
At rest ↓ During recovery ↓	**YES**	**GOOD**
At rest ↑ During recovery ↑	**NO**	**?** (control ergometry at low altitude)
At rest ↓ During recovery ↑	**YES**	**BAD**
At rest ↑ During recovery ↓	**YES**	**GOOD** (rest tachycardia = hypersympaticotonia?)

Discussion

Alongside physical health, a good cardiovascular and training condition, and acclimatization to altitude, mountain climbing requires sport-motorial characteristics, for military mountain climbing especially motorial endurance and power.

Surprisingly, 24% of the 141 test persons did not have the required state of health at the time of the examination. The majority of these cases were due to previously unknown hypertension.

The performance levels related to age and body surface area attained by the military instructors was, on the average, 124.7% with regard to the expected norm and was clearly over the average value of 115.5% for the civilian climbers. As well, the average absolute watt-efficiency per kilogramme of body weight in the individual age groups of the military test persons was well above the sport-medical norm.

The percentage of investigated persons whose performance was below 3 W/kg body weight – and hence under the minimum performance level required for military alpine service — jumped quickly from the age of 40 onwards.

Physical performance and training condition improved clearly from year to year: the average relative performance level as related to age and body surface area of the latest course, 138% with respect to the expected norm, was far above the average value of 125% for the examinations in earlier years. In contrast to previous investigations, in which 17% of the test persons did not reach the required absolute minimum performance level of 3 W/kg body weight, the absolute results of the most recent courses were without exception above this value (Table 6).

Table 6. Watt efficiency – advanced training course / Alpine instructors cadre, May 1987

Age	n	Average watt-efficiency	individual watt-eff. < 3.0W/kg BW
20 – 29	1	4.2 W	- -
30 – 39	7	3.7 W	- -
40 – 49	1	4.2 W	- -
50 –59	2	3.5 W	- -

As regards the characteristic profile, the sport-motorial requirements considered important for military mountain climbing were sufficiently attained by all test persons.

Table 7 shows the performance and sport-motorial test results of the most recent course: The values appearing significant are, among others, those registered for the endurance-, balance- and power-tests in a comparison of a highly trained military instructor whose activities are exclusively in alpine degrees of difficulty under VI according to the UIAA scale with a free climber above degree of difficulty VI.

A comparison of absolute watt-efficiency per kilogramme of body weight with relative percentage efficiency of the expected norm value with regard to age and body surface area (Table 7) clearly shows the necessity of evaluation for qualified alpine service according to absolute performance measured in watts per kilogramme of body weight.

Table 7. Test results of advanced training course – Alpine instructor cadre, May 1987, n = 12

1	2	3	4	5	6	7	8	9	10	11	12
28	169	80	4.2	134	91	-1	77	41.5	16	22	2
30	181	84	3.1	118	76	7	96	11	15	4	1
30	182	86	3.4	135	76	4.5	97	15	17	3	-
31	169	60	3.3	112	70	0	94	17	15	35	3
31	185	75	4.0	142	91	14	102	60	I n j u r e d		
37	178	75	3.7	136	inj	7	89	10	13	4	1
35	172	72	4.6	159	102	13	95	38	16	11	1A
38	168	63	3.9	137	79	16	108	60	18	47	10B
39	180	68	3.7	130	60	4.5	97	20	15	1	3
44	182	63	4.2	143	83	3	93	13	17	29	9
52	172	74	3.4	150	74	2	78	5	13	12	1
54	180	75	3.5	150	not in the instructor cadre						

A = highly trained Army guide
B = Free climber
1 – Age
2 – Height [cm]
3 – Weight [kg]
4 – Ergometry {W/kg]
5 – Age- and body surface area dependent cap. [% of norm]
6 – Step test [number]
7 – Trunk bends [cm]
8 – Side-straddles [degrees]
9 – Standing on a balance-rail on one foot [seconds]
10 – Sit-ups[No/10 s]
11 – Hanging from both arms (1 cm bars)
12 – Pull-ups (1-cm bar) [number]

Conclusions

The medical findings of our investigations allow the following conclusions:

1. Mainly cardiovascular disorders appear to be objectifiable relatively early at higher altitudes.
2. A regular medical check-up of the state of health and condition of primarily the older members of the alpine instructor cadre permits a well-timed discharge from service and can contribute significantly to preventing non-traumatic cases of death during training and rescue operations.
3. Comparison of the sport-motorial characteristic profile with a norm profile allows recognition of the strengths and weaknesses of those sport-motorial characteristics decisive for mountain climbing and hence the development of a sensible training programme.
4. In conclusion, we have the impression that officially ordered medical examinations very often provide motivation for the individual with regard to regular training and a healthier way of living – especially in the case of misuse of alcohol and nicotine.
5. If in future we want to avail ourselves of the standard values for performance-oriented mountain climbers established by sport-physicians (Table 8), then on the one hand the regular training programme of our army mountaineering instructors will have to be improved; on the other hand this objective appears to be realistically achievable only with the age group of 20 to 39-year-olds.

Table 8. Standard values for mountain climbers (Raas, Innsbruck 1982).

Respiratory minute volume max [l]	120 – 130	>140
Vital capacity, BTPS [l]	4.5 – 5.0	> 5
Max. breathing capacity, BTPS [l]	100 – 120	> 120
Max. respiratory rate [/min]	35 – 40	> 40
Max. oxygen uptake, STPD [ml/kg]	kg · 0.6	≥ kg · 0.7
Max. oxygen pulse [ml]	15	≥ 16
Max. pulse rate [/min]	155	≥ 190
Hemoglobin [g%]	14.5 – 15	≥ 15.0
Max. Watt	kg · 4	≥ kg · 4.5
Ergometry (acc. to Kaltenbach)	Performance curve within the norm	Performance curve below the norm

METABOLISM AND FLUID BALANCE IN0MOUNTAINEERING AND CLIMBING

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Abstract

Over a period of two weeks at five different times 29 parameters were tested in 53 participants of training-course on high-altitude climbing for Austrian national mountain guides. Halfway through this period a test climb on Austria's highest mountain (Grossglockner, 3798 m), undertaken by the most difficult routes and taking an average finishing time of about 13 hours, was investigated separately. All data were analysed by means of a special SPSS programme.

The red blood count and the activity of the serum enzymes increased after an initial decrease in a statistically significant manner, whereas the unexpected change in the lymphocyte count was striking. Urea showed no essential changes, contrary to earlier findings. The behaviour of fatty acids and glyceride concentrations showed that the preparation of energy to protect the carbohydrate deposits occurred chiefly through fat oxidation, despite the intensive difficulties in climbing. Sodium, potassium, and phosphorus showed massive changes, whereas the magnesium and calcium levels remained relatively constant. The concentration of plasma cortisol and beta-endomorphines in the plasma showed a slightly significant increase. There was no significant rise in adrenaline, noradrenaline, or prolactin. A highly significant increase of arterial-blood lactate was observed. The significance of a consistent balance of liquid and minerals moves particularly to the fore.

Even taking into consideration the sympatho-adrenergenic .stimulation before the commencement of pressure, it was demonstrated that with regard to the accustomed stress of experienced climbers the trends in stress-hormone behaviour during periods of strain could be confirmed. It seems that an aerobic lipolytic pressure level also prevails in extreme alpine demand.

Introduction

Athletic mountaineering at medium altitudes (1500 to 3000 m above sea level) usually takes the form of climbing in combined terrain, which varies between rocky passages of varying degrees of difficulty and steep faces of ice. This makes very high demands on the stamina and technique of the climbers. In opposition to the uniform way of moving to be found in longer periods of hiking, this is a form of exertion which occurs at intervals with intense aerobic and also anaerobic capacity demands.

One is therefore presented with an endurance performance of many hours and under medium to high demands. Furthermore, the influence of the reduced oxygen pressure at high altitudes comes into operation. Because of these extraordinarily manifold, extreme factors of influence on performance, the metabolic profile of this type of alpine sport is particularly interesting: How will these intensive demands be answered?

Material and methods

Fifty-three participants of a training course for Austrian mountain guides held in the Grossglockner range were tested for the red and white blood counts, serum enzymes, free fatty acids, glyceride concentrations and electrolytes. The tests were carried out at five different times over a period of two weeks. Halfway through this period, a 13 hour test-climb took place on Austria's highest top (3798 m), in which parameters of the carbohydrate and fat metabolism and the blood concentrations of lactate, epinephrine, norepinephrine, cortisol and beta-endorphine were separately investigated. The data thus obtained was statistically evaluated by means of a GPSS programme.

	ERYTHROCYTES (mio/ml)			HEMATOCRIT (%)			LEUKOCYTES (1000/ml)	
	Mean	SE		mean	SE		mean	SE
1	5.070	0.342	1	47.651	2.562	1		
2	4.626	0.282	2	47.163	2.235	2	7232.558	1178.250
3	5.003	0.293	3	47.903	2.150	3	9.503.226	2780.466
4	5.113	0.275	4	48.533	1.889	4	10680.000	2519.223
5	5.190	0.299	5	49.143	2.159	5	7411.905	1373.477

Results and discussion

The red blood count, after an initial decrease from 5.07±0.34 to 4.63±0.28 mio/ml ($p<0.001$), increased significantly after two weeks to 5.19±0.3 ($p<0.005$). The haematocrit values developed similarly although not to an equally same significantly high level. Whereas these results corresponded to the expectations, the same could not be said for the white blood count: The value rose very significantly during the periods of exertion ($p<0.001$) and sank almost to the original level at the end of the test-period. Since repeated endurance activity does not in itself cause an increase in erythropoiesis, these changes in the red blood count must have been due to hypoxia (1).

Enzymes (GOT, GPT, LDH, CK) increased significantly during the phase of exertion, the creatine-phosphokinase from 84±30.6 to as much as 133.5±74.0 µl ($p<0.001$), but had decreased somewhat by final analysis, although still distinctly higher than the original values ($p<0.001$).

Schmid et al. had found amongst 100-km runners a similar, but not so distinct pattern in the enzyme increase immediately after long periods of exertion (4). This could indicate that an additional increase in enzyme activity is caused by the influence of hypoxia. This seems, however, to be related to the duration of exertion, since Lukasek et al established a completely different pattern of enzyme changes during several 15-minute periods of exertion in the negative pressure chamber (at a simulated altitude of 3000 m; 3).

The very slight, statistically not significant increase in creatinine during the activity phase ($p<0.559$) corresponds to the existing findings for endurance performances (2). We found however, contrary to our expectations, no noticeable change in the urea levels.

The behaviour of free fatty acids (drop from 0.53±0.2 to 1.13±0.5 mmol/l) and glyceride concentrations (from 0.09±0.05 to 0.20±0.09 mmol/l; $p<0.001$) before and after the test-tour indicates that a surprisingly large percentage of energy preparation occurs by way of fat oxidation.

This happened although the enormous difficulty of the climbing route called for a continuously intensive performance level.

The behaviour of the electrolytes was of the utmost interest. Very distinct changes were noted during the two-week period with regard to the serum-electrolytes, despite a consistent and ample oral supply of electrolyte drinks, with the potassium level falling from, 4.15±0.6 to 4.03±0.4 ($p<0.001$). Similar tendencies could be found for sodium and phosphorus, whilst the magnesium and calcium levels remained relatively constant.

Six subjects were chosen at random and their levels of cortisol, prolactin, plasma catecholamines, renin and beta-endorphine were determined both before and immediately after the 13-hour test-tour. Taking into consideration that because of the limited number of test-persons these results may be only very cautiously interpreted, the cortisol and beta-endorphine concentrations showed a very mildly significant rise. No significant increase, however, was noted in epinephrine, norepinephrine, and prolactin.

The arterial lactate concentration of all participants was measured immediately at the end of the climb, giving a mean value 7.2±3.2 mmol/l. This seems to be contrary to the other data but must be interpreted in regard to the circumstances that the final 500 metres to the test-station at the top had to be climbed as fast as possible because of a very intensive thunderstorm.

Conclusion

This study demonstrates that an aerobic-lipolytic metabolism dominates even during periods of extreme alpinist exertion in experienced and well-trained climbers. This permits the carbohydrate reserves, combined with a well-developed all-round endurance capacity, to be surprisingly well employed. (Nearly no additional carbohydrate were taken by the climbers during the 13 hours of the test tour.)

On the other hand, the significance of a consistent, balanced intake of liquid and mineral-salts takes on great importance. But in practice this demand is combined with a large problem: despite a forced intake of electrolyte-solutions, the usual rest-periods between daily climbs are not sufficient to allow complete replenishment.

Furthermore, there are several indications that hypoxia, even at medium altitudes, has additional but not great influence on the metabolism.

Taking also in account the behaviour of the stress hormones, in the case of the intensive, comprehensive and continuous exertion criteria to be found in extreme alpine climbing, one can conclude that those mechanisms responsible for regulating hormones and metabolism during general long-term endurance activities are very much in the foreground; provided, however, that the climber has undergone well-planned, optimum training. Without excellent long-term endurance training such climbs cannot be adequately managed by the metabolism – a fact which leads also to a higher risk of accident.

GLUTAMATE-OXALACETIC –ACID [U/l]			GLUTAMATE-PYRUVIC –ACID [U/l]			LACTATE DEHYDROGENASE [U/l]		
	Mean	SE		mean	SE		mean	SE
1	9.721	2.142	1	10.721	3.514	1	161.767	30.551
2	12.279	4.925	2	12.651	4.203	2	191.814	55.963
3	13.903	4.536	3	13.452	4.453	3	235.484	25.029
4	14.857	4.305	4	15.833	4.411	4	237.457	43.456
5	13.000	3.513	5	15.295	4.528	5	179.238	23.987

CREATINE-PHOSPHOKINASE [U/l]			UREA [mg/100 ml]			CREATININE [mg/100 ml]		
	Mean	SE		mean	SE		mean	SE
1	84.372	30.551	1	36.977	5.475	1	1.142	0.122
2	164.628	122.689	2	32.698	4.411	2	1.095	0.097
3	232.268	119.129	3	32.226	5.233	3	1.119	0.105
4	194.400	83.470	4	33.767	6.044	4	1.133	0.108
5	133.452	743.032	5	30.048	5.759	5	1.033	0.107

	PROLACTINE [ng/ml]			CORTISOL [µg/100 ml]			NOREPINEPHRINE [µg/ml]	
	Mean	SE		mean	SE		mean	SE
2	5.550	1.520	2	9.383	6.352	2	666.657	228.269
4	8.900	4.303	4	18.120	4.567	4	962.500	358.550

	EPINEPHRINE [pg/ml]			BETA-ENDORPHINE [pg/100 ml]			RENIN [pg/ml]	
	Mean	SE		mean	SE		mean	SE
2	96.667	29.078	2	84.567	7.763	2	0.020	0.070
4	155.250	59.587	4	95.400	12.300	4	0.924	1.498

	POTASSIUM [mmol/l]			FREE FATTY ACIDS [mmol/l]			GLYCERIDES [mmol/l]	
	Mean	SE		mean	SE		mean	SE
1	4.505	0.610	2	0.532	0.201	2	0.089	0.045
2	4.337	0.365	3	1.125	0.460	3	0.202	0.087
3	4.574	0.562	4	0.928	0.312	4	0.196	0.083
4	4.230	0.505						
5	4.035	0.434						

LACTATE [mg/100 ml] mean: 7.202 SE: 3.206

References

1. Berghold, F., Aigner, A., Muss, N., Pallasmann, K.: Acclimatization and Acute Mountain Sickness in High Altitude Climbing- In: Current Topics in Sports Medicine, Urban & Schwarzenberg Wien-München/Baltimore, 517-529, 1984. **2.** Gleispach, H., Schmid, P., Porta, S.: Metabolische Änderungen beim Sportklettern. Tagungsband des Int. Symposium für Leistungsmedizin Graz, 173-183, 1980. **3.** Poortmans, J. F.: Biochemistry of Exercise. In: Medicine And Sport, Vol. 3, S. Karger-Verlag Basel-New York, 1969. **4.** Schmid, P., Wolf, W., Biffl, H.: Zur Beurteilungsproblematik labordiagnostischer Untersuchungsergebnisse bei Leistungssportlern. In: Der Prakt. Arzt, 34, 1980, 5. **5.** Zintl, F.: Zur körperlichen Beanaspruchung bei verschiedenen Ausprägungsformen des Bergsteigens. Prakt. Sport-Traum. Sportmed. (München), 1985, 2: 14-20.

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ATRIAL NATRIURETIC PEPTIDE AND ACUTE MOUNTAIN SICKNESS

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Subjects suffering from acute mountain sickness (AMS) have an antidiuresis compared with healthy subjects. An expedition to Mt Kenya involving *22* subjects ascending rapidly to 4300 m afforded an opportunity to study urinary output, plasma aldosterone (PA) and atrial natriuretic peptide (ANP) levels in relation to severity of AMS.

Subjects travelled to 3100 m by road and the following day walked to 4300 m. Measurements of 24-h urine volume and sodium excretion, Hb and PCV were made over two days at 1500 m before ascent and for two days after arrival at 4300 m. In 15 subjects blood samples were taken for PA and ANP at 4.00 and 9.00 am on the same 4 days.

On ascent (with exercise) there was a marked decrease in 24-h urine volume and sodium excretion but no significant change in Hb or PCV. PA was elevated on the first day and ANP on both altitude days.

AMS symptom scores showed an inverse correlation with 24-h urinary sodium. PA tended to be lowest in subjects with low symptom scores and higher sodium excretion. No correlation was found between AMS and Hb, PCV, urine volume or weight change. ANP at low altitude showed a significant inverse correlation with AMS symptom scores on ascent. The same association was seen at altitude.

These results suggest that the subject resistant to acute mountain sickness will be found in, on ascent to altitude, to have a sodium led diuresis, lower plasma aldosterone and higher ANP levels, he or she may also be characterized by higher ANP levels at sea level.

THE ROLE OF THE THROMBIN-PLASMIN SYSTEM IN BODY ADAPTATION

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Abstract

It has been determined experimentally that the thrombin system and the plasmin one function as a single thrombin-plasmin system (TPS). TPS has been proved to be present not only in the blood, lymph, and interstitial connective tissue, but in every body cell too, playing an important role in regulation of the vital activity level of the cells of parenchymal organs. TPS has a modelling effect on the structural and functional state of cells and their adaptation to changing environmental conditions by regulating the polymerization of their actin microfilaments and changing the conformational state of different cellular proteins.

In generalized decompensated thrombinogenesis, hyperpolymerization of actin filaments and considerable denaturation of other proteins may develop, this manifesting itself in structural and functional disturbances of the cells and organs in general (coagulation theory of pathogenesis). Prophylactic use of heparin prevents these changes. The use of plasmin during the first hours after the signs of such disturbances appear, provides complete, rapid and stable recovery of the structures and functions of the cells and organs.

It has been revealed by electron microscopy that plasmin causes depolymerization of actin filaments and denaturation of other proteins: it promotes cell clearance of irreversibly damaged structures and stimulates intracellular regeneration processes simultaneously. Thus, TPS is of great importance in cellular adaptation mechanisms both under normal and pathological conditions.

In experiments on animals it was shown that generalized intensification of thrombinogenesis lowers the functional activity level of cells and organs, while the generalized intensification of plasminogenesis results in the functional activity level being raised(V. A. Monastyrski, 1972).

Decompensated intensification of thrombinogenesis leads to the impairment of the structure and functions of parenchymatous organs, sometimes with development of their acute insufficiency. By means of electronic microscopy and ultrastructural cytochemistry, it was found that in such cases transformation of cytosol into cytogel is observed in some cells of myocardium, kidneys, liver, and other organs, which is manifested in an increase of their electronic density (the so-called "dark" cells). Simultaneously there occurs mass loosening of different cell organelles, there is gradual decrease of the number of free polyribosomes and attenuation of the granular endoplasmic reticulum down gradually up to their complete disappearance, and the activity of intracellular enzymes becomes reduced sharply. Data from the literature convince us that two kinds of changes – polymerization of actin and denaturation of other intracellular proteins lie in the basis of all the aforesaid changes. Circulatory hypoxia caused by the vessel spasm or by the disseminated microthrombosis cannot be the reason for this cell damages, because it has been shown that it occurs already 2 – 3 minutes after the beginning of development of the generalized decompensated thrombinogesis whereas after the ligation of the corresponding artery an analogous cell impairment develops 5 – 6 times later (V. A. Monastyrski 1972, I. I. Birka 1987).

On the other hand it was found that plasmin administered during the first 24 hours after the beginning of the development of the above-mentioned disorders causes a rapid, complete, and stable regeneration of the structure and functions of the impaired organs. It was shown by means

of electronic microscopy and ultrastructural cytochemistry that under the influence of plasmin cells which had preserved their vitality normalized, the aggregated condition of their cytoplasm, got rid of their irreversibly impaired organelles, had the contour of their preserved membranes regenerated, their nuclei were enriched with chromatin, the number of their free polyribosomes increased sharply, and formation of the granular endoplasmic reticulum and assemblage of their other organelles began. All this resulted in complete regeneration of the ultrastructure of such cells in 24–45 hours. There are grounds to suppose that under such conditions regeneration of the cell structure takes place owing to depolymerization of actin, renaturation of reversibly denaturated proteins, a hydrolysis of the irreversibly denaturated proteins, and acute stimulation of the process of intracellular reparative regeneration (V. A. Monastyrski 1972, N. V. Birka 1984, M. I. Voronyak 1988).

In investigating the mechanisms of these phenomena we have come to the following conclusions:

1. The thrombin system and the plasmin system function practically as subsystems of more complex thrombin-plasmin system (TPS);
2. TPS is present and functions not only in blood but also in stroma and what is particularly important, in every cell of the organism;
3. 3. TPS, alongside with asymmetric transformations of fibrinogen, is capable of realizing two symmetric processes: first, transformation of cell actin according to the scheme: polymerization, i. e. the formation of F-actin (with prevalence of thrombinogenesis), <===> depolymerization or the formation of G-actin (with prevalence of plasminogenesis); and second, conformable changes in other proteins according to the principle: denaturation (with prevalence of thrombinogenesis) <===> renaturation (with prevalence of plasminogenesis).

It follows from this fundamentally new proposition that TPS, in addition to securing local haemostasis and subsequent recanalization of vessels, plays one more, probably a more important, role in the organism, that of a peculiar modulator of the structural-functional condition of cells, organs and the organism in general viz.: the prevalence of thrombinogenesis is accompanied by a decrease in the level of functional activity of cells a predominance of plasminogenesis, on the contrary, leads to its increases.

This ability of TPS plays an important role in the mechanism of body adaptation in physical exertion and under various extreme conditions.

Data from the literature also testify to the fact that physical exertions may cause certain changes of TPS, viz. enhancement of either thrombinogenesis or plasminogenesis. At the beginning, when the functional activity level is rather high, there is a marked prevalence of plasminogenesis, while the appearance of fatigue is accompanied by a tangible prevalence of thrombinogenesis.

By way of drawing a conclusion, I should like to stress that further substantial study of this problem will markedly expand our knowledge on the role of TPS in the adaptation mechanism and will provide an opportunity to work out effective means of active regulation of these processes, the use of drugs included.

VARIATION OF PLASMA BIOCHEMICAL PARAMETERS IN ALPINE SKIERS

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Abstract

To evaluate plasma biochemical parameter in alpine skiers, we studied 11 subjects (9 males and 2 females) attending a course of training for alpine skiing. We examined the 11 alpine skiers before and after a 650 meter climb (Colle Margherita mt. 2000). A second climb was undertaken after three months of training. The first climb was at a much cooler environmental temperature than the second one. In the second climb glycaemia was increased and FFA, though elevated, was lower than in the first climb; lactic acidosis was significantly higher ($p<0.001$), carnitine fractions showed an increase of short chains and long chains of acyl fractions after both climbs with respect to the basal values. These data suggest that during alpine skiing intense lipolysis occurs and the effort may be done both in aerobic and anaerobic conditions.

FEATURES OF PSYCHIC CHANGES IN TRAINED MOUNTAINEERS AT HIGH ALTITUDE: CORRECTION AND PROPHYLAXIS BY DRUGS

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During recent years high-altitude ascents have been rapidly increasing in number. The value of stepwise acclimatization is being overlooked, ascents to the 7000 m high mountains in the so-called alpine style are rather frequent.

The effects of the components of the alpine climate (temperature of air, oxygen deficiency, solar radiation and etc.) increase as a result of emaciation of the compensatory and adaptive systems of the body for these conditions. I consider that the investigations worked off by V. B. Zakusina, E. A. Alexinants and N. N. Zelenina (1986) make very interesting reading. According to these authors adaptation to cold becomes ineffective against a background of preformed adaptation to oxygen deficiency the balance of the human organism is then reduced sharply against the complex impact of cold and oxygen deficiency.

According to the pertinent literature and my own observations, the nervous system is the most susceptible to the “alpine factors”, and above of all, its higher components are. It is known that the cerebrum is supplied with oxygen, energy and plastic stuft in the first place, but nevertheless dynamic defects of the central nervous system appear comparatively early.

Some investigators (L. A. Orbely, 1940; A. D. Slonim, 1943; M. M. Mirrakhimov, 1963 and others) point out that the low atmospheric pressure has irritating effect at first and then the oppressive one. The character of changes of cortical functions depends on the mountain height according to of N. N. Sirotinin (1954, 1965); E. N. Kutchak (1963).

According to my observation in the Caucasus at a height of 2000–2500 m the internal inhibition of reflexes and fine differentiation changes in non-trained persons. As the ascent proceeds, the latent period of speech responses increases, the speed of thought is reduced, speech responses become more primitive.

At a height of 4000 m the processes of internal inhibition are upset. The quantity of conditioned reflexes becomes changeable. Passivity of the excitation process develops and there is weakness of inhibition. A wide cortical inhibition towards the hypnotic phase appears at relatively considerable heights (5000 m and above).

In a group of trained sportsmen experienced in high ascents, track effects are expressed strikingly as a result of the influence of high-altitude adaptation during the ascents of previous sporting seasons. A reduction of memory processes and of fine differentiation are observable in this group (as opposed to the first one) at a height of over 4000 m during the first 2–3days. At this height individual differences in the adaptation to cold and oxygen deficiency have been observed in accordance with the criterion of emotional-behaviour reactions of the body. This connection the functional organization of the central nervous system and the type of higher nervous activity are very important (V. B. Zakusina, 1986).

Comparison of the results of primary medical control of the trained sportsmen at a height 4000–5000 m showed that the best results were typical for persons with a strong type of higher nervous activity (according to I. P. Pavlov). Sportsmen with a tendency towards emotional lability characterized by a higher level of excitability proved to be more liable to the influence of the high-altitude climate. In this group, at the height of 4000–4500 m, the features of the syndrome of psychoemotional stress are observed, such as a dim anxiety, hypochondria, bad sleep, and irritability. Personal qualities stood out in all the groups of sportsmen.

The changes at a height of over 6500 m were the most variable, up to pathologic ones. The groups with changes in sportsmen´s psychic aspects differed in respect of sex, age, type of higher nervous activity, level of training. Highly emotional disorders inadequate to the outer irritants ranged from hardly noticeable to unusual emotional lability, low spirits, submaniacal conditions, and even features of severe psychosis with wild ideas, psychomotor excitation prevailed among women (the season of 1988, the Central Pamir).

Changes in the psychic respect were observed as the asthenic-neurotic syndromes in persons with a tendency to accentuation of alarmed-hypochondriac type among trained mature men. Visibility-emotional experience on the neurotic level with the preservation of criticism of the condition visual – more often hypnogogic, auditory – as ordinary sounds, calls to name are comparatively often.

Some representatives of the group of trained elderly sportsmen were of considerable interest. Observed were effects of intellectual reduction, apathy, appreciable reduction of criticism, with all these phenomena accumulating with climbing height over 6500 metres. The opposite development of these effects with the loss of height against a background of medicinal correction is expressed to a considerably lesser degree than in the previously mentioned cases.

The medicinal correction included preparations influencing the syndrome. They were tranquilizers, neuroleptics, taking effect furthermore its principle qualities as antioxidants. The correction with tranquilizers and neuroleptics was carried out against a background of preparations given to improve the metabolism of the brain, providing a higher supply with oxygen, plastic energy stuft without use of oxygen with a body.

The importance arrangements directed to the overcoming free-radical oxidation and improving the microcirculation and rheological characteristics of blood was confirmed. On the basis of the experience of gained in the ascents of 1988, a higher-risk group was picked out among high-skilled sportsmen. It consisted persons of advanced age, women, and persons with some peculiar tendency an accentuated character who had suffered from cranial-cerebral trauma.

A plan of preventive measures had been worked out before the above group went to the mountains. The preventive measures improved sufficiently the adaptation of the high-risk group to high-altitude climate. They had practically no changes in their psychology, the height they had climbed increased considerably, right up to climbing 7000 m high mountains.

THE USE OF PLATELET ANTIAGGREGANTS IN HIGH-ALTITUDE PATHOLOGY: AN ORIGINAL EXPERIMENT IN ANNAPURNA I (8.081 M)

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Abstract

Haemodynamic and haematological problems play an important role in high-altitude pathology. Together with polyglobulia, platelet aggregation is a factor to be taken into account, especially in complaints due to cold. While the use of platelet antiaggregants is accepted as an efficient therapy, it had not been used in a preventive way.

During an expedition to Annapurna I, we carried out an experiment with preventive and later therapeutical aims, using DITAZOL as a platelet antiaggregant. The study was carried out in two groups which reached the summit with different pathological results in spite of the climatological conditions being similar'

A total of 40 frozen fingers and toes in the climbers who did not accept the preventive treatment, later imposed the use of antiaggregants as an optimum measure in all members of the groups followed up. Haematological analysis carried out 10 days after reaching the summit showed platelet values nearly three times greater than those accepted as normal.

Considering the disadvantages of other types of medicines, antiaggregants prove to be ideal in high-altitude pathology both as preventives and in the therapy of established lesions.

Introduction

Haematological alterations are very important in high-altitude pathology. Among them, the increase in the red blood count and modification of blood platelet behaviour are fundamental.

Actually there is evidence that effect of hypoxia itself produces an increase in blood platelets. These have been found inside the normal values in our study on the stay of an alpinist during 66 days on the top of Aconcagua (7000 m). However, the absent acclimatization to high altitude, the in temperature fall, and vascular endothelium injury increase platelet aggregability and this together with the polyglobulia and the increase in a haematocrit value favours thrombus and microthrombus formation in the RETINA, PERIPHERAK CIRCULATION (frostbite), LUNG, and CEREBRUM (oedemas at high altitude).

Finally, other factors such as parietal, bioelectric, and plasmatic changes caused by haemodynamic variations, effort, and high-altitude hypoxia tell evidently on blood platelet behaviour and hyperaggregability.

Justification of the experiment.

Analysis of the above-mentioned facts seems to justify experimental inhibition of platelet aggregability as a consequence of the conditions imposed by high Altitude. This inhibition can be either preventive: in order to reduce the risk of high-altitude thrombotic pathology, or therapeutic: we can consider the possibility that an established clinical description could be complicated with an occlusive vascular phenomenon.

In spite of this, there is not much experience with pharmacological alternatives or something of the kind, with „cold injuries“ always requiring treatment. In this case we could be sure that anticoagulants would do good service considering the physiopathology of the lesion-forming process, but does not their use involve important risks outside the hospital?

That is why we consider it necessary to do beyond the obligatory therapy and apply preventives in relation to all diseases described, and we introduced platelet antiaggregants in our expedition to Annapurna I, 8091 m high, in the Himalayas in Nepal.

The antiaggregants have to fulfil all the following requirements: not interfere with a haemostasis, which is necessary in case of loss of blood, not modify the prothrombin time, not damage the platelets, be tolerated well, be easily administered and cleared.

Our choice was DITAZOL (Ageroplas 400), which had been used successfully by our group in the treatment of cold injuries at the University Clinic Hospital of Zaragoza.

Characteristics of the experiment: material and method.

From a total 18 persons who were on the base field we only considered 13, who were to work between 4500 and 8091 m. Nine of them were members of the expedition and four were Sherpas; 12 were men and one was woman. The age range was 22 to and 32 years.

The experiment was described to all of the expedition people before leaving Spain, and to Sherpas in their Country. After this, nine accepted the preventive administration of the medicine (GROUP WITH DITAZOL), and four did not accept (GROUP WITHOUT DITAZOL).

Before to setting out for Nepal, a medical examination and general analysis of the whole group in Spain did not give any irregular test.

The drug was administered, at first purely preventively at a dosage of 400 mg every 24 hours (1 capsule every day). The treatment began when the expedition arrived at the base field (4500 m) and continued until the return journey after the top had been reached. The whole period of administration lasted 37 days.

Results.

GROUP WITH DITAZOL.

Two people stopped receiving the medicine and being physically active because of an icteric hepatitis 15 days after arrival at the base camp.

One had the dose increased to 800 mg/24h because of sudden neurological problem at 6000 m: he developed TRANSITORY AFASIA without accompanying symptoms of acute cerebral oedema, during his third ascent to that height.

Four people climbed to 7400 m without important problems.

Two reached the top without problems

No one showed secondary effects or evident intolerance.

GROUP WITHOUT DITAZOL.

One climbed without problems to 7400 m.

Three reached the top suffering very bad III degree frostbite in 24 toes and, less serious (II degree, superficial or deep), in 20 fingers. After this DITAZOL was administered to the group therapeutically.

We emphasize that their platelet counts after being admitted to the hospital in Zaragoza, 11 days after the climb to the mountain top, were 617.000 and 585.000 (normal values are between 150.000 and 440.000).

Discussion.

Comparatively speaking about the results, it is not easy to precisely differentiate the stages of the development obtained with preventive treatment.

It could be possible to think about the different environmental and personal conditions in each of the group at the moment of onset of the pathology mentioned, but these were not determined.

We did not make "in situ" measurements to be able to evaluate the results with some scientific precision. In spite of this, against the occlusive vascular background implied and being usual in high-altitude pathology, with direct participation of platelets, and basing our theory on experimental work on laboratory animals, we evaluate very positively as a success the use of platelet antiaggregant versus the cases described. The antiaggregant was applied preventively and certainly antiaggregants are indicated for therapy of the type of injuries mentioned above without any risk of anticoagulants being used out of hospital.

References.

1. Carvalho Altez, C.: La actividad física y su incidencia sobre la agre gabilidad plaquetarie. Arch. Med. Dep., 3, 1986, 9: 11–17. **2.** Darnaud, B.: Las afecciones oftalmológicas, en Medicina de la Montana de J.P. Richalet, p. 95. Editorial Masson 1985. **3.** Etienne, J. L.: Médecine et sports de montagne, Editorial Acla (Paris) 1987. **4.** Foray, J.: Patología vinculada al frío, en Medicina de la Montana de J.P. Richalet, p. 100–112. Editorial Masson 1985. **5.** Gomez Casal, F., Martinez Villen, G., Vazquez, C., Moneva, J., Morandeira, J. R.: Resultados hematológicos tras la permanencia durante 66 días a 7000 metros, libro de abstract VIII Jornadas Nacionales de Medicina de Montana, p. 34, Zaragoza-Jaca 1987. **6.** Gralino, B. J., Porter, J. M., Rosch, J.: Angiography in the diagnosis and therapy of frostbite. Radiology 1976, 119, 301–305. **7.** Lorente Zuzaga, J. F.: Retinopatía hemorragica de la altura, en Medicina de Montana, VI Jornadas, del Servicio de Publicaciones del Gobierne Vasco, p. 271–281. Editorial Itxaropena 1984. **8.** Martinez Villen, G.: Contribución al estudios etiopatogénico de las lesions localizadas por acción del frío y experimental, Tésis doctoral, Facultad de Medicina (Universidad de Zaragoza), junio 1987. **9.** Mills, W. J.: Congelación, en Tiempos Médicos, 8, 1975, 9: 13–20. **10.** Rathat, C.: Patología vinculada a la hypoxia, en Medicina de la Montana de J.P. Richalet, p. 76–99. Editorial Masson 1985. **11.** Robins, S. L., Cotran, R. S.: Patología structural y functional, p. 495–520. Editorial Interamericana (2 ed.) 1984. **12.** Schmid-Schönbein, H.: Conception récente du compartement des hématies dans la microcirculation normale et pathologique. Abstract book Congres international de Medecine de Monatgne: L´epuisement en Altitude, p. 7, Chamonix 1984. **13.** Schumacker, H. B.: Congelación, en Chirurgía de la mano, p. 490–499. Editorial Toray (1 ed.) 1977.

THE EFFICACY OF TWO ORIGINAL ANTIHYPERTENSIVE AGENTS IN EXPERIMENTAL PULMONARY HYPERTENSION

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Abstract

The efficacy of two new antihypertensive agents, metazosin (alpha-blocker) and mepamil (calcium-channel blocker), was tested in two models of experimental pulmonary hypertension in dogs and rabbits. In dogs, the pulmonary hypertension was caused by endotoxin administration and the pressure in the pulmonary artery was recorded. In artificially ventilated rabbits, the right ventricular pressure was recorded and pulmonary hypertension was developed by changing the composition of the breathing mixture.

The preliminary results confirmed the efficacy of both substances in these models of pulmonary hypertension.

Introduction

The hypoxia in high altitudes leads to the development of pulmonary hypertension. This adaptive reaction can give rise to pulmonary oedema, one of the signs of acute mountain sickness (7). The usual therapy of moderate and severe forms of pulmonary oedema is oxygen supplied together with the administration of diuretics, corticosteroids and sometimes nitrates (2). According to recent experimental findings, the increase in pulmonary vascular resistance can be mediated by activation of alpha-adrenoceptors (1,3,4). The alpha-blockade should therefore tend to reduce the pulmonary hypertension. Some calcium channel blocking drugs are reported to have a similar effect (6,8).

We therefore decided to test the efficacy of alpha-blocker metazosin and calcium channel blocker mepamil in two models of experimental pulmonary hypertension. We intended to find out whether there was the prevalence of alpha-blockade or calcium-channel blockade in the effect of decreasing pulmonary arterial resistance.

Metazosin and mepamil are both original substances developed in the Research Institute for Pharmacy and Biochemistry in Prague. Metazosin is a selective alpha1-adrenergic blocker with proved antihypertensive activity and the unique possibility of being given intravenously. Mepamil is a phenylalkylamine calcium-channel blocker that displayed minimal reduction of cardiac inotropy in many experiments.

Methods

Mongrel dogs of both sexes were used in the experiments (13–23 kg). After the induction of pentobarbital anaesthesia Swan-Ganz floating catheter was placed into the pulmonary artery and the pressure changes were recorded. An increase of the arterial pulmonary pressure was brought about by i.v. infusion of 1 mg/kg Escherichia coli endotoxin. Pulmonary hypertension is a regular phase of an endotoxin shock. Metazosin or mepamil were administered at a dose 1 mg/kg i.v. at the end of endotoxin infusion and the effect was observed for 180 minutes

In anesthetized chinchilla rabbits (3.7–4.5 kg), the right-ventricle pressure was recorded. The catheter was placed into the right ventricle through the right jugular vein and its position was

verified according to the typical shape of the pressure curve. The spontaneously breathing animals were exposed by means of a simple mask to 100 percent atmosphere of carbon dioxide under normal atmospheric pressure for 45 seconds. The consequent short-term increase in the mean right-ventricle pressure was recorded. After repeated control measurements the animals were given metazosin 1 ml/kg and 10 mg/kg or mepamil 0.5 mg/kg and 5 mg/kg. These doses were established on the basis of former hemodynamic experiments. Three minutes after administration of the test drugs the pressure response to carbon dioxide was again recorded.

Results

In control dogs the administration of endotoxin resulted in a rapid increase of systolic pulmonary artery pressure. The magnitude of this increase reached a maximum 180% of initial pressure values. This effect was short lasting and ceased in 15 minutes. Both metazosin and mepamil in a dose of 1 mg/kg abolished the increase of blood pressure in pulmonary artery (Fig. 1). Except of for a brief transient initial increase, metazosin converted the response to endotoxin into negative values. The suppression of endotoxin effect was statistically significant up to 30 minutes after administration. Mepamil also dramatically reduced the response to endotoxin. Its effect was of statistical significance during the first 4 minutes after endotoxin. From the 30th to the 180th minute pulmonary pressure decreased below the starting values in the control group and after both drugs. This decrement was more pronounced after mepamil and there was significant difference from the control group at intervals of 120 and 180 minutes.

In rabbits, the inhalation of carbon dioxide gave transient increase of the mean right ventricle pressure reaching approximately 6–7 mmHg. The increment of right ventricle pressure was suppressed by metazosin and mepamil in the dose-dependent manner. Statistical significance was found after metazosin administered in a dose 10 mg/kg only (Fig. 2).

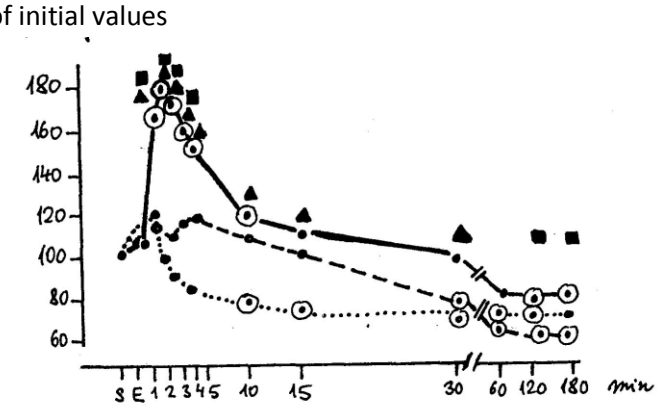

Fig. 1. **Changes of pulmonary artery systolic pressure in dogs after endotoxin administration expressed as per cents of initial values.** Metazosin (.....) or mepamil (–·–·–) at a dose of 1 mg/kg were administered at the end of endotoxin infusion (S-E interval). Control animals (_____) were given saline only. Data are presented as the means, N=6; ⊙ - significantly different from the initial values (P<0.05), ▲ - statistical significance of difference between control group and metazosin group (P<0.05), ■ - statistical significance of difference between control group and mepamil group (P<0.05).

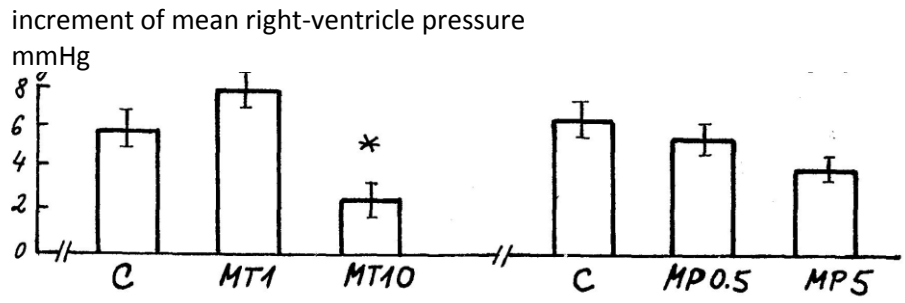

Fig. 2. **Effects of metazosin and mepamil on the increment of mean right-ventricle pressure after carbon dioxide inhalation.** Both agents were given in two cumulative doses, metazosin 1 mg/kg (**MT 1**) and 10 mg/kg (**MT 10**), mepamil 0.5 mg/kg (**MP 0.5**) and 5 mg/kg (**MP 5**). Data are presented as the means ± SE, N=6; * - significantly different from control (C) measurement (paired t-test, P<0.05).

Discussion and Conclusions

Acute transient pulmonary hypertension had developed by different mechanisms in both models. The mechanism of pulmonary hypertension after endotoxin is not yet fully understood. A complex effect of mediators of inflammation and PAF has been assumed (5). In rabbits, pulmonary hypertension developed as a consequence of the additive effects of hypoxia, hypercapnia and acidosis. The use of metazosin and mepamil offered two different approaches of affecting pulmonary vasculature. In the case of metazosin, an alpha-1 - blockade of the sympathetic input was involved. The mechanism of action of mepamil is more subtle on the cellular level of the vascular smooth muscle, inhibiting the calcium inward current. Though metazosin and mepamil seem to have a protective effect in both models of pulmonary hypertension, metazosin exerted a bit stronger effect than did mepamil. This could suggest more complex changes evolved by adrenergic activation in the development of pulmonary hypertension. The more pronounced effect of metazosin and mepamil in the model of endotoxin pulmonary hypertension suggest a greater sensitivity of this model to experimental therapy.

References

1. Greenlees, K. J., Gamble, R., Eyre, P.: Adrenoceptor function in the bovine pulmonary circulation. Can. J. Physiol. Pharmacol., 64: 689-693, 1986. **2.** Hochstrasser, J., Nanzer, A., Oelz, O.: Das Höhenödem in den Schweizer Alpen. Schweiz. med. Wschr., 116: 866-873, 1986. **3.** Hyman, A. L., Lipton, H. L.. Kadowitz, P. J.: Autonomic regulation of the pulmonary circulation. J. Cardiovasc. Pharmacol., 7 (Suppl. 3): 680-S95, 1985. **4.** Kolbeck, R. C., Speir, W. A.: Regional contractile responses in pulmonary artery to alpha- and beta-adrenoceptor agonists. Can. J. Physiol. Pharmacol., 65: 1165-170, 1987. **5.** Meyrick, B., Brigham, K. L.: Vasoconstriction and remodelling in pulmonary hypertension. Chest, 88 (4): S268-8270p 1985. **6.** Simonneau, G., Escourou, P., Duroux, P., Lockhart, A.: Inhibition of hypoxic pulmonary vasoconstriction by nifedipine. N. Engl. J. Med., 304: 1582-1585, 1981. **7.** Wagner, P. D., Sutton, J. R., Reeves, J. T., Cymerman, A., Groves, B. M., Malconian, M. K.: Operation Everest II: pulmonary gas exchange during a simulated ascent of Mt. Everest. J. appl. Physiol., 63 (6): 2348-2359, 1987. **8.** Young, T. E., Lundquist, L. J., Chesler, E., Weir, E. K.: Comparative effects of Nifedipine, verapamil and diltiazem on experimental pulmonary hypertension. Am. J. Cardiol., 51: 195-200 1983.

MENTAL AND GYNAECOLOGICAL PROBLEMS IN MOUNTAINEERING WOMEN

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With all due consideration being paid to individual (psycho-somato-sociological) differences between mountaineers and the differences in their environments and personal experiences both in the mountains and throughout their lives, some typical traits may be identified in climbing effects on female organism as resulting from the extreme strain, stress, and exertion. Nevertheless, lasting or several menstruation disorders, e. g. were not observed by the authors, although some irregularities may appear both during the adaptation period in mountains, and during the time of extreme stress.

With changes that are now taking place in female activity in general, mountaineering proves to be more frequent among women, although it has not yet become a mass sport with them. As both expected and verified, the general female personality traits are not substantially altered with climbing.

Preliminary conditions of a successful climbing career: genetic disposition, frequent stays in mountain regions, during a major part of preceding life, physical and mental fitness, appropriate partner orientation, adequate employment, etc. Age and function stratification: a women should not start with this sport before adolescence. Any training has to be stopped during pregnancy. Many women use to abstain from climbing during the infancy of their children, and some do not return to it as long as the children are young, or stop mountaineering at all. In other cases, they take their children with them, and leave them in safety conditions at a base or with some relatives etc.

Reasons for preferring climbing to other sports: at the beginning there may be social grounds – a fashionable sport, not too crowded with people, mountaineering friends etc. Among the advantages is the start of training during adolescence, the possibility of combining mountaineering with some other sport disciplines to achieve some sort of trained condition at any season, frequent stays in open nature, a feeling of satisfaction with one's own performance, of being equal to men, activation of physical and mental faculties, activity even at a comparatively advanced age. There are also drawbacks, of course: it is a rather time-consuming sport, both in training and actual performance dangers and risks arise and change with climbing site, and this not only in top performance, different interests of other family members, climbing interfering with activities at home etc. A solution can found in combining the interests of the partners, in the whole family turning to climbing, mutual understanding and cooperation etc.

Among basic factors of disappointment in mountaineering women should be mentioned: emotional dissatisfaction due to adverse reactions of friends, family protests, ideas about romantic life in mountains proving to be false$_r$ disappointment with male climbers or being heroes with ideal manners of chivalry manners, with their heroism being only human in contrast to films and stories. On the other hand, interest in climbing may be shared with others, a lasting partnership or friendship among climber-group members may form, family life may be strengthened by a common interests.

In training of the young climbers´ generation, a scientifically founded approach proves to be indicated, as in other sport disciplines. Besides careful training and complex mental, physical and social fitness, top climbing performances requires extended experience for the choice of the site, time, and other conditions, sound judgment and quick decision, a capacity to evaluate the actual conditions in a particular environment, and human cooperation. These prove to be the most important factors.

Not having found among the climbers her dreamt-of partner, a woman is more prone to stop climbing definitely, more easily than a man. As in other sport disciplines, such purely feminine solutions become less frequent with increasing number of women climbers.

In mass media presentation, mountaineering should be featured in cooperation with experienced climbers for avoiding disinformation. The beauty of nature, and the hard training should be stressed, and also the long way to top performance, the lapse of time between the first experiences and the satisfaction of a victory. Short-cuts between basic training, a base camp and famous climbing success are likely to serve as a source of disinformation, and of disappointment for beginners.

False heroism and risking with inadequate training, climbing outfit and experiences should be criticized, not glorified.

Of course, sport climbing provide satisfaction and pure joy to many people. Phantasies about mountain horrors may serve ae a pass-time for the television and cinemas public, and should be taken as such, while they are far from propagating climbing as a sport. In their majority, women prove to be emotionally more accessible to such disinformation. At the same time, with their sense of reality, they often correct the false information quickly.

V. PREVENTION OF ACCIDENTS AND TRAINING IN TACKLING EMERGENCY SITUATIONS

TRAINING FOR ROCK CLIMBING

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Abstract.

The sport of rock climbing is now being changed by its leading participants adopting strict training regimes. Many of these are based on "word of mouth" ideas, rather than a knowledge of physiology and state of the art information from other sports where there is a long history of training and much expertise and physical and mental conditioning.

The author has been a member of a Committee for the last two years which has been investigating this whole topic. From these researches a book will be published by the BMC at the end of this year under the title "Rockfit".

This work covers all aspects of this activity, including avoidance of injury, diet, and mental preparation techniques. This talk therefore will dwell on the most important findings by this Committee, and will include reference to a programme of testing which was undertaken by the BMC into the physical performance capabilities of existing top rock climbers, their strengths and weaknesses, and also why it was that many leading climbers were suffering soft tissue injuries.

Rock climbing is currently undergoing a tremendous upsurge in standards of performance and interest. The introduction of organised competitions will speed up this process, and many of today's participants are embarking in training programmes. Some of these are proving harmful to the health of the climbers involved, resulting in over-use injuries, diet deficiencies and the potential for long-term irreversible damage particularly to the finger and lower arm joints.

Introduction

Attitudes and approaches to rock climbing as a sport are changing. Climbers used to delight in being "unfit" people and never took training too seriously. When they were climbing they committed their full physical and mental powers to the task in hand but in between activity on the crags they undertook little or nothing in the way of physical conditioning.

Nowadays with ever rising standards and the greater general emphasis on physical fitness, coupled to the development of climbing walls throughout the country, climbers are keeping themselves fit throughout the winter, spells of bad weather, or mid-week periods by various types of training regimes which may utilise weight training, aerobics, circuits and climbing walls. Much of what has been going in not well thought out to combat this and to avoid the risk of injury, the British Mountaineering Council has commissioned a book, “Rockfit”, which deals in depth with the whole topic of training for rock climbing. Each chapter in the book is written by an expert on their topic and for those wishing to embark on a structured training programme for rock climbing “Rockfit” is a must.

The points made in this article are general and should not be slavishly followed. To train for rock climbing properly at high standards of performance requires a scientific approach which is outside the scope of this paper which is only intended as a brief introduction to the topic. If you wish to take the subject seriously then go into it in greater depth with the help of "Rockfit".

Beginners especially should consider carefully just what physical and other training they need and which it is safe to undertake bearing in mind the danger of damaging muscles and other structures by too early and too heavy loading.

(1) Diet

Dieting does not just mean trying to lose weight. It means adjusting your food intake to your body's requirements. For high energy demand activities you need a high carbohydrate, low fat diet. You need some protein, some vitamins and certain vital trace minerals. There are many food fads about at the moment but if a system works for you well and good. It is a question of balance and you should take something like 60% of your diet in carbohydrates such as cereals, rice, potatoes, vegetables, and pasta. 25% should be fats such as dairy products, liver, and 15% should be protein such as meat, milk and poultry. If you eat fresh food, particularly fruit and green vegetables, they should contain all the trace minerals and vitamins you need. Alternatively you may need to take supplements such as iron tablets and/or ascorbic acid.

If you wish to lose weight, then simply keep your food intake down and your activity levels up. If you are expending a lot of energy then you must keep up your carbohydrate intake or you will begin to feel jaded. In the long term you cannot keep using massive amounts of energy and not keep up your energy intake. Energy intake is measured in calories and how many of these you need per day depends on how much energy you are expending. 6,000 calories a day is a large intake but not unusual for an athlete. If you are burning that quantity of energy per day and only eating food to supply 3,000 calories, then in the long term you will get weaker and not stronger and any diet must take this into account.

(Watch out for kilojoules, an energy unit becoming used more often. 1 calorie = 4.2 kilojoules)

Finally many climbers do not drink enough. This does not mean alcoholic beverages, which contain many calories, but fruit juice, tea, water etc. Water is essential to the body´s functioning and we are all of us mainly composed of it.

(2) Planning a training programme

lt is in the approach to planning that one can see the gap which lies between climbers and other athletes. A top performer in another sport is always on a long-term training programme. This programme is adjusted to take account of progress, or injury, but in broad terms athletes like Steve Cram or Fatima Whitbread will know exactly that their training objectives are in March or April or November. The programme is usually built up, first from a weekly programme, then a monthly one and finally a yearly plan made up of something like a three or four year cycle because of the demands of events such as the Olympic Games or World Championships.

One of the things which climber have not yet learned is the importance of rest. Many young activists who are compulsive about working out are spending hours each days on climbing walls or running or pushing and pulling weights. The body must have rest to recover and at least one or two days each week must be set aside for this. Regular hours and regular sleep patterns are needed with something like eight hours sleep each night. There is moreover something to be said for an "off season" each year, of less intensive training, with one or two days or more of "excess" if only for psychological relief.

(3) Warming up/cooling down

It is important before beginning intensive training sessions to warm up sufficiently. Essentially, such activity decreases the chance of injury by raising the muscle temperature, increasing blood flow and by stretching muscles, ligaments etc. Skipping, running, and stretching are all ways to warm up. After a strenuous training session it is essential to cool down. The warming up processes is reversed, with a slow winding down. If for instance you are on a climbing wall, finish with easy, slow, rhythmical traversing.

(4) Flexibility

This is perhaps the most undervalued component of physical fitness. There are two types of flexibility- exercises: (a) Static, where one stretches slowly and (b) Explosive ballistic stretching. Flexibility enables a greater range of movement to be made and thus if it is allied to strength, speed and endurance it will definitely help a climber to improve and is worth taking seriously.

(5) Endurance

This is basic to climbing activities. Running once, twice, or at the most three times a week is a good way to develop endurance. This develops a basic fitness with a good metabolic rate and oxygen uptake capacity. However running stretches certain muscle group and encourages stiffness. Thus marathon and top standard rock climbing are not easy bed fellows. Circuit training is a classic way of developing endurance but it is perhaps best developed in climbing by repetitive movements: traversing is a good example. If such traversing is done wearing weight belts these should be lightweight, about 12 to 15 pounds and the weight should be as evenly distributed as possible.

(6) Strength

There are many exercises which climbers can undertake to develop strength; pull ups, press ups, sit ups etc. The most easily available piece of apparatus for developing strength is one's own body weight. With another climber there are many additional exercises which can be carried out such as a wheel-barrow, or Indian wrestling. If you have a modern gym with a multi-gym unit available then weight training systems can be utilised.

Generally, light weights and many repetitions of the exercise develop endurance and heavier weights develop strength.

In strength development one must understand the principle of overload. It is only when you are overloading the human muscle system that you are actually gaining in strength. If you can easily carry out 10 sets of 5 pull ups between short rests this is not increasing your strength. However if 10 sets of 8 pull ups shatters you this is doing you more good and 10 by 10 would be better still. The arms should ache, the muscles groan with the strain, but once this is no longer the case, then you should increase the repetitions. You cannot carry out overload exercises every day and you must allow for easier days and days of rest and recuperation.

(7) Speed.

Speed of limb movement can be essential on some modern climbs. Speed characteristics are closely associated with other components, particularly strength and flexibility in the moves which

we call “dynos”. Speed can be trained for, particularly in the reduction of reaction time. Imagine that you are climbing, hanging on, searching out the next moves and your fingers are beginning to open, but there is a jug which you have only just spotted away to the left, only just within reach. You can train both mind and body to act decisively and quickly in such situations by practising and simulating such situations. A way to increase speed of movement is by using short recovery, high repetition work such as squat jumping, quick press ups, and bounding. Plyometrics is the name given to what we do when we dyno and they can be trained for.

(8) Circuit Training/Aerobics

General fitness training using circuits of physical exercises has been with us for a long time. Short sprints, pull ups, press ups, jumps and sit ups done in sequences are common. Aerobic training is a more recent innovation and simply means demanding physical exercise which makes a large oxygen demand on the participants.

In fitness training books one will find circuits specific to many sports and in the book Rockfit there are circuits for rock climbing. You can experiment with these and adapt and change them to suit your own situation. You do not need a gym and you can even work out circuits of exercises in your own home and you can do aerobics in your front room to a tape if you are so minded.

(9) Specificity

Training must be tailored to the specific needs of the individual and be applicable to climbing. If you are poor at balance climbing put effort in in that direction. If you are weak on roofs, plug away at them (but not with a bolt kit). Are you useless at mantle shelves? Keep pressing up. This is the way to improve.

(10) Injury and how to avoid it.

So many of our leading climbers are becoming injured due to damage to tendons, ligaments, and muscle tissue that one is forced to conclude that much of what we have been doing is wrong. We do not warm sufficiently; we train for too long at high intensity; we overload too often. Some climbers are going to climbing walls for all day sessions. They are doing six and eight hours per day and during this time the finger and shoulder joints are being constantly overloaded. They will not be able to cope if this happens regularly and serious damage can result.

If you are injured ease off immediately. Get advice, and here you will need specialist help, for your G.P. will most likely not know much about tendon injuries to the fingers, arms and shoulders. If you are badly injured you need to go to a Sports Injuries Clinic and will have to be referred there by your G.P. When you can start to climb and train again start at a very low level of intensity and work slowly back up to your maximum.

(11) Young climbers

Be careful not to overtrain. Avoid using weights to overload with, in pull ups, use your body weight only. Do not try to train on heavy weights, but concentrate on flexibility training. When you are very young you are the most flexible you will ever be and if you work at this you will retain much of this into adulthood. Young people need more rest and more protein but are usually able to keep fit by such activities as cross country running, orienteering, jogging, and school games. These build

endurance which provides a firm base for intensive training when older, by which is meant after 16 or 17 years of age, when you have more or less finished growing. Remember that any training must be seen as a long term undertaking. Unless you are specially gifted it will take a long time to yield results.

(12) Older climbers

Perhaps older climbers for whom training may be a dirty word and a foreign activity should reconsider their position. If you do begin, start gradually, ever so gradually and at the very least it should make you feel better if you are sitting at a desk eight hours each workday. Climbing is undoubtedly the best training for climbing but in future the highest levels of difficult climbing will probably demand more from the human body than climbing solely on a crag can develop. At lesser levels being fit at the start of our short summer season will help you to get the best out of that rare sunny day.

(13) Relaxation and Mental Preparation

Few climbers practise such skills but more and more in sport relaxation techniques, meditation, autogenic training and visualisation are being used. A book could he written on these aspects, of training alone and for instance in meditation there are 42 different methods of using this to progressively relax. Autogenic training is almost a form of self-hypnosis and it is extremely effective in relaxing the mind and the body.

Visualisation is perhaps something that climbers can usefully learn to use. You can use these techniques to prepare to climb, by imagining the moves and rehearsing them mentally. You can also use this technique to relax by imagining that you are somewhere enjoyable or restful, such as down by a river mid-week.

You must warm up mentally for climbing in just the same way that you warm up physically. People often fail on problems or climbs just because their mental approach has been negative. A progressive build up to what is for you a real "mind bender" of a problem is a good way to tackle it. Start with easy problems, then more difficult, still more difficult, until you confront your ultimate.

Finally,

always remember that training like climbing should be fun. Do not get obsessive about it. If you miss a session or are injured there is always tomorrow. It is a real hare and tortoise situation, and it cannot be stressed too strongly that you will not become a good climber simply by training in a gym or following aerobic and circuit training programmes. Training for rock climbing should be seen as an adjunct to the sport, something which can add benefit and interest to rock climbing activities. It is not a substitute for the real thing and given the chance of a training session or actually going climbing on a crag then the best advice is to go climbing. AIways.....!

HEALT EDUCATION OF THE MEMBERS OF THE CZECHOSLOVAK MOUNTAINEERING ASSCOCIATION: ORGANIZATION, METHODS, AND EFFECTS

I. Rotman, T. Skřička, J. Tomčala; Czechoslovak Mountaineering Association, ČSSR

Abstract

The Czechoslovak Mountaineering Association (13,505 members in 313 alpinist clubs) is one of the sports organizations of the Czechoslovak Union of Physical Education (ČSTV – Československý svaz tělesné výchovy). The ČSTV is formed of the Czech and the Slovak Unions of Physical Education and associates 2,022,577 people (17.7% of the population) interested in various sports and physical culture activities.

Organizational structure of methodological activities in the Czechoslovak Union of Physical Education

C E N T R A L & T E R R I T O R I A L B O D I E S	
operational	*advisory*
Central Committee	Scientific Council Medical Council other councils and commissions
Czech / Slovak Central Committee	Scientific-Methodological Councils Medical Councils other councils and commissions
Regional Committees	Methodological Commissions Medical Commissions other commissions
District Committees	Methodological Commissions Medical Commissions other commissions
Physical Education Clubs	Specialists in methodology Medical officers

S P O R T A S S O C I A T I O N B O D I E S	
operational	*advisory*
Czechoslovak Mountaineering Association – Central Committee	Methodological Commissions Trainer Councils Medical Commission other commissions
Czech / Slovak Mountaineering Association – Central Committees	Methodological Commissions Trainer Council Medical Commissions other commissions
Regional Committees Mountaineering Association	Medical Commissions… other commissions
District Committees Mountaineering Association	Medical Officers… other commissions
Committees of Mountaineering Clubs	Specialists in methodology Medical officers

The growing popularity of mountaineering in Czechoslovakia in recent years has resulted in a high number of injuries. Although mountaineering does not appear among the sports with the highest accident rate (approximately 1%), the high number of injuries includes serious ones: each seventh being fatal.

Therefore the programme of education and training of climbers and mountaineers is of great importance. The Committee of Czechoslovak Mountaineering Association with its specialist bodies, in particular methodological and medical commissions, are the responsible organizers. The education and training in basic and advanced mountaineering knowledge and technical skills are provided by instructors in alpinist clubs.

Instructors of the fourth class reach rock climbing for beginners; third class, climbing in mountains in summer conditions; second class, winter mountain climbing, and the first class, climbing in mountains with glacier regions. Medical doctors are in charge of teaching First Aid and hygiene for ordinary mountaineers, and their instructors. An extramural course for first class instructors in mountaineering lasts two years (430 hours);, second class instructors go through a two-week course (inclusive of 10 days in the High Tatras); third class instructors have a 7 day course in the High Tatras; and fourth class instructors a 3-day in a region wind sandstone of other or other minor rocks.

Health care and education in mountain climbing is very important above all from the point of view of safety and injury prevention. The health activities of both voluntary and professional sanitary services in mountaineering include regular preventive medical examination, protective vaccination, rehabilitation, and health education.

MAIN TASKS 0F THE MEDICAL COMMISSIOMS OF THE MOUNTAINEERING ASSOCIATION

1. ORGANIZATIONAL AND METHODOLOGICAL GUIDANCE

of medical commissions on lower association levels

- collaboration with territorial medical councils and commissions and with the state health care service (departments of sports medicine
- education of club medical officers
- control of observance of health rules for sports activity

2. COLLABORATION WITH OTHER ADVISORY BODIES OF COMMITTEES

especially with commissions for methodology, training, safety, sport gear, competition, youth etc.

3. ACCIDENT PREVENTION

Records and analysis of accidents, collaboration with the Mountain Rescue Service, accident prevention measures

4. SPORT HYGIENE EDUCATION

5. HEALT EDUCATION

of members, instructors, trainers, and functionaries in First Aid, somatology, physiology, and accident prevention

METHODS OF HEALTH EDUCATION

CLASES AND COURSES FOR MEDICAL OFFICERS, TRAINERS AND INSTRUCTORS
LECTURES FOR MEMBERS AT ALPINIST CLUBS
CONFERENCES ON ACCIDENT PREVENTION
CIRCULATION OF INFORMATION SHEETS ("METHODOLOGICAL LETTERS")
ARTICLES IN MOUNTAINERING PERIODICALS AND JOURNALS

INFORMATION SHEETS ON MEDICAL PROBLEMS AND ACCIDENT PREVENTION: TITLES ISSUED

1978 Danger in the Mountains
Climbing Areas in Czechoslovakia. Geology.
1978 Belaying in Mountaineering
All-round Training for Mountaineers
Education and Training Methodology for Beginners
1977 Belaying in Mountaineering
Education of Mountaineering Youth
1980 Basic Training for Beginners in Mountaineering
Accidents and Accident Prevention
Acclimatization and Mountain Sickness
1981 Inflammatory Disease of Climbers' Fingers
1988 Frostbites and Hypothermia in Mountaineering
1983 Grounding in Hygiene for Mountaineering Instructors (1st ed.)
1984 Safety Principles in Mountaineering (1st ed.)
1985 Proceedings of UIAA Medical Commissions Conferences, 1984
Proceedings of Conference on Accident Prevention, 1984
Grounding in Hygiene for Mountaineering Instructors (2nd ed.)
1986 Proceedings of Medical Commissions Conferences, 1985
Grounding in Hygiene for Mountaineering Instructors (3rd ed.)
Safety Principles in Mountaineering (2nd ed.)
Solo Climbing
1987 Proceedings of Medical Commissions Conferences, 1986
Mountaineering - A Basic Training Programme
1988 Proceedings of Medical Commissions Conferences, 1987
Health Risks in Contemporary Mountaineering

PSYCHOLOGY FOR MOUNTAINEERS

Pavel Veselý; Medical Commission of the Czech Mountaineering Association, ČSSR

Abstract

Psychology of mountaineering is a rather attractive topic and therefore often taken up. The frequently posed question: "Who is a mountaineer?" to the mountaineer really means: "Who am I?" Now, this is a question that has interested, interests and will interest everyone at all times. Although it is nice and of paramount importance to dwell in the spheres, the high altitude of the human spirit, it can hardly provide useful help to a mountaineer in his coping with obstacles encountered in the mountains. It leads to reflexion, self-reflexion, and the necessity to analyse the quality of the reflecting mirror. As far as a mountaineer up there in the mountains is concerned, quite the opposite is needed. Let us leave to him who he is, but let us try to explain to him how he can benefit from some knowledge of the psychology and training of self-control. I propose that a training programme such as "psychology for mountaineers" is what waits to be formulated and what should offer an interesting inspiration to a mountaineer's independent mind.

Introduction

Great changes in mountaineering have come about during recent years. Among the heretofore rather homogeneous population of mountaineers, two extreme groups have appeared:

- HIGH ALTITUDE CLIMBERS (above 800 m w/o oxygen), exposed to a risk of sudden indisposition often leading to fatal accidents;
- ROCK CLIMBERS, prone to ruin the working capacity of their hands if they unwisely overstrain them.

The difference between both groups and the rest of the community, i.e. the ordinary mountaineers, lies in a predisposition for the strenuous task that stems out of the biotype of these outstanding climbers.

This in the case of high altitude climbers is the physiological capacity to cope with hypoxia and other adverse effects of conditions at extreme height, and for rock climbers it consists of anatomical proportions, quality of the mesenchymal tissues and next to acrobatic coordination.

This means that high performance in mountaineering is a top sports activity conditioned by inborn prerequisites of an almost professional character and therefore can no longer be achieved by compensatory complementation of skills, strength and intelligence as it used to be before.

For numerous ordinary mountaineers, however, climbing and mountaineering still remain more of a sportsmanship and endeavour than a sort of professional sport. The reason lies very deep. It is an intrinsic reward, a satisfaction from one's own existence, that climbing experience brings, sometimes at the life-and-death border. It does not matter that this border lies at a different place for everybody. Viewed in this way, it is reminiscent of the old-time style of proving one's maturity, in fact the right to exist.

A proposal

For these reasons it seems that for a climber it now becomes more pressing not only to acquire the proper physical and psychic skills necessary for overcoming obstacles in rocks and mountains, but also to be able to recognise his/her propensities and limitations granted or imposed by his/her own inherited biotype. Now, this, in my opinion, can only be achieved by improved education and training with this involving the critical study of some heretofore unusual subjects and thus representing a new extension of the climber's training scheme.

Such a programme as it is described in Table 1, I suggest, could increase safety in the mountains. For beginners, by making them better understand their motives. For ordinary mountaineers by providing new hints in self-control and thus improving responses to critical conditions. For top climbers, it might offer interesting comparison with their own experience and perhaps assist in formulating their contribution to the psychology for mountaineering.

Table 1. Basic concepts of a programme of psychology for mountaineers

Topic:	**Content:**	**Method:**
Knowledge About oneself	Human body, biotypology, identification of one´s own biotype & motivations	Study & Meditation
Prevention	Safe and efficient Training & regeneration	Study & Experimentation
Self-control	I n d i v i d u a l l y : Relaxation (also during Climbing), concentration, Meditation & mental activation to improve self-confidence; self-command, autosuggestion, "das "Autogenic Training" & yoga	Study & Training
	S o c i a l l y : formulation of ideas, planning, rules of communication and resolution of conflicts for improvement of sociability	Study & Disputation

Conclusions

These new dimensions in alpinism and the new requirements stemming from them might also represent a contribution of mountain experience to mountaineer's ordinary life. It would upgrade the level of the ancients' examination of maturity through teaching how to recognise one's own possibilities and limits. It would furthermore bring in its wake a better comprehension of other people and their situations, and in this way it would contribute to improved sociability on the whole.

Acknowledgement

The author wishes to thank Dr. Slavomír Hájek for excellent linguistic cooperation.

THE PSYCHOPHYSICAL TRAINING OF ALPINISTS IN THE PROCESS OF THEIR PREPARATION FOR EXTREME SITUATIONS

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First of all there is a need to define more exactly what situations in alpinism should be referred the extreme ones. Strictly speaking, alpinism may be considered as work performed by a human organism under extreme conditions. We are most likely interested only in those situations and work in such conditions as can lead to death or a serious damage of health. So we are interested not in the environmental health hazards but in such a complex of external and internal factors that in the long run lead to a considerable decrease of a human adaptability to some concrete situation. Therefore it is essential to pay attention not to modelling of all possible hard environmental effects, but to the development of a heightened capability of quick adaptation in any unfavourable condition during the preparation to extreme situations.

The preliminary modelling of the possible extreme situations faces not only technical difficulties but also difficulties of a psychological character: it is hardly possible for a working alpinist-sportsman to desire to train himself, for example, to endure “a cold night”. During the training the sportsmen willingly work in certain unfavourable situations that could arise on the forthcoming route (the peculiarities of relief, influence of altitude, climatic conditions), but there should be one obligatory condition – such modelling of forthcoming difficulties should be carried out under possibly favourable situations, for example the most difficult relief must be combined with good weather or bad weather with easy relief etc. Any efforts aiming at complete and most accurate imitation of extreme situations encounter conscious or unconscious protest on the parts of the examiners and the author sympathizes with them.

Therefore the task of a coach, a doctor and a psychologist is to work out such a method of training a preparation of sportsmen for extreme conditions that would help to develop the body potential for adaptation without exposing it to the direct influence of the unfavourable factors. The present system for alpinists in the USSR on the whole satisfies these requirements and includes training physical endurance, learning the theoretical norms of survival, analysis of the accidents that happened during a year, with the mistakes and infringements of safety rules that led to these accidents. Undoubtedly this part of a training course of the preparation for extreme situations is a basic one and must be necessarily included in training programmes for all alpinists. However, this programme is quite adequate for beginners, but alpinists of the middle and high grades feel a deficit in supplementary methods that would better help to prepare them for possible extreme conditions.

In analyzing the present methods suitable for this purpose, the author has come across the idea that using some elements of the yoga system would be quite helpful. First of all the main principle of the yoga system – the human body functioning under hypoxic conditions – corresponds best of all with alpinism where the hypoxia is the source of practically all difficulties that arise under the extreme conditions. The second yoga principle – work of the human body in a regime of maximal energy economy also corresponds finely with the main principle of the survival under extreme conditions. The ability to regulate at least some physiological processes of the body by the force of the will is also quite a tempting perspective for alpinism. Of course, the training of middle- and high-grade alpinists using the elements of the yoga system could hardly solve all problems connected

with the survival in extreme conditions, but the knowledge of some practical methods of psychophysical regulation worked out by European doctors on the basis of the yoga system could be of real help in such situations.

It is not the aim of this report to present a concrete method or a complex of exercises for the development of body abilities for adaptation but only to draw attention of coaches and doctors of alpinist clubs to the possibility of using some non-traditional methods of the psychophysical training for this purpose. Nevertheless, J would like to give as an example illustrating everything mentioned above, one of the exercises for psychophysical training worked out by the French doctor L. Ferrer which is of direct interest for the training of alpinists.

The exercise is based on the different physiological effects of colours of the spectrum on the excitability of the nervous system (red colour excites, blue calms etc.). A person should sit down comfortably, relax and breath easily and feely. At a distance of 1.60 cm from eyes, a brightly red screen is placed and for 30 seconds the eyes should be concentrated on it with such attention as is devoted to reading of a report whose content you want to remember for ever. Then the person closes his/her eyes and tries to hold the coloured image in his/her mind. As soon as the image vanishes the person opens his/her eyes and intensively looks at the screen for some seconds. And then closes the eyes again. The exercise is repeated for 2 minutes. The work proceeds in the same way with the other colours of the spectrum. When the person can visualize the image of any colour of the spectrum in his mind at his will, he begins to try visualizing it in different parts of his body. For example, the visualization of the blue colour in the region of an injury reduces the feeling of pain up to complete anaesthesia; visualization of the brightly red colour in the region of the navel gives the feeling of a burst of energy and arouses the "reserve" energetic abilities; the visualization of green colour in the whole body helps to speed up the process of rehabilitation during rest. No doubt the effectiveness of such psychophysical training depends to a great extent on the individual characteristics of the person under but his resistance and the time spent on the training will also play an important role. Experience shows that any alpinist when he is high up in the mountains has enough time to learn and use this method, which is not so difficult.

TRAINING OF PEAK PERFORMANCE AND PREVENTION OF INJURIES IN SPORT CLIMBING

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Abstract

The performance of sport climbers increases from year to year. Unfortunately injuries are concomitants, especially those resulting from general overuse of upper extremities. They have become well-known because of their terrible extent, which has been described by several examinations from CSSR, Austria, France, Germany, Spain and Switzerland. The dominant reasons for such sport injuries are in most cases based in the very incorrect preparation (training) of the climbers.

On the sample of a group of 12 sport climbers (5 climb to 10th UIAA-degree; mean of the group 9^- (9) at Berne – trained by the author since 1984 – it is shown that peak performance training can increase the climbing performance with much less or even no injuries.

The most important features of training are:

- explanation of the plan of training, principles of training, theory of training; procurement of the sport medical background for all athletes;
- training control of the athletes, training diary and medical control;
- large number of forms of training, variability of training intensity, training units, training duration, type of training, etc.;
- special wooden beam developed for finger training, based on functional anatomical analysis;
- measures for regeneration;
- training of tactics and techniques.

The experience with such specific training showed that injuries can be reduced to a minimum, while the mean performance of the group increased by about 2 degrees in 4 years. Therefore, it is possible to say: Correct training is the best prevention of injuries.

Introduction

For the last about ten years there has been a considerable increase in the performance of sport climbers, often from the sixth to the tenth degree. During this time most of climbers have developed a very impressive arm and finger power. But if you look behind the stage, you see the real problems of more than ninety per cent of all sport climbers: injuries are unfortunately concomitants, especially those resulting from general overuse of the upper extremities. They have become well-known because of their terrible extent, which has been described following several examinations made in CSSR, Austria, France, Germany, Spain, and Switzerland.

The problem of injuries can be reduced almost completely to one single point: the ignorance of sport climbers, which is rooted in their poor knowledge about training. So far, in most cases, there are no coaches who are able to help climbers increase their limit performance. So climbers think training only makes sense if, their training grips are like grips at the rocks: very very small. The result is too monotonous and too intensive finger load on rock and force training with high non-physiologic finger loads such as hyperextension in the distal finger articulations.

However, training methods have changed. Today we know that competition intensity (hard rock climbing) has to be different from optimal training intensity to prepare one for peak performance.

The example of a group of 12 sport climbers (5 climbers climb the 10^{th} UIAA degree; mean of the group: 9^{-} / 9) at Berne – trained by the author since 1984 – shows that peak performance training can increase climbing performance with much less or even no injuries.

On the example of exercise and training methods for finger training, it will be shown how climbing training using the latest knowledge of sport science should be done.

Exercise for Finger Training

First of all we use more than 16 different finger exercises in order to have the training variable and not monotonous. These exercises result from an anatomic analysis of the mechanical load on the locomotor system of fingers in sport climbing.

There are exercises for the flexion and extension of the hand wrist and one for pronation and supination of the hand. Also used is single finger training: the climbers are hanging during this exercise only by the distal, medial, or proximal phalanges of one finger. The profound finger flexor muscle is trained. One of our climbing athletes is able to pull more than 900 Newton in this way; he has a body weight of 65 kg.

Special grips have been constructed to train intermuscular coordination to be as effective as during boulder training.

A wooden beam has been developed for finger training of climbers. It is based on a functional anatomic analysis so as to train in the best physiological way the different finger and forearm muscles. It has seven different grip positions. It is important that the individual finger measurements such as length of finger joints or thickness of fingers are transferred to that beam. The idea is to prevent finger injuries by physiological positions of finger and hand articulation tendons and tendon sheaths. The load is distributed to all structures of the hand and not on to two or a single finger.

After this training beam has been tested for four years in our training group at Berne, the experience shows that not only finger injuries can be reduced to a minimum but also the dysbalance in local finger muscle force – for example between the profound and superficial muscles – can be compensated and finger force enhanced much better than with other training exercises.

Methods of Training

Besides these exercises the methods of training are very important. We use nine different methods to ensure variable and not monotonous load intensity.

The illustration (Table 1) shows that we use a periodic system of methods to increase finger force.

hypertrophy	hypertrophy + intramuscular coordination	intra + intermuscular coordination	eccentric
10	2	6	2 weeks
anaerobic non – lactic training			
anaerobic lactic training			
global aerobic training			
local aerobic training			
regeneration			

Tab. 1. Periodic System of Training Methods to Develop Maximal Force and Force Endurance

First we build up the base for maximal force by ten weeks´ training for muscle hypertrophy. The single muscle fibres and myofibrils become thicker and anaerobic non-lactic metabolism increases. This method of hypertrophy training in combination with the use of our training beam is the essential precondition for developing the maximal force.

A two week period of combined hypertrophy and intra muscular coordination training is followed by a six-week period of intra and intermuscular coordination training and a two week period of eccentric training. The ability of recruitment and the synchronous activation of muscle fibres should be trained by these highly intensive methods. Furthermore, the metabolism of ATP and CP should be activated and improved.

During these twenty weeks we also use other training methods: Anaerobic lactic acid training leads to a high glycolytic metabolism, resistance against pain, and better buffer effect in cells and blood for a later beginning acidosis. Local and global aerobic training aims at a better ability of regeneration between trainings, climbing, or competitions. They increase the force endurance determined by aerobic metabolism and morphological compounds like volume of mitochondria, type I, IIc and IIa-fibre-area, capillary network, etc.

Other Factors of Performance

Besides exercises and methods of training, further important points based on our training experience are:

- explanation of the plan of training, principles of training, theory of training, as well as sport-scientific and sport-medical background for all athletes;
- training control of athletes, raining diary and medical control; a large number of forms of training, variability of training intensity, training units, training duration, types of training, etc.;
- provision for regeneration;
- training of tactics and techniques.

Conclusion

The experience with the above-described specific training exercises and methods – only a small part of that training could be documented in this paper – has shown for all twelve of the climbing athletes a significant reduction in finger injuries while the mean performance of the group increased by about two degrees in four years. As a result of our experience it is possible to say: appropriate training is the best prevention of injuries. Additionally, long-time planning of peak performance is a much easier way for avoiding injuries.

CONCLUDING COMMENT

I would like to thank the Organizing Committee of the meeting of the UIAA Medical Commission in Prague for the very good work they have done.

For the first time a meeting of our commission could be organized in an Eastern country and this gave the opportunity to many delegates and other interested persons of Eastern countries to join the meeting and compare their data to these of delegates from Western countries. This also gave the possibility just to meet and know the people. This is a very important progress and I hope that it will be possible in the future to meet more often.

Being the secretary of the International Society for Mountain Medicine, I would like to use the opportunity to inform the assembly that our Society wishes to become the meeting point of all scientific interest related to mountain medicine. We publish a semestrial journals as a supplement book of the "International Journal of Sports Medicine" and I would like to invite all interested people to send us papers of good scientific level that could be published in our review. For further information write to:

International Society for Mountain Medicine
The Secretary General
Clinique Générale
1950 Sion Switzerland

Again, thank you very much to the Organizers and all the speakers for this very good congress

Fréderic DUBAS, M. D.
International Society for Mountain Medicine
General Secretary

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CZECHOSLOVAK MOUNTAINEERING ASSOCIATION
of the CZECHOSLOVAK UNION OF PHYSICAL CULTURE (ČSTV)

Medical Commission

Medical Commission

Mountain Medicine Conference

MEDICAL ASPECTS IN MOUNTAINEERING

PROGRAMME & ABSTRACTS

PRAGUE, CZECHOSLOVAKIA, 20 – 22 OCTOBER 1988

U I A A M O U N T A I N M E D I C I N E C O N F E R E N C E

PRAGUE, Czechoslovakia, 20 - 22 October 1988

MEDICAL ASPECTS IN MOUNTAINEERING

Organized by the

CZECHOSLOVAK MOUNTAINEERING ASSOCIATION
of the CZECHOSLOVAK UNION OF PHYSICAL CULTURE

and the

MEDICAL COMMISSION
of the INTERNATIONAL UNION OF ALPINIST ASSOCIATIONS

Under the Sponsorship of the

CZECHOSLOVAK SOCIETY OF SPORTS MEDICINE
of the J.E.PURKYNĚ ASSOCIATION OF CZECHOSLOVAK MEDICAL SOCIETIES

and

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U I A A M O U N T A I N M E D I C I N E C O N F E R E N C E

MEDICAL ASPECTS IN MOUNTAINEERING

PRAGUE, Czechoslovakia, 20 - 22 October 1988

Friday 21st October 1988

Location of the Conference:
UNIVERSITAS CAROLINA, CAROLINUM BUILDING
Entrance: BUQUOYSKÝ DŮM, UNIVERZITA KARLOVA,
20, Celetná street, Praha 1
(UK KAROLINUM on Plan of City Centre: E4-E5; Town Plan: F8)
Nearest underground station: MŮSTEK, lines A and B

07.30 - 08.30 REGISTRATION, CAROLINUM BUILDING

08.30 OPENING

J. Wolf, Vice-President of U.I.A.A.,
Welcome Address

Ch. Clarke, President of the
U.I.A.A Medical Commission

M. Máček,
President of the Czechoslovak Society of Sports Medicine

T. Skřička,
Chairman of the Conference Organizing Committee

09.00 - 12.00 CLIMBERS' ACCIDENTS AND INJURIES

Chairmen: J. Wolf, Ch. Clarke, L. Radlinger

09.00
INCIDENCE, ANALYSIS AND PREVENTION OF MOUNTAIN ACCIDENTS
F. Berghold, E. Rabofsky (Austria)

09.10
EPIDEMIOLOGIC ANALYSIS OF CLIMBERS' INJURIES BASED ON DATA FROM THE RESCUE REPORT REGISTER OF GORSKA SLUŽBA SPASAVANIJA (MOUNTAIN RESCUE SERVICE) OF THE MOUNTAINEERING ASSOCIATION OF SR CROATIA, YUGOSLAVIA B.Aleraj (Yugoslavia)

09.20
MOUNTAIN ACCIDENTS IN THE ENGLISH LAKE DISTRICT
M. Townend (England)

09.30
CAUSES AND STATISTICAL ANALYSIS OF ACCIDENTS IN THE AUSTRIAN ALPS E. Jenny, M. Burtscher (Austria)

09.40 THE INCIDENCE OF ACUTE MOUNTAIN SICKNESS IN TREKKERS ON THORONG-LA (5400 M), NEPAL B. Kayser (Netherlands)

09.50
HIGH ALTITUDE CEREBRAL OEDEMA Ch.Clarke (Great Britain)

10.00
BRAIN DAMAGE AND HIGH ALTITUDE Z. Ryn (Poland)

10.10
AN ANALYSIS OF THE DEATHS ON K2 IN 1986 B.L.Holt (England)

10.20
SOME MEDICAL PROBLEMS CONNECTED WITH POLISH EXPEDITIONS TO THE HIMALAYAS AND KARAKORUM J. Serafin (Poland)

10.30
A NEW ETIOPATHOGENIC AND CLINICAL-DEVELOPMENTAL CLASSIFICATION OF LOCALIZED INJURIES DUE TO THE ACTION OF COLD
J.R.Morandeira, G.Martinez Villén, R.Arregui, F.J.Senosiain (Spain)

10.40 - 11.00
C o f f e e a n d P o s t e r D i s c u s s i o n

DEATHS DURING MOUNTAINEERING AT EXTREME ALTITUDE
A.Pollard, Ch.Clarke (England)

FATAL ACCIDENTS IN CZECHOSLOVAK MOUNTAINEERING
I.Rotman (Czechoslovakia)

INJURIES AND SECURITY IN THE MOUNTAINS
K.Gurský (Czechoslovakia)

LIGHTNING INJURY IN MOUNTAINEERING
E.Ehler (Czechoslovakia)

HEALTH COMPLAINTS AND FINGER DEFORMITIES IN CZECHOSLOVAK SPORT CLIMBERS M.Staněk, I.Rotman, T.Skřička, P.Veselý, J.Hylmarová, J.Bušík, J.Říhová, M.Novotný, M.Třináctá (CSSR)

11.00
PATTERNS OF SOFT TISSUE INJURIES IN EXTREME ROCK CLIMBING
R.S.Bollen (England)

11.10
CLIMBER'S SPECIFIC TRAUMATIC PATHOLOGY DUE TO GEAR
G.Martinez Villén, R.Arregui, J.R.Morandeira (Spain)

11.20
ETIOPATHOGENESIS OF OVERUSE INJURIES OF THE HAND IN EXTREME ROCK CLIMBERS
I.Rotman, M.Staněk, T.Skřička, T.Havránek, D.Zicha, P.Veselý (Czechoslovakia)

11.30
OSTEOARTHRITIS IN CLIMBERS' FINGERS R.S.Bollen (England)

11.40
OVERUSE SYNDROMES IN MOUNTAINEERS J.Serafin (Poland)

11.50
GENETIC ASPECTS OF CONNECTIVE TISSUE CHANGES CAUSED BY EXCEEDING STRAIN IN SPORTS CLIMBERS: THE PROBLEMS OF CONTROL AND PROGNOSIS
B.P.SOKOLOV (USSR)

12.00 - 13.00 L U N C H T I M E

13.00 - 15.50
PROBLEMS WITH LABORATORY ASSESSMENT OF A CLIMBERS' TOLERANCE OF EXTREME HEIGHTS AND POSSIBILITIES OF ON-THE-SPOT TESTING OF THE CLIMBERS' PHYSIOLOGICAL FUNCTIONS

Chairmen: T.Skřička, P.Bernett, D.Gray

13.00
OVERVIEW OF CONTEMPORARY MOUNTAIN MEDICINE
Ch. Clarke (Great Britain)

13.10
INDIVIDUAL SUSCEPTIBILITY TO HYPOXIA A.N.Krasjuk (USSR)

13.20
THE THERMOREGULATION UNDER CONDITIONS OF HYPOXIA
P.V.Beloshitsky (USSR)

13.30
DETERMINANTS OF ACCLIMATIZATION AND PERFORMANCE IN HIGH ALTITUDE EXPEDITIONS
J.-P.Richalet, P.Bouissou, J.-P.Herry, A.Kéromes, P.Larmignat, C.Rathat (France)

13.40
HIGH ALTITUDE EXPEDITIONS WITH AND WITHOUT A DOCTOR: POSSIBILITIES FOR TESTING PHYSIOLOGICAL FUNCTIONS AND MEDICAL ASSESSMENT ON THE SPOT
J.R.Morandeira, G.Martinez Villén (Spain)

13.50
EFFECT OF ACUTE HYPOXIA ON EXERCISE-INDUCED HORMONAL AND METABOLIC RESPONSE
V.Stich, J.Zelený, A.Veselková, R.Mader (Czechoslovakia)

14.00
CHANGES OF SELECTED PHYSIOLOGICAL FUNCTIONS IN SAGARMATHA 1984 EXPEDITION MEMBERS UNDER MODELLED CONDITIONS IN PRESSURE CHAMBER L.Hubačová, I.Borský, B.Líška, M.Palát, F.Strelka, G.Kováč (Czechoslovakia)

14.10
THE ALPINIST'S DREAM LAND Z.Ryn (Poland)

14.20
MEDICAL MOUNTAINEERING EXPEDITION PAMIR 1988
L.Laho, M.Kováč, V.Zábrodský, M.Krajčovič, S.Dluholucký, E.Bielik, B. Švecová, K.Kralinský, J.Bulejčík, J.Lehocký, P.Dedič (Czechoslovakia)

14.30 - 14.50 C o f f e e B r e a k

14.50
RESULTS OF CONTINUOUS SURVEILLANCE OF HEALTH, TRAINING CONDITION, SPORT MOTOR CHARACTERISTICS AND ACCLIMATIZATION TO ALTITUDE IN MOUNTAIN GUIDES OF THE AUSTRIAN ARMY E.Jenny (Austria)

15.00
MENTAL AND GYNAECOLOGICAL PROBLEMS IN MOUNTAINEERING WOMEN
J.Semotán, Z.Klapálková, J.Karpinská,M.Semotánová, (CSSR)

15.10
METABOLISM AND FLUID BALANCE IN MOUNTAINEERING AND CLIMBING
F.Berghold (Austria)

15.20
ATRIAL NATRIURETIC PEPTIDE AND ACUTE MOUNTAIN SICKNESS
J.S.Milledge, J.M.Beeley, A.Morice (England)

15.30
THE ROLE OF THE THROMBIN-PLASMIN SYSTEM IN BODY ADAPTATION
V.A.Monastyrsky, A.Z.Romaniv, I.I.Birka, M.I.Voronyak, N.V.Birka (USSR)

15.40
VARIATIONS OF PLASMA BIOCHEMICAL PARAMETERS IN ALPINE SKIERS
R.M.Candeago, M.Nardin, A.Sommavilla, G.Angelini (Italy)

15.50
A CASE OF ACUTE EROSIVE GASTRITIS WITH SHOCK AND SEVERE ANAEMIA DURING GASHERBRUM I AND II EXPEDITION G.Gaffuri (Italy)

16.00
THE USE OF PLATELET ANTIAGGREGANTS IN HIGH ALTITUDE PATHOLOGY: AN ORIGINAL EXPERIMENT IN ANNAPURNA I (8091 M)
G.Martinez Villen, R.Arregui, J.R.Morandeira (Spain)

16.10
FEATURES OF PSYCHIC CHANGES IN TRAINED MOUNTAINEERS AT HIGH ALTITUDE T.A.Volkova (USSR)

16.20 - 16.40
T e a a n d P o s t e r D i s c u s s i o n

THE ACTIVITIES OF THE MOUNTAIN RESCUE SERVICE IN CZECHOSLOVAKIA
I.Miko (Czechoslovakia)

PSYCHOLOGY FOR MOUNTAINEERS
P.Vesely (Czechoslovakia)

HEALTH EDUCATION OF THE MEMBERS OF THE CZECHOSLOVAK MOUNTAINEERING ASSOCIATION: ORGANIZATION, METHODS, AND EFFECTS
T.Skřička, I.Rotman, J.Tomčala (Czechoslovakia)

AN ANALYSIS OF NEUROLOGICAL DIAGNOSIS TO EXTRACT INFORMATION CRITICAL FOR LAYMAN CLIMBERS
Z. Konrád, P.Vesely, I. Rotman (Czechoslovakia)

EFFICACY OF TWO ORIGINAL ANTIHYPERTENSIVE AGENTS IN EXPERIMENTAL PULMONARY HYPERTENSION M. Smíd, I. Helfert (Czechoslovakia)

16.40 - 17.50
EDUCATION AND TRAINING IN PREVENTION OF OVERUSE SYNDROMES AND IN TACKLING EMERGENCY SITUATIONS

Chairmen: K. Gurský, E. Gippenreiter, Z. Ryn

16.40
INTRODUCTION TO THE THEME
T. Skřička (Czechoslovakia)

16.50
TRAINING FOR ROCK CLIMBING
D. Gray (England)

17.00
TRAINING OF PEAK PERFORMANCE AND PREVENTION OF INJURIES IN SPORT CLIMBING
L. Radlinger (Switzerland)

17.10
HYPOXIC APPARATUS: EFFICIENCY IN ALTITUDE SIMULATION AND POSSIBLE USES IN MOUNTAINEERS. J. Novák, I. Fibiger (CSSR)

17.20
PANEL DISCUSSION
F. Berghold, Ch. Clarke, D. Gray, M. A. Michailov, I. Miko, L. Radlinger, T. Skřička, P. Veselý, J. Wolf

17.50
CONCLUDING COMMENTS
Ch. Clarke (Great Britain)

CLOSURE OF CONFERENCE
T. Skřička (Czechoslovakia)

The programme is subject to change

LANGUAGE
The official language of the Conference will be English
No simultaneous translation will be provided

PRESENTATION TIME
Owing to the high number of announced contributions, the presentation time has had to be limited to 8 min only. All SPEAKERS are asked to keep within this limit, and carefully consider presentation of their material and select appropriately their slides.

SLIDES
Only 5x5 cm slides will be accepted for projection.
Participants must submit their slides at the Slide Desk 1 hour before presentation at the latest

FULL TEXT OF PAPERS
Please submit a full text copy of each paper for the Proceedings of the Conference at the Registration

INCIDENCE, ANALYSIS AND PREVENTION OF MOUNTAIN ACCIDENTS

F. BERGHOLD, E. RABOFSKY
Oesterreichisches Kuratorium für alpine Sicherheit
1040 Wien, Prinz-Eugen-Strasse 12, Austria

Alpine accident research has been existed for about 100 years. In the beginning, the usual procedure was to discuss and analyse striking, individual cases in order to evaluate the efficiency of recommendations for accident prevention. This method has, however, increasingly been replaced by statistical accident investigation.

INCIDENCE. Alpine accidents demonstrate the epidemiological characteristics of this type of sport casualties and can be found in practically all mountain countries throughout the world. The records provide a survey of events and can be made use of, above all, for developmental observations. They are therefore of great value even if they do not provide any evidence of the risk and the causative accident factors. The main problem of alpine accident statistics lies in the lack of representativity and the so far world-wide unsolved problem of the by-passeffect. With these limitations, providing a statistically accurate method is used, they can nevertherless provide a valuable basis for the proposition of a hypothesis of the causes of accidents.

ANALYSIS. Scientific analysis of an alpine accident and the characteristic course of events always begins with the disclosure and evaluation of the causative factors. After a working through the different steps of various procedures, a causal pattern does eventually appear. Several related patterns are listed together in so-called accidents groups. The superiority of an accurate accident analysis in comparison to statistical listing can be shown by the fact that an alpine accident is always the result of several factors of varying time and locality. These factors cannot be included in the statistics and evaluated there.

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PREVENTION. The results of the methodical accident analysis, based on the scientific principle of interdisciplinarity, permit immediate and practice-relevant prevention concepts to be developed. These methods have been developed and successfully tested for six years at the University of Salzburg. We hope for the future that there will be some valuable contributions towards a better and more effective prevention of mountain accidents.

EPIDEMIOLOGIC ANALYSIS OF CLIMBERS' INJURIES BASED ON DATA FROM THE RESCUE REPORT REGISTER OF GORSKA SLUZBA SPASAVANIJA (MOUNTAIN RESCUE SERVICE) OF THE MOUNTAINEERING ASSOCIATION OF SR CROATIA, YUGOSLAVIA

B. ALERAJ
YU-41000 Zagreb, Prilaz J.A. 73, Jugoslavija

MOUNTAIN ACCIDENTS IN THE ENGLISH LAKE DISTRICT

M. TOWNEND
Cockermouth, Cumbria, Great Britain

The English Lake District is the most compact and easily accessible mountain area in Britain, attracting large numbers of visitors each year. Mountain walking, rock climbing, winter mountaineering and ice climbing are all available.

An analysis is made of the types of accidents attended by mountain rescue teams in the area according to the type of activity being pursued by the victims, with reference to their standards of equipment and experience.

CAUSES AND STATISTICAL ANALYSIS OF ACCIDENTS IN THE AUSTRIAN ALPS

E. JENNY, M. BURTSCHER
Alpine Medical Station of the Austrian Alpine Club, Rudolfshütte, 2315 m, Hohe Tauern, Austria

Since 1985 the Austrian Alpine Club has had the possibility of electronically processing the alpine accident survey of the Federal Ministry of the Interior. The present study primarily deals with a descriptive epidemiology, with occasional analytical approaches. In comparing the total numbers of the accident statistics from 1985 to 1987, fatal accidents sank from 283 to 242 while the total number of those involved in accidents rose from 2532 to 2988. We attribute this tendency to an optimization of rescue operations and emergency medical measures. In the distribution of accidents of 1987 to the various alpine areas, 59% were due to ski-slope accidents. It remains to be considered that the ski accidents registered by the Ministry of the Interior were only those allowing suspicion of negligance by others, or those which ended fatally. Under such circumstances it is understandable that 87 of 100 accidents involved collisions. The second place in the frequency distribution is held by mountain hiking accidents (23%, 697 accident victims) followed by ski touring accidents (7%, 206 victims). 4% (119 victims) were due to rock climbing accidents and 1% each has been registered for ice climbing (27) and glacier tours (29). Paragliding accidents enter the alpiner statistics for the fist time in 1987, at 2% (49). "Tripping, slipping" (75) and "cardiovascular emergencies" (71) are the major causes of fatal alpine accidents (1987: 242). Following these, classified according to frequency, are avalanche fatalities (23), falls and collisions on the ski slope, and crashes with aircraft (hang-gliders, etc.). Accients due to lack of physical condition are more typical for persons at an advanced age, while accidents due to lack of experience and training early show a lower average age on the part of the persons involved.

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The head is the part of the body most liable to injury due to accidents on the ski slope and rock- and ice-climbing accidents. The lower extremities dominate for injuries during ski and glacier tours, hiking and paragliding. While the lower leg and knee are affected the most in skiing, hiking affects the ankle. 25% of all paragliding accident victims suffered vertebral injuries.

Hypothese of effective prophylactic measures, adaptation of the training and equipment of rescue personnel, as well as analytical approaches and experimental investigations must be the necessary consequences and continuation of the present study.

THE INCIDENCE OF ACUTE MOUNTAIN SICKNESS IN TREKKERS ON THORONG-LA /5400 M/, NEPAL

Bengt KAYSER
Himalayan Rescue Association, Nepal

The results of an epidemiological study on acute mountain sickness in trekkers are discussed. AMS was studied in 371 trekkers with the use of questionnaires. This is the first study to describe AMS in trekking over a mountain-pass instead of up and down a valley- or mountain-trail. The questionnaire consisted of two parts, a general part and a measuring part (Environmental Statistical Questionnaire III, Sampson et al '83).

The overall incidence of AMS was 58%. AMS was positively correlated with speed of ascent. AMS was negatively correlated with age, acclimatization and physical condition in the elderly. Women were more often, and more seriously involved than men. AMS was not correlated with size of trekking-groups, previous altitude experience, travel organisation, smoking-habits or use of oral contraceptives.

HIGH ALTITUDE CEREBRAL OEDEMA

Ch. CLARKE
Department of Neurological Sciences
St. Bartholomew's Hospital, London, Great Britain

BRAIN DAMAGE AND HIGH ALTITUDE

Z. RYN
Department of Social Pathology, Krakow, Poland

Long-term psychiatric and psychological research (with EEG, Bender, Benton, Graham-Kendall tests) was carried out in 44 Polish alpinists before, during and after high-mountain expeditions. In 11 persons symptoms of organic brain damage were observed. One could refer to this syndrome as HIGH-ALTITUDE CEREBRAL ASTHENIA (HACA).

I distinguished three forms of HACA: characteropathic, encephalopathic, and neuroplegic. In the first, emotional disturbances prevail; in the second, the prevailing symptoms are those of focal brain damage; whereas in the third form, symptoms of peripheral neurological disfunction (paresis) are predominant.

Adopted as a new clinical syndrome, HACA would broaden our recognition of the pathology due to high-altitudes. HACA constitutes the next step after acute mountain sickness (AMS) and high-altitude cerebral edema (HACE), and completes the pattern as follows: AMS --> HACE --> HACA. In DSM III, there is no equivalent for high-altitude cerebral asthenia. It seems that there is sufficient reason for concentrating on the specific causes and characteristic features of the syndrome, introducing a new name describing the damage done to the brain as an effect of severe and long-term high-altitude stress.

AN ANALYSIS OF THE DEATHS ON K2 IN 1986

B. L. HOLT
Doctor to the British K2 Expedition 1986

During the summer of 1986 nine different expeditions were given permission to climb K2. A total of twelve climbers including Alan Rouse, the leader of the British team, lost their lives in different accidents. An analysis of the deaths is presented by the British doctor, who has specialized in problems of hypoxia and the causes involved. When considered in conjunction with other recent Himalayan climbing accidents, certain conclusions are reached concerning high altitude deaths. In particular the problems of climbing at extreme altitude without oxygen are examined.

SOME MEDICAL PROBLEMS CONNECTED WITH POLISH EXPEDITIONS TO THE HIMALAYAS AND KARAKORUM

J. SERAFIN
Orthopaedic Clinic, Warsaw, Poland

The paper presents data on death accidents, high altitude sickness (HAS) and other general diseases involving risk of life that occurred in the years 1971-1987 during Polish expeditions to the Himalayas and Karakorum.

Within this period 114 expeditions were organised 48 of them to peaks exceeding 8000 m, with 986 alpinists participating.

There were 34 death accidents (3.4%). Another 72 alpinists (7.4%) suffered from serious general disease endangering life unless treated by specialist.

In total, 11% of participants experienced a severe health disorder or died.

The causes of the accidents, HAS and other diseases, as well as questions of prevention are discussed.

A NEW ETIOPATHOGENIC AND CLINICAL-DEVELOPMENTAL CLASSIFICATION OF LOCALIZED INJURIES DUE TO THE ACTION OF COLD

J. R. MORANDEIRA, G. MARTINEZ VILLEN, R. ARREGUI, F. J. SENOSIAIN
Service of Biomedicine and Biomaterials, University of Zaragoza, Spain

Lesions caused by the local action of cold have traditionally been classified in degrees of intensity. The attempt to relate the extent of tissue damage in the depth of the lesions withtheir posterior evolutionary course has led some authors to make diagnostic-developemental classifications. We propose a classification which considers not only these but also etiopathogenic aspects.

In our casusitic material of 97 patients with localized lesions due to the effect of cold we assessed and correlated the etiological, pathogenic, clinical and developmental aspects. These factors show that at very low temperatures and in a dry atmosphere, necrotic lesions, predominantly cryogenic, are produced, with little vasomotor component and few trophical or functional sequels, except for potential amputation in some cases.

With values above 0 ^{o}C, even if very cold, and in a humid atmosphere and under long exposure, mainly deep vasomotor lesions appear, leaving serious functional and trophical sequels. Between these two extremes, there is a series of intermediate mixed lesions.

DEATHS DURING MOUNTAINEERING AT EXTREME ALTITUDE

Andrew POLLARD, Charles CLARKE
UIAA Mountain Medicine Data Centre,
St. Bartholomew's Hospital, London EC1

A study was made of fatalities on British Expeditions to peaks over 7000 metres between 1968 and December 1987 through analysis of reports collected from Mountain Magazine (an international mountaineering journal). There were 83 expeditions (533 mountaineers) with 23 fatalities occurring on 10 of the 51 peaks visited,a mortality rate of 4.3% or one death every fifth expedition. 70% of deaths were caused by mountain accidents. 13% resulted from cerebral and/or pulmonary oedema. In 17% the cause of death remains unknown. This study draws attention to the dangers involved in mountaineering at extreme altitude.

From personal experience and accounts of expeditions it seems likely that in many of the fatalities, apparently from mountain accidents, there were components of misjudgement, disorientation, or exhaustion caused by severe hypoxia. Since, for logistic reasons, the use of supplementary oxygen is limited, mountaineers must take heed of these figures when climbing to extreme altitude.

FATAL ACCIDENTS IN CZECHOSLOVAK MOUNTAINEERIMG

I. ROTMAN
Medical Commission of the Czechoslovak
Mountaineering Association, CSSR

The amount of risk in any sport is determined by the sport activity and the personality of the sportsmen. Climbing and mountaineering represent one of the most dangerous human activities. Despite some increase in the number of fatal accidents, which can be explained by the increase in the number of people at risk, the percentage of fatalities remains at the same level or has even decreased somewhat. During the last 30 years (1958-1987) there have been 265 fatal accidents among the member of the Czechoslovak Mountaineering Association or an average of 9+5 accidents (1-24 deaths) per year. Recent statistics do indicate certain trends: in the period 1961-70, the rate was 2.7%; in 1971-80, 1.2%; and in 1981-87 1.1%.

The cause of each accident is compounded of many factors. Since the classification dividing the causes into different categories (related to the individual, the equipment, the environment) or into so called subjective and objective causes are often misleading, the Medical Commission has proposed to analyse the risk factors in mountaineering (environmental and personnal) and to distinguish strictly between the "mechanisms" and "causes" of accidents. In an analysis of 265 fatal accidents the "mechanisms" in the order of frequency were as follows: falls of climbers (158 cases; 59.6%), entrapment in an avalanche (41; 15.5%), exhaustion and exposure (26; 9.6%), earthquake (14; 5.3%), falling rock (10; 3.8%), and others (lightning, acute mountain sickness etc.). As far as the causes are concerned, inattention, inexperience, fatigue, overestimation of abilities, faulty belay, not wearing a helmet, climbing unroped or alone or in poor weather, inadequate equipment accounted for the majority of accidents (217 cases, 81.9%); falling rocks, earthquake and lightning were responsible for only 34 accidents (12.8%).

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It is concluded that the individual is the main factor, although the equipment and the environment may play roles of variable importance. The preventive measures are mostly of a methodological, educational and organizational character.

INJURIES AND SECURITY IN THE MOUNTAINS

K. GURSKÝ
Department of Sports Medicine
P. J. Šafarik University Prešov, ČSSR

During the period 1980-83 we monitored injuries in the mountains of Slovakia and the share of young people and women. During that period there were 11 807 injuries in winter and 6786 injuries in summer. Very serious attention should be paid for the fact that the highest number of ski injuries occurs during the first five downhills. The male:female ski injury ratio between men and women is 1.7 : 1.

The highest age-specific frequency of injuries was reported up to 20. The most frequent cause of death in mountain climbing was a fall (77.1%), exhaustion and snow avalanche coming next. Subjective failure or mistake was involved in 88.4% of cases.

Taking into consideration that most injuries in the mountains have subjective causes, we suggest that measures be organized at the the levels of the Department of Education of the Czechoslovak Socialist Republic, the Czechoslovak Union of Physical Training, the trade unions, the Socialist Union of Youth, local national committees, recreation centres and interhotels.

We believe that this could decreas the rates of accidents and injuries in men, women, adolescents, and children in spite of the continuing increase in the number of mountain visitors.

LIGHTNING INJURY IN MOUNTAINEERING

E. EHLER, I. ROTMAN
Medical Commission of the Czech Mountaineering Association, CSSR

In a poster demonstration, the physical nature of lightning and the conditions for its origination will be presented. The electric energy of the lightning may cause thermic lesions (burns), ocular injury (impairment of vision), or an electric shock. A stroke of lightning may produce characteristic lesions of the skin, the muscle, the heart (arrhytmias), and the blood vessels (vasomotoric changes). It may also affect the nervous system, causing neuropathies, lightning paralysis, loss of consciousness, and/or cerebral haemorrhage with brain oedema. Biochemically, myoglobinuria with resulting renal failure, increased creatinkinase, and haemolytic jaundice may be observed. Lesions may be noted also on the EEG, ECG, and computerized tomogram of the brain.

During a storm in the mountains, particularly in a mountaineering area, severe injury may be incurred indirectly as well - by a fall, from a pressure wave, or by inadequately acting in a difficult terrain.

The most important measures to prevent lightning injury are to foresee the storm and recognize the actual risk according to the meteorologicasl indications; of course, each mountaineer should be familiar with these. Appropriate action is necessary to minimize the risk of injury during the storm. Finally, the authors present a scheme of adequate first aid and first medical aid in the case of a lightning injury.

HEALTH COMPLAINTS AND FINGER DEFORMITIES IN CZECHOSLOVAK SPORT CLIMBERS

M. STANĚK, I. ROTMAN, T. SKŘIČKA, P. VESELÝ, J. HYLMAROVÁ, J. BUŠÍK, J. ŘÍHOVÁ, M. NOVOTNÝ, M. TŘINÁCTÁ
Medical Commission of the Czech Mountaineering Association, Czechoslovakia

Overuse injuries in the sport climbing result from an imbalance between the load and the tissue tolerance to this load. It is already well established that the prevalence of these injuries in sport climbers' fingers is very high. Especially finger tendons and joints seem to be damaged.

In 1987-1988, 103 climbers (23.5±5.2 years old men surmounting climbing difficulty-grade 8 (UIAA) on an average, free climb from 6 to 10-) were interrogated using a modified anamnestic questionnaire (Bartschi, Radlinger) and subjected to physical orthopaedic examination of the hands.

Only 19 out of 103 climbers (18.4%) had no long-lasting complaints in the upper extremities and/or finger deformities. Fifty-eight suffered from long-lasting pain in fingers; fusiform swellings, nodes and flexion deformities of finger joints were present in 61 out of 84 climbers (72.6%). Ten climbers complained of longlasting pain in the shoulders, 8 in the elbows, 25 in the forearms, and 21 in the wrists.

Eighteen climbers had already been examined in 1987 and the repeated examination in 1988 showed a deterioration of finger damage in 13 (72.2%) of them.

The most affected were the 3rd and the 4th finger, especially the proximal interphalangeal joint of the 3rd finger.

The results support the continued use of these investigation methods not only, to assess subjective symptomatology and development of pathological changes in climbers' fingers due to overloading but also to find out what factors predispose and predetermine the damage, particular attention being paid to the structure, frequency, and intensity of training, genetic and other factors. A study using the Czechoslovak computer program GUHA was carried out for this purpose.

PATTERNS OF SOFT TISSUE INJURY IN EXTREME ROCK CLIMBERS

S. R. BOLLEN
Rheumatism Research Unit, University of Leeds, Great Britain

As climbing standards have rapidly increased in recent years, the recognition and treatment of soft tissue injuries has assumed increased importance. In a survey of 86 climbers, climbing regularly from E1 to E7, approximately 50% of injuries had occurred during training.

Eighty-five per cent injuries affected the upper limb and of these the majority were of the hand and wrist. Overuse injuries were common. Supraspinatus tendinitis, golfer's and tennis elbow and "climber's elbow" (brachial tendinitis) were reported.

The PIP joints of the middle and ring fingers were the commonest site of injury in the hand and seemed to represent flexor digitorum superficialis tenoperiostitis in many cases. Injury to the pulley mechanism of the flexor sheath was another finding apparently unique to the rock climber.

CLIMBER'S SPECIFIC TRAUMATIC PATHOLOGY DUE TO SPORT GEAR

G. MARTINEZ VILLEN, R. ARREGUI, J. R. MORANDEIRA
Service of Biomedicine and Biomaterials,
University of Zaragoza, Spain

The practice of mountaineering as a sport is associated with an important pathology of traumatic origin, enhanced lately by some new complaints, some of them typical of other sports. Of all the possible features, there exists a group of peculiar characteristics which generally appear in climbers.

From a casuistry collected by our group, the following problems related with the traumatological field are analysed: ankle fractures; tenosynovitis in the fingers of the extreme climber and other lesions due to climbing gear, among which those caused by harnesses and grips during glacier progression are prominent (Thomas Morton metatarsalgia).

In this series of complaints a cause-effect relation is seen indicating the significance of a correct preventive attitude as a means of avoiding or minimizing the lesions described.

ETIOPATHOGENESIS OF OVERUSE INJURIES OF THE HAND IN EXTREME ROCK CLIMBERS

I. ROTMAN (1), M. STANĚK (1), P. VESELÝ (1,2), D. ZICHA (2), T. HAVRÁNEK (3), T. SKŘIČKA (1)
(1) Medical Commission of the Czechoslovak Mountaineering Asscociation, Czechoslovakia
(2) Institute of Molecular Genetics, Czechoslovak Academy of Sciences, Prague
(3) General Computing Centre, Czechoslovak Academy of Sciences, Prague, Czechoslovakia

An attempt was made to analyse data on overuse injuries of the hand in 100 Czechoslovak sport climbers taking part in extreme climbing competitions in 1987 (Rotman et al, Davos 1988; see also poster of this Conference - Staněk et al.: Health complaints and finger deformities in Czechoslovak sport climbers) The GUHA (1) method - Package of Programmes for Exploratory Data Analysis, Programme "assoc."was used.

The GUHA programme is an original Czechoslovak approach to uncovering all possible interrelationships in a set of data and defining all significant correlations. GUHA was used with the hope to provide an insight into all possible factors related to the etiopathogenesis of the overuse injuries of the hand. The data collected and used as variables (antecedents and succedents) describe anthropometric parameters, professional and sport activities, modes of training, localization of health complaints, and objective signs of finger damage, e.g. finger deformities, particularly nodes, fusiform swellings, and flexion deformities affecting finger joints in extreme climbers.

The results of this approach will be reported and discussed.

(1). Hájek, P. & Havránek, T.: Mechanizing hypothesis formation - mathematical foundations for a general theory, Springer Verlag, Heidelberg 1978.

OSTEOARTHRITIS IN CLIMBERS' FINGERS

S. R. BOLLEN, A. BOWKER
Rheumatism Research Unit, University of Leeds, Great Britain

Whether the enormous strain put on the finger joints by hard modern climbing predispose to premature osteoarthritis is of concern to many in the climbing world. A pilot study x-raying the hands of 25 of our top climbers is being carried out, comparing their x-rays with matched controls. The results will be published at the meeting.

OVERUSE SYNDROMES IN MOUNTAINEERS

J. SERAFIN
Orthopaedic Clinic, Warsaw, Poland

Fifty-eight cases of overuse syndromes in mountaineers were treated at the Orthopaedic Clinic in Warsaw in the years 1978-1988.

The mechanisms of their development and methods of treatment are discussed.

There were different localizations of pathological changes: metatarsal bones, Achilles tendon and patellar ligament attachments, lumbar spine, sacroiliac joints, shoulder joints, and knee joints.

Histological examinations in 5 cases showed: muscle-fibre fragmentation, proliferation of mesenchymal cells around vessels, necrosis and calcification of collagen fibres, and necrotic changes of bone surrounded by metaplastic connective tissue.

GENETIC ASPECTS OF CONNECTIVE TISSUE CHANGES CAUSED BY EXCEEDING STRAIN IN SPORT CLIMBERS: THE PROBLEMS OF CONTROL AND PROGNOSIS

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OVERVIEW OF CONTEMPORARY MOUNTAIN MEDICINE

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INDIVIDUAL SUSCEPTIBILITY TO HYPOXIA

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Academy of Sciences of USSR, Kiev, USSR

THE THERMOREGULATION UNDER CONDITIONS OF HYPOXIA

P. V. BELOSHITSKY
EMBS, Terskol, USSR

DETERMINANTS OF ACCLIMATIZATION AND PERFORMANCE IN HIGH-ALTITUDE EXPEDITONS

J.-P. RICHALET, P. BOUISSOU, J.-P. HERRY,
A. KEROMES, P. LARMIGNANT, C. RATHAT
A. R. P. E., Faculté de Médecine, Créteil, France

Performance at high altitude was evaluated in 174 alpinists (136 men and 38 women) participating in a high altitude expedition. The maximal altitude reached (MaxAlt) during the expedition or maximal altitude ever reached by a particular subject (MaxAlt+) served as indices of performance. $\dot{V}O_2max$ and ventilatory (HVR) and heart rate (HHR) responses to hypoxia ($FIO_2=0.115$) at 50% $\dot{V}O_2max$ were determinated before the expedition. Symptoms of acute mountain sickness (AMS), assessed by means of a clinical score, and climbing profile were recorded during the expedition.

MaxAlt and MaxAlt+ were related to $\dot{V}O_2max$ but not to HVR or HHR. Occurrence of AMS was related to HVR and HHR but not to $\dot{V}O_2max$. Subjects suffering from AMS have a spontaneous ventilatory pattern with higher frequency and lower tidal volume than nonsusceptible subjects. Occurrence of AMS is higher below 18 and above 50 yrs. The minimum number of days necessary to reach a given altitude was determinated as a function of the susceptibility to AMS and $\dot{V}O_2max$.

Acclimatization to high altitude proceeds in 4 phases. Phase 1 (0-6 h): no or few signs of AMS; phase 2 (6h-1 week): acclimatization, max. signs of AMS; phase 3 (1-3 weeks): max. performance period; phase 4 (>3 weeks): degradation period. HVR and HHR are determinants of phase 2. $\dot{V}O_2max$ is a determinant of phase 3. Climbing Everest without oxygen seems possible with low HVR but unlikely with low $\dot{V}O_2max$.

(This work was supported by grants from the Ministry of Sports and from Laboratories Sandoz France).

HIGH-ALTITUDE EXPEDITIONS WITH AND WITHOUT A DOCTOR: POSSIBILITIES FOR TESTING PHYSIOLOGICAL FUNCTIONS AND MEDICAL ASSESSMENT ON THE SPOT

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Service of Biomedicine and Biomaterials,
University of Zaragoza, Spain

The authors have supervised medically 10 expeditions to high altitudes. In 6 of them they took an active part as mountain doctors. In another 3, they supervised the medical aspectside but the on-the-spot control and assessment were entrusted to a mountaineer who was not a doctor. The last of the expeditions involved the medical study of a survival experiment, with a climber who stayed in solitude for 66 days on the summit of Aconcagua contacting with the medical team periodically by radio.

The results show that even when there had been careful training in medical experience at high altitude, both the control of physiological functions and medical assistance were very deficient in all those cases in which there was no doctor on the spot.

EFFECT OF ACUTE HYPOXIA ON EXERCISE - INDUCED HORMONAL AND METABOLIC RESPONSE

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IVth Clinics of Internal Medicine, Prague,
National Health Institute for Sport, Prague.

The effect of acute hypoxia on exercise-induced hormonal responses was studied in a hypobaric chamber. Six healthy volunteers were subjected to graded exercise under normoxic (NO) and hypoxic (HO) conditions. Spirometric data and plasma levels of epinephrine, norepinpehrine, cortisol, growth hormone, glucose, pyruvate, lactate and fatty acids were measured at rest and different grades of exercise.

No significant changes for rest values of hormones and substrates were found. Exercise-induced catecholamine responses were significantly increased at HO, while no significant differences were found for other hormones. The exercise-induced increase of fatty acids was higher at HO. The respiration ratio was lower at HO.

These data confirm that there is a shift toward augmented lipid utilization under an exercise load and this shift in energy substrate metabolism could be controlled by a higher catecholamine response to exercise in hypoxia.

CHANGES OF SELECTED PHYSIOLOGICAL FUNCTIONS IN SAGARMATHA '84 EXPEDITION MEMBERS UNDER MODELLED CONDITIONS IN PRESSURE CHAMBER

L. HUBAČOVÁ (1), I. BORSKÝ (1), B. LIŠKA (2), M. PALÁT (3), F. STRELKA (1), G. KOVÁČ (4)
(1) Research Institute of Preventive Medicine, Bratislava
(2) Department of Chemistry and Biochemistry, Medical Faculty, Comenius University, Bratislava
(3) Department of Physiatry and Balneology, Postgraduate Medical Institute, Bratislava
(4) L. Dérer Hospital, Bratislava, Czechoslovakia.

We examined 13 men: 8 mountaineers who planned to ascend Mount Everest and 5 research workers (geographs) who planned ascent to the maximal altitude of 5,000 m in the Himalaya mountains in 1984. We performed the basic clinical examination, including electrocardiography and ergometric examination, under the normal atmospheric pressure. We proposed a scheme of examination in the modelled conditions of the pressure chamber (up to an altitude of 7.000 m). This scheme was verified in experiments. We ascertained the influence of hypobaric-hypoxic conditions (at rest and in combination with a physical load on a bicycle ergometer) on selected physiological functions and on some indices of psychic and biochemical functions of the probands. On the basis of our examination the functional efficiency of the probands was judged. The result was delivered to the Medical Commission of the Czechoslovak Mountaineering Association. It was used as the basis for the selection of the top team members for the Mount Everest summit.

THE ALPINIST'S DREAM LAND

Z. RYN
Department of Social Pathology, Krakow, Poland

A dream recording project was realized in 10 university-educated alpinists (age 28-46) during a Polish 14 months long expedition to the Patagonian Andes in 1973-74. Over 100 dreams were recorded. The freguency of dreams was directly proportional to the altitude and to emotional tensions before climbing and attacking the peak, usually in the morning. About 70% of dreams were connected with the sexual sphere. Directly or through symbols, these dreams show the subjective and subconscious desires and needs of the climbers.

On the 2nd frequency plane were anxiety and catastrophic dreams as well as dreams connected with home and family. These most often expressed the imminence experienced in reality and resulting from the dangers during the expedition or the feeling of homesickness, missing one's family and closest friends which occurred at certain stages of the expedition. Dreams of both kinds were very realistic and colourful and were accompanied by psychosomatic reactions. These dreams in a compensating way fulfilled those important needs that could not be satisfied during the expedition in a normal way. The homogeneity, power and vividness of these dreams express the level of unfulfilment of these needs during the long-term mountain expedition.

The phenomenon described here can be looked upon as one of the psychological and physiological defence mechanisms operating in an extreme situation.

MEDICAL MOUNTAINEERING EXPEDITION "PAMIR 1988"

L. LAHO, M. KOVÁČ, V. ZÁBRODSKÝ, M. KRAJČOVIČ, S. DLUHOLUCKÝ, E. BIELIK, B. ŠVECOVÁ, K. KRALINSKÝ, J. BULEJČÍK, J. LEHOCKÝ, P. DEDIČ
Slovak Medical Mountaineering Expedition "Pamir 1988", ČSSR

The expedition will have two main aims:

1. To establish possibilities of laboratory measurements in the conditions of the base camp (ABB, minerals, lactate, and other biochemical parameters)
2. To investigate the role of hypocapnia in the etiopathogenesis of the high altitude disease.

RESULTS OF CONTINUOUS SURVEILLANCE OF HEALTH, TRAINING CONDITION, SPORT-MOTOR CHARACTERISTICS, AND ACCLIMATIZATION TO ALTITUDE IN MOUNTAIN GUIDES OF THE AUSTRIAN ARMY

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In order to supply a continual training programme for mountain guides of the Austrian Army and to evaluate their health, training standard, cardiovascular efficiency, acclimatization to altitude, and sport-motor characteristics, we investigated 141 mountain guides of the Army at an altitude of 2315 m.

Pathological results, mainly hypertension, could be obtained in 24% of the cases. From our investigations we concluded that the cardiovascular efficiency of the Army members was 125% in comparison to 115% in other mountain climbers. The maximal absolute watt efficiency/kg body weight was over 4 watt in 13%, between 3.6 and 4 watt in 30%, between 3 and 3.5 watt in 40%, and below 3 watt in 17% of the cases.

According to sport-medical standards, a 4-watt efficiency should be obtained in mountain climbers, which seems to be a rather high level. In order to approach this requirement, a more intensive training programme ought to be implemented.

MENTAL AND GYNAECOLOGICAL PROBLEMS IN MOUNTAINEERING WOMEN

J. SEMOTÁN, Z. KLAPÁLKOVÁ, J. KARPINSKÁ,
M. SEMOTÁNOVÁ
Railway Institute of Health Care, Plzen, ČSSR
Independent Scientist, Praha 8-Bohnice 138,ČSSR

With due consideration to differences in psycho-somato-social characteristics in female personalities, both in mountaineering behaviour and in general life, some typical traits may be identified as climbing effects on the female organism, such as those provoked by extreme strain and exertion. Nevertheless, lasting or severe disturbances have not been noticed by the authors, although some irregularities of menstruation, f.i., may appear during the adaptation period on the mountains and during extreme exertion. With various other activities mountaineering proves to be practised by women ever often, but not as a mass sport yet. Presumed and verified characteristics of the female personality as related to climbing: preliminary conditions: genetic and environmental factors. Age stratification. Any training has to be stopped during pregnancy and infancy of the children; some women take them on the mountains leaving them in a base camp with relatives, etc. Reasons for prefering climbing to other sports. Advantages and drawbacks of climbing and the mental-hygiene approach. Solution of inner and social conflicts. Basic factors of disappointment in female mountaineers. Training of the next climber generation on a scientific basis. Ending a climbing career in women. Mass media information, phantasy, warning, and horrors.

METABOLISM AND FLUID BALANCE IN MOUNTAINEERING AND CLIMBING

F. BERGHOLD, N. BACHL, M. MAYRHOFER, K. PALLASMANN
University of Salzburg, Salzburg, Austria

Twenty-nine parameters were examined over a period of two weeks at five different times on 53 participants of a training-course in high altitude climbing for Austrian national mountain guides. Halfway through this period a test climb on Austria's highest mountain (Grossglockner, 3798 m), which was undertaken using the most difficult routes and taking an average finishing time of about 13 hours, was investigated separately. All data were analysed by means of a special SPSS programme.

The red blood count and the activity of the serum enzymes increased after an initial decrease in a statistically significant manner, whereas the unexpected change in the lymphocyte count was striking. Urea showed no essential changes, contrary to earlier findings. The behaviour of fatty acids and glyceride concentrations show that the preparation of energy to protect the carbohydrate deposits occur chiefly through fat oxidation, despite the intensive difficulties in climbing. Sodium, potassium, and phosphorus showed massive changes, whereas the magnesium and calcium levels remained relatively constant. The plasma concentration of cortisol and beta-endomorphines showed a slightly significant increase. There was no significant rise in adrenaline, noradrenaline and prolactine. A highly significant increase of arterial-blood lactate was observed. The significance of a consistent balance of liquid and minerals moves particularly to the fore.

Even taking into consideration the sympatho-adrenergenic stimulation before the commencement of pressure, it was demonstrated that with regard to the accustomed stress of experienced climbers the trends in stress-hormone behaviour during periods of strain could be confirmed. It seems that an aerobic lipolytic pressure level also prevails in extreme alpine demand.

ATRIAL NATRIURETIC PEPTIDE AND ACUTE MOUNTAIN SICKNESS

J. S. MILLEDGE, J. M. BEELEY, S. McARTHUR, A. H. MORICE
Northwick Park Hospital, Harrow, Great Britain

Subjects suffering from acute mountain sickness (AMS) have an antidiuresis compared with healthy subjects. An expedition to Mt Kenya involving 22 subjects ascending rapidly to 4300 m afforded an opportunity to study urinary output, plasma aldosterone (PA) and atrial natriuretic peptide (ANP) levels in relation to severity of AMS.

Subjects travelled to 3100 m by road and the following day walked to 4300 m. Measurements of 24-h urine volume and sodium excretion, Hb and PCV were made over two days at 1500 m before ascent and for two days after arrival at 4300 m. In 15 subjects blood samples were taken for PA and ANP at 4.00 and 9.00 am on the same 4 days.

On ascent (with exercise) there was a marked decrease in 24-h urine volume and sodium excretion but no significant change in Hb or PCV. PA was elevated on the first day and ANP on both altitude days.

AMS symptom scores showed an inverse correlation with 24-h urinary sodium. PA tended to be lowest in subjects with low symptom scores and higher sodium excretion. No correlation was found between AMS and Hb, PCV, urine volume or weight change. ANP at low altitude showed a significant inverse correlation with AMS symptom scores on ascent. The same association was seen at altitude.

THE ROLE OF THE THROMBIN-PLASMIN SYSTEM IN BODY ADAPTATION

V. A. MONASTYRSKY, A. Z. ROMANIV, I. I. BIRKA, M. I. VORONYAK, N. V. BIRKA
Lvov Haematology and Blood Transfusion Research Institute, USSR

It has been determined experimentally that the thrombin system and the plasmin one function as a single thrombin-plasmin system (TPS). TPS has been proved to be present not only in the blood, lymph and interstitial connective tissue, but in every body cell too, playing an important role in regulating the vital activity level of the cells of parenchymal organs. TPS has a modelling effect on the structural and functional state of cells and their adaptation to changing environmental conditions by regulating the polymerarization of their actin microfilaments and changing the conformational state of different cellular proteins.

In generalized decompensated thrombinogenesis, hyperpolymerization of actin filaments and considerable denaturation of other proteins may develop, this manifesting itself in structural and functional disturbances of the cells and organs in general (coagulation theory of pathogenesis). Prophylactic use of heparin prevents these changes. The use of plasmin during the first hours after the signs of such disturbances appear, provides complete, rapid and stable recovery of the structures and functions of the cells and organs.

It has been revealed by electron microscopy that plasmin causes depolymerization of actin filaments and renaturation of other proteins; it promotes cell clearance of irreversibly damaged structures and stimulates intracellular regeneration processes simultaneously. Thus, TPS is of great importance in cellular adaptation mechanisms both normal and pathological conditions.

VARIATION OF PLASMA BIOCHEMICAL PARAMETERS IN ALPINE SKIERS

R. M. CANDEAGO, M. NARDIN, A. SOMMAVILLA, C. ANGELINI
University Hospital of Padova
and General Hospital of Bolzano, Italy

To evaluate plasma biochemical parameters in alpine skiers, we studied 11 subjects (9 males and 2 females) attending a course of training for alpine skiing. We examined the 11 alpine skiers before and after a 650 meter climb (Colle Margherita mt. 2000). A second climb was undertaken after three months of training. The first climb was at a much cooler environmental temperature than the second one. In the second climb glycaemia was increased and FFA, though elevated, was lower than in the first climb; lactic acidosis was significantly higher ($p<0.001$), carnitine fractions showed an increase of short chains and long chains of acyl fractions after both climbs with respect to the basal values. These data suggest that during alpine skiing intense lipolysis occurs and the effort may be done both in aerobic and anaerobic conditions.

A CASE OF ACUTE EROSIVE GASTRITIS WITH SHOCK AND SEVERE ANAEMIA DURING GASHERBRUM I AND II EXPEDITION

Giovanna GAFFURI
Medical Doctor of the Expedition, Italy

Gastritis problems are common during high altitude climbing. They include mild symptoms as dyspepsia, nausea, epigastric discomfort, but also severe epigastralgia and vomiting. Furthermore, the incidence of gastric ulcer and haemorrhage deriving from such ulcers are greater at high altitude than at sea level, both in native and residents. Several factors may determine such pathology: stress, inadequate alimentation, hypoxia, drugs.

I wish to describe a case of a climber who spent 4 days at 7400 m because of bad weather, with inadequate alimentation and hydration. When he returned to the base camp he first developed epigastralgia and nausea followed by haematemesis and melena with hypovolemic shock. He was treated in the base camp with ranitidina, plasma expander, fluids, iced drinks. Melena continued for 4 days and on the 5th day he was transported by a helicopter to Rawalpindi and admitted in the Central Military Hospital. The laboratory data showed a severe anaemia: Hb 3.0, G.R. 0.9, MCV 90.

A gastroscopy performed six days after the start of the bleeding showed a pale but normal gastric and duodenal mucosa. At this period he was asymptomatic except for asthenia. After 4 blood units the hemoglobin value rose to 7.0.

THE USE OF PLATELET ANTIAGGREGANTS IN HIGH-ALTITUDE PATHOLOGY: AN ORIGINAL EXPERIMENT IN ANNAPURNA I (8.091 MD

G. MARTINEZ VILLEN, R. ARREGUI, J. R. MORANDEIRA
Service of Biomedicine and Biomaterials,
University of Zaragoza, Spain

Haemodynamic and haematological problems play an important role in high-altitude pathology. Together with polyglobulia, platelet aggregation is a factor to be taken into account, especially in complaints due to the cold. While the use of platelet antiaggregants is accepted as an efficient therapy it had not been used in a preventive way.

During an expedition to Annapurna I, we carried out an experiment with preventive, later therapeutical aims, using DITAZOL as a platelet antiaggregant. The study was carried out on two groups which reached the summit with different pathological results in spite of the climatological conditions being similar.

A total of 40 frozen fingers and toes in the climbers who did not accept the preventive treatment, later imposed the use of antiaggregants as an optimum measure in all the members of the groups followed. The haematological analysis carried out 10 days after reaching the summit, showed platelet figures of values nearly three times greater than those accepted as normal.

With the disadvantages of other types of medicines, antiaggregants prove to be ideal in high-altitude pathology both as a preventive and in the therapy of established lesions.

FEATURES OF PSYCHIC CHANGES IN TRAINED MOUNTAINEERS AT HIGH ALTITUDE

T. A. VOLKOVA
Public Health Service, Novomoskovsk, USSR

THE ACTIVITIES OF THE MOUNTAIN RESCUE SERVICE IN CZECHOSLOVAKIA

I. MIKO
Medical Commission of the Slovak Mountain Rescue Service, Czechoslovakia

Substantial part of the Czechoslovak territory (127 881 square km) is covered by mountains, which are extensively visited by tourists, skiers and climbers. Moderate altitudes prevail (85% from 200 to 1500 m), only 2% of the territory is above 1500 m. The ridge of the highest mountain range - the High Tatras (260 square km) - is 26.5 km long, with an altitude of 2250 m on an average and with the highest peak, Gerlach, measuring 2655 m.

The Mountain Rescue Service (MRS) in Czechoslovakia is affiliated to the Czechoslovak Union of Physical Culture (CSTV) and is represented in the International Organization for Mountain Rescue (Internationale Kommission fur alpines Rettungswesen, IKAR). The MRS totals 1939 members and is divided into 15 mountain areas, the number of physicians reaches up to 10% of the membership in some places. All the physician are volunteer MRS members.

They arrange first-aid education for all professional and volunteer MRS members (inclusive of mountain guides, avalanche specialists, and members of air rescue parties), render first aid in the mountains, and take part in education of the general public, especially on prevention of mountain accidents, taking advantage of collaboration with mass media. The Medical Commissions of the Czech and Slovak Mountain Rescue Services cooperate closely with other sport organizations, with the Medical Commissions of the Mountaineering Association, with the mining rescue service of Czechoslovakia, and state health institutions.

In 1987, members of the MRS delivered 6233 lectures and talks, organized 12 298 terrain patrols and 251 search undertakings, and 1039 times rendered assistance at sports events. They worked 102 800 hours in emergency service and treated 6123 injured persons, 2689 of them severely (with 43 deaths accidents).

PSYCHOLOGY FOR MOUNTAINEERS

P VESELY
Medical Commission of the Czech Mountaineering Association, Czechoslovakia

Psychology of mountaineering is a rather attractive topic and therefore often taken up. The frequently posed question: "Who is a mountaineer?" for the mountaineer really means: "Who am I?" And this is a question that interest everyone at all times. Although it is nice to dwell in these spheres, it can hardly provide useful help to a mountaineer in his coping with obstacles encountered in the mountains. It only leads to self-reflexion and the necessity to analyse the quality of the reflecting mirror. My opinion is that as far as a mountaineer is concerned quite the opposite is needed. Leave to him who he is but try to explain to him how he can benefit from some knowledge of psychology and training of self-control.

I propose that such a training programme as "psychology for mountaineers" is what waits to be formulated and what should offer an interesting inspiration to a mountaineer's independent mind. I shall attempt to show what should be considered to fall within this framework.

HEALTH EDUCATION OF THE MEMBERS OF THE CZECHOSLOVAK MOUNTAINEERING ASSOCIATION: ORGANIZATION, METHODS, AND EFFECTS

T. SKŘIČKA, I. ROTMAN, J. TOMČALA
Czechoslovak Mountaineering Association, ČSSR.

The Czechoslovak Mountaineering Association (13 506 members in 313 alpinist clubs) is one of the sports organizations of the Czechoslovak Union of Physical Culture (ČSTV - Československý svaz tělesné výchovy). The ČSTV is formed of the Czech and the Slovak Unions of Physical Culture and associates 2 022 577 people (17.7% of the population) interested in various sports and physical culture activities.

The growing popularity of mountaineering in Czechoslovakia in recent years has resulted in a high number of injuries. Although mountaineering does not appear among the sports with the highest accident rate (approximately 1%), the high number of injuries includes serious ones, each seventh being fatal.

Therefore the programme of education and training of climbers and mountaineers is of great importance. The Committee of the Czechoslovak Mountaineering Association with its specialist bodies, in particular methodological and medical commissions, are the responsible organizers. The education and training in basic and advanced mountaineering knowledge and technical skills are provided by instructors in alpinist clubs.

Instructors of the fourth class teach rock climbing for beginners; third class, climbing in mountains in summer conditions; second class, winter mountain climbing, and the first class, climbing in mountains with glacier regions. Medical doctors are in charge of teaching First Aid and hygiene for ordinary mountaineers, and their instructors. An extramural course for first class instructors in mountaineering lasts two years (430 hours); second class instructors go through a two-week course (inclusive of 10 days in the High Tatras), third class instructors have a 7 day course in the High Tatras; and fourth class instructors a 3-day in a region with sandstone or other minor rocks.

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Health care and education in mountain climbing is very important above all from the point of view of safety and injury prevention. The health activities of both voluntary and professional sanitary services in mountaineering include regular preventive medical examination, protective vaccination, rehabilitation, and health education.

AN ANALYSIS OF NEUROLOGICAL DIAGNOSIS TO EXTRACT INFORMATION CRITICAL FOR LAYMAN CLIMBERS

Z. KONRÁD, I. ROTMAN, P VESELÝ
Medical Commission of the Czech Mountaineering Association, Czechoslovakia

The problem of education and training of mountaineers above the basic course of "the first aid in mountains" in medical prevention and care is not reasonably solved yet. It is now pressing mainly with reference to top climbers who have to cope with various medical problems especially during lightweight expeditions to very high mountains, where medical doctors are usually missing.

The possibility to extend the training above the basic level depends also on a qualified estimate of what has and can be taught. For this purpose we considered using the means offered by artificial intelligence in expert systems methodology.

We decided to start with neurology which seems to be quite important from the viewpoint of high altitude sickness and other syndroms caused by hypoxia and/or hypothermia in high mountains. The most probable diagnoses in healthy mountaineers in this environment have been selected as goals. Then all diagnostic steps were considered and used to produce modified AND/OR graph where certainty of decisions are expressed as YES - DOUBT - NO. The resulting scheme is analysed from the point of view of availability and reliability of diagnostic steps in order to produce a realistic conclusion with emphasis on the safer side.

The final graph and conclusions reached will be presented and discussed..

EFFICACY OF TWO ORIGINAL ANTIHYPERTENSIVE AGENTS IN EXPERIMENTAL PULMONARY HYPERTENSION

M. ŠMÍD, I. HELFERT
Research Institute for Pharmacy and Biochemistry, Prague, ČSSR

The efficacy of new antihypertensive agents, metazosin (alpha-blocker) and mepamil (calcium-channel blocker), was tested in two models of experimental pulmonary hypertension in dogs and rabbits.

In dogs, the pulmonary hypertension was caused by endotoxin administration and the pressure in the pulmonary artery was recorded. In artificially ventilated rabbits, the right ventricular pressure was recorded and pulmonary hypertension was developed by changing the composition of the breathing mixture.

The preliminary results confirmed the efficacy of both substances in these models of pulmonary hypertension.

TRAINING FOR ROCK CLIMBING

Dennis GRAY
British Mountaineering Council, Great Britain

The sport of rock climbing is now being changed by its leading participants adopting strict training regimes. Many of these are based on "word of mouth" ideas, rather than a knowledge of physiology and state of the art information from other sports where there is a long history of training and much expertise and physical and mental conditioning.

The author has been a member of a Committee for the last two years which has been investigating this whole topic. From these researches a book will be published by the BMC at the end of this year under the title "Rockfit".

This work covers all aspects of this activity, including avoidance of injury, diet, and mental preparation techniques. This talk therefore will dwell on the most important findings by this Committee, and will include reference to a programme of testing which was undertaken by the BMC into the physical performance capabilities of existing top rock climbers, their strengths and weaknesses, and also why it was that many leading climbers were suffering soft tissue injuries.

TRAINING OF PEAK PERFORMANCE AND PREVENTION OF INJURIES IN SPORT CLIMBING

L. RADLINGER
Berne, Switzerland

The performance of sport climbers increases from year to year. Unfortunately, injuries are concomitants, especially those resulting from general overuse of upper extremities. They have become well-known because of their terrible extent, which has been described by several examinations from CSSR, Austria, France, Germany, Spain, and Switzerland. The dominant reasons for such sport injuries are in most cases based in the very incorrect preparation (training) of the climbers.

On the sample of a group of 12 sport climbers (8 climb to 10th UIAA-degree; mean of the group: 9-(9) at Berne - trained by the author since 1984 - it is shown that peak performance training can increase the climbing performance with much less or even no injuries.

The most important features of the training are:

- explanation of the plan of training, principles of training, theory of training; procurement of the sport medical background for all athletes;
- training control of the athletes, training diary and medical control;
- large number of forms of training, variability of training intensity, training units, training duration, type of training etc.;
- special wooden beam developed for finger training, based on a functional anatomical analysis;
- measures for regeneration;
- training of tactics and techniques.

The experience with such specific training showed that injuries can be reduced to a minimum, while the mean performance of the group increased by about 2 degrees in 4 years. Therefore, it is possible to say: Correct training is the best prevention of injuries.

Vydal : T.J.ALPIN PRAHA pro potřebu zdravotní komise
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Dear Friends - Queridos Amigos,

Because of my involuntary absence at UIAA Medical Congress in Prague I have a pleasure to dedicate my 21th August 1988 ascent to POPOCATÉPETL to all Congress Participants and Organizers, with best wishes of fruitful days in Golden Prague.

SALUDOS y felicitaciones muy cordiales con deseos de amistad internacional entre los hombres de montaña - desde la cumbre más mágica del mundo - el POPOCATÉPETL !

Zdzistaw Ryn
México, 2nd Sept. 188

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Aérea al amanecer del Cráter del Popocatepetl.
Air view at dawn of the Popocatepetl Volcano.
MEXICO

UIAA Mountain Medicine Conference to all PARTICIPANTS and ORGANIZERS

PRAGA - CZEKOSLOVAKIA
20-22 October 1988

and personaly to
Dr Ivan Rotman and
Dr Tomáš Skřička

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UNION INTERNATIONALE DES ASSOCIATIONS D'ALPINISME

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UNIONE INTERNAZIONALE DELLE ASSOCIAZIONI ALPINISTICHE
UNION INTERNACIONAL DE ASOCIACIONES DE ALPINISMO

MOUNTAIN MEDICINE
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UIAA MEDICAL CONFERENCE - PRAGUE 1988

The UIAA Mountain Medicine Conference "Medical Aspects of Mountaineering" was held in Prague, Czechoslovakia from 20th - 22nd October 1988.

The meeting was organised by the Czechoslovak Mountaineering Association of the Czechoslovak Union of Physical Culture and the Medical Commission of the International Union of Alpinist Associations. It was under the sponsorship of the Czechoslovak Society of Sports Medicine, of the J E Purkyne Association of Czechoslovak Medical Societies and the Czech Alpine Clubs - Alpin Praha, Liaz Jablonec, Lokomotiva Decin, Slovan SBCS Praha.

The visit to Prague began with the UIAA Medical Commission Meeting on Thursday 20th October which was attended by 14 nations.

On Friday 21st October 1988 the Mountain Medicine Conference took place in the Carolinum Building, Universitas Carolina, in the Old City of Prague.

The first morning session was devoted to Climbers' Accidents and Injuries with an analysis of injuries and deaths both in the Alpine regions and in the Himalaya with particular attention being paid to deaths on mountains over 8000 metres. The second important issue was Soft Tissue Injuries and Boney Injuries suffered in extreme rock climbing, particularly in competitive climbing.

In the afternoon session we addressed the problems of the Laboratory Assessment of Climbers' Tolerance to Extreme Heights and the possiblity of on the spot testing of climbers' physiological functions. A series of papers were given in which we discussed the implications of measuring the maximum oxygen uptake and hypoxic ventilatory response, the recent work on Acute Mountain Sickness and atrial natriuretic peptide. There were interesting papers on specific medical problems dealt with on expeditions - erosive gastritis with severe anaemia and high altitude cerebral oedema.

The meeting was conducted in English. Abstracts are available from Dr Ivan Rotman, address below.

UNION INTERNATIONALE DES ASSOCIATIONS D'ALPINISME

THE INTERNATIONAL UNION OF ALPINIST ASSOCIATIONS
INTERNATIONALER VEREIN DER ALPINISTEN VERBÄNDE
UNIONE INTERNAZIONALE DELLE ASSOCIAZIONI ALPINISTICHE
UNION INTERNACIONAL DE ASOCIACIONES DE ALPINISMO

MOUNTAIN MEDICINE
DATA CENTRE
c/o Dr. Charles Clarke,
Dept. of Neurological
Sciences,
St. Bartholomew's Hospital,
38 Little Britain,
London EC1, England.

The participants were entertained extremely well by our hosts and the meeting concluded with a weekend of rockclimbing and hill walking in the Bohemian Paradise.

We were extremely grateful to our Czechoslovakian colleagues for such a successful meeting.

Charles Clarke
President - UIAA Medical Commission

27th October 1988

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MEDIZINISCHE ASPEKTE BEIM BERGSTEIGEN - Bergmedizinkonferenz der UIAA in Prag

Vom 20.-21. Oktober 1988 fand in der Hauptstadt der Tschechoslowakei ein internationaler Kongreß über Fragen der Bergmedizin statt - zum erstenmal in einem Land des Ostblocks. Hauptthemen waren Bergunfälle und Höhenprobleme sowie Überlastungssyndrome bei Sportkletterern.

Bergmedizin, Bergunfälle

Ch. Clark, der englische Präsident der medizinischen Kommission der UIAA, gab einen interessanten geschichtlichen Überblick der Bergmedizin. Wurde anfänglich nur die reine Höhenphysiologie erforscht, kamen später klinische Fragestellungen wie Höhenkrankheit, Lungen- und Hirnödem hinzu, während heute auch psychologische Aspekte und Überlastungssyndrome beim Sportklettern im Vordergrund stehen. Künftige Probleme und Forschungsansätze dürften bei Medikamenten in großer Höhe sowie bei den Kletterwettbewerben (Doping?) liegen.
M.Townend aus England analysierte die Unfallstatistik im britischen Lake-District, dem populärsten englischen Wander- und Klettergebiet. Trotz wesentlich höherer Besucherzahlen in den letzten Jahren stieg die Zahl der Verunfallten insgesamt nur unwesentlich an. Auffallend ist dabei der zunehmende Anteil an Todesfällen durch Erkrankungen des Herz-Kreislaufsystems bei Bergwanderern, vermutlich bedingt durch höheres Alter und mangelnde Fitness sowie schlechte Ausrüstung vor allem im Winter.

Höhenprobleme

B. Kayser aus den Niederlanden untersuchte die Häufigkeit von akuter Höhenkrankheit (AMS) auf der Annapurna-Rundwanderung (höchster Punkt Thorong-Paß mit 5400 m!) mit Hilfe eines Fragebogens, da eine ärztliche Untersuchung aus Zeitmangel nicht möglich war. 58 % aller Trekker hatten Symptome von AMS. Die Häufigkeit sank mit dem Alter, der Akklimatisierungszeit und bei älteren Bergsteigern mit der Fitness. Frauen litten häufiger und vor allem stärker unter der akuten Höhenkrankheit (wobei auch der Menstruationszyklus eine Rolle zu spielen scheint). Es besteht kein Zusammenhang mit der Größe der Gruppe, dem Reiseveranstalter, früherer Höhenerfahrung, dem Rucksackgewicht, Rauchgewohnheiten oder der Einnahme der Anti-Baby-Pille.
J. Serafin aus Polen berichtete über Erfahrungen bei polnischen Expeditionen. Zwischen 1971 und 1987 wurden 114 polnische Expeditionen im Himalaya- und Karakorumgebiet durchgeführt, davon 48 über 8000 m und 40 sehr anspruchsvolle Unternehmungen z.B. im Winter. Von den 986 Bergsteigern starben 34 (3,4 %), weitere 72 (7,4 %) zogen sich lebensgefährliche Erkrankungen oder Verletzungen zu. Die Todesfälle waren zu zwei Dritteln verletzungsbedingt und zu einem Drittel medizinisch verursacht (Erschöpfung, Lungenödem, Hirnödem u.a.). Als Begleitumstände wurden angegeben: Geringes Tempo, Erschöpfung nach Biwaks und beim Abstieg nach Erreichen des Gipfels, sauerstofflose Besteigungen und eine längere Verweildauer in sehr großer Höhe.
B. Holt aus England analysierte die Unfälle des fatalen Sommers 1986 im Karakorum, als insgesamt 12 Bergsteiger am K2, dem zweithöchsten Gipfel der Welt, ihr Leben verloren. Während eines Wettersturzes konnten sich nur die 2 Ältesten am Berg retten, vermutlich wegen ihrer großen Erfahrung. Auch bei "reinen" Unfällen wie Absturz aus Fixseilen dürfte oft eine Hypoxie mit Verminderung der geistigen und körperlichen Leistungsfähigkeit zugrunde liegen. Dies wiederum kann zu einem folgenschweren Fehlverhalten führen, u.a. zu einem unnötig langen und daher gefährlichen Aufenthalt in extremer Höhe. Nach 2-3 Wochen Akklimatisation sollte eine Besteigung optimalerweise zwischen der 3.-6. Woche erfolgen, da danach die physische und psychische Leistungsfähigkeit wieder sinkt. Durch den heutigen Trend, auch höchste Gipfel ohne Sauerstoffgeräte zu besteigen, wird es in Zukunft sicher zu weiteren hypoxiebedingten Unfällen kommen.

Überlastungssyndrome beim Sportklettern

S. Bollen aus England berichtete über Verletzungen des Weichteilgewebes bei 86 extremen Sportkletterern. Die Läsionen verteilten sich dabei gleichmäßig auf Training und Klettern (je 50 %), überwiegend war die obere Extremität betroffen (85 %), und hier ganz besonders die Hände (50 %). Überlastungssyndrome waren häufig z.B. Tendinitiden des Supraspinatus, Epikondilitiden des Ellenbogens (Tennis- und Werfer-Ellenbogen) sowie als neue typische Läsion der "Kletter-Ellenbogen" (eine Brachialissehnenüberlastung in der Ellenbeuge). Als "Kletterfinger" wurden die PP-Gelenke von Mittel- und Ringfinger bezeichnet, bei denen oft eine Sehnen-Periost-Reizung des Flexor digitorum superficialis vorzuliegen scheint. Auch abgerissene Sehnenscheiden der Fingerflexoren sind typisch und werden ebenfalls nur bei Sportkletterern beobachtet.
Ob die extreme Finger-Zugbelastung bei heutigen Top-Kletterern auch vorzeitige degenerative Auswirkungen auf die Fingergelenke hat, war der Ausgangspunkt für eine weitere Studie des gleichen Referenten. Bollen untersuchte 25 Spitzenkletterer, die mindestens VIII+ beherrschen, und fand klinisch vor allem Gelenkschwellungen und Beugekontrakturen der Finger. Radiologisch fielen kortikale Verdikkungen, Randzacken und Frakturen durch diese arthrotischen Knochenveränderungen auf. Da diese Pilotstudie auf noch viel größere Probleme in der Zukunft schließen läßt, ist eine Prophylaxe besonders wichtig, z.B. durch vorheriges Aufwärmen und möglichst geringes Eigengewicht des Kletterers.
L. Radlinger aus der Schweiz, der seit 4 Jahren Spitzenkletterer intensiv betreut, zeigte, daß durch richtiges Training Verletzungen und Überlastungssyndrome vermieden werden können, und stellte als Beispiel einen anatomisch individuell geformten Trainingsbalken vor.

Resümee

Es war Pech für die Prager Veranstaltung, daß sie nur wenige Wochen nach dem hervorragenden 4-tägigen Kongreß im schweizerischen Davos stattfand. Dadurch kam es teilweise zu Wiederholungen. Auch litt die Aufnahmefähigkeit der Teilnehmer darunter, daß wegen der Vielzahl der Beiträge aus Zeitmangel die Vortrags- und Diskussionsdauer sehr knapp bemessen war, zumal trotz Englisch z.T. doch sprachliche Verständigungsschwierigkeiten bestanden. Auf der anderen Seite muß man den tschechoslowakischen Verantwortlichen großes Lob zollen, daß trotz erheblicher organisatorischer und finanzieller Schwierigkeiten dieser Kongreß zustandegekommen ist.
Beeindruckender als neue wissenschaftliche Erkenntnisse war die Tatsache, daß eine intensive persönliche Kommunikation zwischen bergsteigenden Ärzten aus Ost und West in Gang gekommen ist. Wann hatte man schon die einzigartige Gelegenheit, mit russischen oder tschechoslowakischen Kollegen zu diskutieren oder auch mit einem Vertreter des Bergsteigerverbandes der DDR (der übrigens nicht Mitglied in der UIAA ist)? Dank der großen Gastfreundschaft der Organisatoren kam es bei den abendlichen Veranstaltungen und während des interessanten Wochenendausfluges ins böhmische Kletterparadies bei Turnow zu einer sehr angenehmen Gesprächsatmosphäre, die auch einige neue private Kontakte entstehen ließ. Beim gemeinsamen Klettern im Sandstein wurde die "europäische Seilschaft" wieder einmal Wirklichkeit. Unter diesen Gesichtspunkten war die Bergmedizin-Veranstaltung ein voller Erfolg.

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МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ СССР

КОСМИЧЕСКАЯ БИОЛОГИЯ И АВИАКОСМИЧЕСКАЯ МЕДИЦИНА

ЯНВАРЬ — ФЕВРАЛЬ

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CONTENTS

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Зав. редакцией М. Ф. Григорян

возрастает, АТК свидетельствовал о развитии выраженной гипокоагуляции.

Таким образом, тесты, характеризующие общую коагуляционную активность крови, свидетельствуют о том, что у неадаптированных облученных животных в условиях высокогорья развивается гипокоагуляция. Понять механизм этой реакции можно лишь при анализе показателей, характеризующих отдельные фазы процесса свертывания крови. Так, протромбиновое время у облученных животных, не адаптированных к условиям высокогорья, увеличивается, концентрация фибриногена практически не изменяется, тромбиновое время проявляет тенденцию к увеличению, толерантность плазмы к гепарину уменьшается, возрастает концентрация антитромбинов и практически не меняется тотальный и Хагеманзависимый фибринолиз. Вместе с тем этаноловый тест у 9 из 10, а протаминсульфатный у 7 из 10 собак оказались положительными. Эти данные можно объяснить лишь при сравнении их с результатами, полученными на необлученных собаках. У тех и других животных концентрация фибриногена оставалась практически одинаковой, приблизительно в одинаковом числе были положительными этаноловый и протаминсульфатный тесты. Все это дает основание говорить о том, что у облученных, не адаптированных к условиям высокогорья собак внутрисосудистое свертывание крови протекает менее интенсивно, чем в условиях низкогорья.

Мы считаем, что это связано с более благоприятным фоном у собак в условиях высокогорья при кратковременной адаптации перед последующим облучением. У не адаптированных к высокогорной гипоксии интактных животных в первые дни пребывания повышается фибринолитическая активность крови. Усиление развития внутрисосудистого свертывания крови приводит к тому, что у таких собак после облучения проявляются признаки вторичной гипокоагуляции, обусловленной концентрацией вторичных антикоагулянтов.

Таким образом, полученные данные свидетельствуют о том, что наряду с нарушением тромбоцитопоэза в патогенезе гипокоагуляции у не адаптированных к условиям высокогорья собак при лучевой болезни играет роль развитие тромбогеморрагического синдрома. Развитие внутрисосудистого свертывания крови на 3-и сутки пребывания в горах приводит к появлению у животных признаков вторичной гипокоагуляции, которая способствует уменьшению интенсивности развития постлучевого тромбогеморрагического синдрома в условиях высокогорья.

ЛИТЕРАТУРА

1. *Браун А. А., Чернова Т. Г.* // Таджикский мед. ин-т: Науч. конф., 21-я: Материалы.— Душанбе, 1972.— С. 9—12.
2. *Данияров С. Б., Приживойт Г. Н., Молдоташев Б. У.* // Радиобиология.— 1978.— № 1.— С. 115—119.
3. *Данияров С. Б., Эсенбекова З. Э.* // Там же.— 1980.— № 4.— С. 609—612.
4. *Джаракьян Т. К.* Геморрагический синдром острой лучевой болезни.— Л., 1976.
5. *Каландарова М. П.* // Радиобиология.— 1976.— № 1.— С. 143—147.
6. *Кузник Б. И., Михайлов А. Д., Альфонсов В. В.* Тромбогеморрагический синдром в онкогинекологии.— Томск, 1983.
7. Радиация и гемостаз / Балуда В. П., Володин В. Д., Поспишил Я. и др. / Под ред. В. П. Балуды.— М., 1966.
8. *Сушкевич Г. Н.* // Мед. радиол.— 1981.— № 4.— С. 60—64.
9. *Шарипов Ф. Ш.* Митотическая активность почки при различных экспериментальных условиях в долине и высокогорье: Автореф. дис. ... д-ра мед. наук.— Душанбе, 1972.
10. *Эсенбекова З. Э.* Влияние ионизирующего излучения на гемостаз животных в процессе их адаптации к высокогорью: Автореф. дис. ... канд. биол. наук.— Фрунзе, 1982.

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МЕЖДУНАРОДНАЯ КОНФЕРЕНЦИЯ ПО ГОРНОЙ МЕДИЦИНЕ (19—23 ОКТЯБРЯ 1988 г., ПРАГА, ЧССР)

За последние годы число работ по исследованию состояния человека в горных условиях значительно увеличилось. Это объясняется расширением сфер человеческой деятельности в горной местности: строительством новых промышленных объектов, спортивных сооружений, научно-исследовательских станций, домов отдыха, санаториев и лечебных учреждений, а также развитием наук, связанных с развитием авиации и космонавтики. При этом человек испытывает влияние кислородной недостаточности и других факторов высокогорного климата как эпизодически при некоторых видах профессиональной и спортивной деятельности, так и постоянно при проживании в горной местности. Обеспечение нормальной жизнедеятельности и работоспособности человека в этих условиях является одной из основных проблем экологической физиологии. Не вызывает сомнений и целесообразность использования острой гипоксии для медицинского отбора лиц, поступающих на службу в авиацию и претендующих на участие в космических полетах.

К настоящему времени накоплен обширный материал, полученный в горных и лабораторных условиях, о реакциях человека при высотной гипоксии. Однако вопрос о механизме адаптации к гипоксии во многом остается до сих пор неясным.

В связи с этим представляют интерес сведения о результатах изучения состояния человека, его функциональных резервных возможностях в экстремальных условиях высокогорья, способах оценки и прогнозирования переносимости кислородной недостаточности практически здоровыми лицами, а также средствах профилактики несчастных случаев и травм в горах, оказания срочной медицинской помощи в высокогорной зоне, которые были представлены на Международной конференции по горной медицине в Праге.

Конференция была организована Чехословацкой ассоциацией альпинизма при Союзе физической культуры ЧССР по поручению и под эгидой медицинской комиссии Международного союза альпинистских ассоциаций (УИАА). Ее спонсорами являлись Чехословацкое общество спортивной медицины Ассоциации медицинских обществ ЧССР им. Яна Пуркинье и 7 чешских альпинистских клубов.

В работе конференции приняли участие 145 специалистов из 23 стран, в том числе из Австрии, Бельгии, Великобритании, ВНР, ГДР, Греции, Дании, Испании, Италии, Нидерландов, Норвегии, НРБ, ПНР, СССР, Франции, ФРГ, ЧССР, Швейцарии, Швеции, СФРЮ.

Из Советского Союза в Прагу прибыли 10 специалистов — научные сотрудники, представлявшие Институт медико-биологических проблем Минздрава СССР (Москва), Институт физиологии им. А. А. Богомольца (Киев), Институт физиологии и экспериментальной патологии высокогорья АН Киргизской ССР (г. Фрунзе), Эльбрусскую медико-биологическую станцию АН УССР (Терскол), Львовский медицинский институт и НИИ гематологии и переливания крови (г. Львов), Институт медицинской генетики АМН СССР (Москва), Московский НИИ психиатрии Минздрава РСФСР, а также врачи-практики, привлекаемые к сезонной работе в международных альпинистских лагерях системы Госкомспорта СССР и на альпинистских учебно-спортивных базах.

На заседаниях было заслушано и обсуждено 38 докладов специалистов из 12 стран Европы и представлено 15 стендовых сообщений. В них приводились результаты научных исследований в экстремальных условиях высокогорья и содержалась информация практического характера, главным образом по следующим проблемам:

— оценка переносимости человеком предельных высот и тестирование физиологических функций в имитируемых и естественных условиях высокогорья;

— несчастные случаи, травматизм и заболевания при за-

нятиях альпинизмом и спортивным скалолазанием, их профилактика и лечение;

— психологические вопросы альпинизма;

— обучение и тренировка альпинистов и скалолазов с медицинской точки зрения.

Е. Б. Гиппенрейтер (Москва) выступил с докладом «Экспертная оценка высотной устойчивости у кандидатов в состав советской экспедиции «Эверест-82» (соавторы О. Г. Газенко и В. Б. Малкин), прокомментировал советские научно-популярные кинофильмы «Гималайские сборы» и «Восхождение на Эверест» и преподнес в дар организаторам конференции монографию «Физиология человека в условиях высокогорья», подготовленную коллективом сотрудников Института медико-биологических проблем Минздрава СССР (М.: Наука, 1987). Книга, как и фильмы, вызвала большой интерес, получила высокую оценку специалистов, и организаторы конференции обратились за разрешением перевести и издать ее в ЧССР.

В выступлениях других советских участников были освещены особенности терморегуляции в горах (П. В. Белошицкий, Терскол), механизмы индивидуальных различий в устойчивости к гипоксии (О. Н. Красюк, Киев), изменение физиологических функций при вахтовом режиме труда на высоте 1750 м (А. А. Максимов, г. Фрунзе), роль системы тромбин — плазмин в адаптации организма (И. И. Бирка, г. Львов), психические изменения у тренированных альпинистов на больших высотах (Т. А. Волкова, Новомосковск), психофизиологическая тренировка альпинистов (М. А. Михайлов, Москва), опыт лечения высокогорного острого отека мозга у японского восходителя на пике Коммунизма, Памир (С. Г. Пряников, Алма-Ата).

Среди зарубежных научно-исследовательских работ, доложенных на конференции, наибольший интерес, с нашей точки зрения, представляют доклады по изучению процесса горной акклиматизации и динамики работоспособности у альпинистов-высотников (J.-P. Richalet и соавт., Франция) и о прогностическом тестировании физиологических функций у кандидатов в состав экспедиции 1984 г. на Эверест (L. Hubačova и соавт., ЧССР).

Французские специалисты оценивали работоспособность по максимально достигнутой высоте при восхождениях в Гималаях. Наблюдениями было охвачено 174 восходителя (136 мужчин и 38 женщин). Перед выездом в экспедицию у них определяли уровень максимального потребления кислорода (V_{O_2max}) и реакцию кардиореспираторной системы на дыхание гипоксической смесью, эквивалентной по содержанию кислорода высоте 4800 м, в сочетании с выполнением физической работы на велоэргометре мощностью 50 % от V_{O_2max}.

Для сравнения можно указать, что при экспертной оценке высотной устойчивости у советских кандидатов в состав советской экспедиции «Эверест-82» применялся аналогичный метод — предложенная В. Б. Малкиным комбинированная функциональная проба, сочетавшая воздействие гипоксии и физической нагрузки, причем газовая смесь была обеднена кислородом до 9,5—10 %, что имитировало условия высоты будущего базового лагеря экспедиции — 5300—5400 м, т. е. на 500 м выше, чем при проведении экспериментов французскими исследователями. Ими были установлены зависимость уровней максимально достигнутых высот от величин V_{O_2max} и отсутствие таковой от показателей частоты сердечных сокращений (ЧСС) и частоты дыхания при выполнении комбинированной пробы (гипоксия плюс физическая нагрузка) перед выездом в горы. Частота развития острой горной болезни, наоборот, была связана с этими двумя показателями, но не зависела от величин V_{O_2max}. Она чаще наблюдалась у лиц моложе 18 л и старше 50 лет. В процессе акклиматизации к условиям высокогорья и, следовательно, в динамике самочувствия и состояния работоспособности наблюдаются, по их мнению, 4 фазы: 1-я — 0—6 ч; 2-я — 6 ч — 1 нед; 3-я — 1—3 нед, 4-я — более 3 нед. В 1-й фазе признаки острой горной болезни отсутствуют или минимальны, во 2-й их проявление достигает максимума с одновременным развитием акклиматизационных сдвигов, причем определяющими здесь являются показатели ЧСС и дыхания, в 3-й достигается уровень максимальной работоспособности, причем детерминирующую роль на этой стадии играет величина V_{O_2max}, в 4-й фазе начинается постепенное снижение работоспособности и ухудшение общего состояния организма.

Чехословацкие ученые обследовали 13 человек — 8 кандидатов в состав эверестской экспедиции и 5 научных сотрудников. Они использовали метод оценки переносимости человеком недостатка кислорода — подъем в барокамере до высоты 7000 м в условиях покоя и при одновременном выполнении физической нагрузки на велоэргометре с регистрацией ряда физиологических, психологических и биохимических показателей. Полученные результаты легли в основу отбора кандидатов в состав гималайской экспедиции.

В ряде докладов зарубежных специалистов были приведены статистические данные о несчастных случаях при занятиях альпинизмом, в том числе со смертельным исходом, проанализированы обусловившие их причины субъективного и объективного характера и рекомендованы средства профилактики (F. Berghold, Австрия; M. Townend, Великобритания; E. Jenny, Австрия; B. Aleraj, СФРЮ и др.). При этом было указано, что многие чрезвычайные происшествия (ЧП) не связаны с технической сложностью маршрутов и предотвратимы, так как вызваны небрежным отношением восходителей к правилам безопасности. Так, в Австрийских Альпах общее число несчастных случаев при занятиях альпинизмом, горнолыжным спортом, а также дельта- и парапланеризмом в горах возросло с 2532 в 1985 г. до 2988 в 1987 г., однако число погибших при этом снизилось с 283 до 242 человек за счет повышения эффективности работы горноспасательной службы и оперативности оказания срочной медицинской помощи. Как сообщил B. Durrer (Швейцария), в этой стране действуют 3 организации горноспасательной службы, имеющие в своем распоряжении вертолеты, что позволяет через 15—30 мин после вызова прибыть к месту аварии для оказания необходимой помощи. На вертолетах ежегодно эвакуируются из бездорожной горной местности до 1000 пострадавших.

В горных районах ЧССР за последние 30 лет (1958—1987 гг.) погибли 265 человек, при этом в результате срывов и падений — 158 (59,6 %), в лавинах — 41 (15,5 %), от общего истощения и переохлаждения организма — 26 (9,6 %), землетрясений — 14 (5,3 %), удара камнем — 10 (3,8 %), острой горной болезни, поражения молнией и других причин — 16 (6,2 %). Основными причинами этих несчастных случаев чехословацкие специалисты считают невнимательность, неопытность, состояние чрезмерного утомления, переоценку своих возможностей, неправильную страховку, отсутствие каски, восхождения без связки, в одиночку и в плохую погоду, использование неподходящего снаряжения (217 случаев, или 81,9 %); только 34 (12,8 %) случаев произошли в результате удара камнем, поражения молнией и землетрясений. На основании этого анализа ими сделан вывод, что главной причиной ЧП является человеческий фактор, хотя некоторую роль могут играть и так называемые «объективные» факторы — некачественное снаряжение и неблагоприятные условия окружающей среды. Профилактические меры должны включать мероприятия методического, образовательно-воспитательного и организационного характера.

Особую группу докладов составили материалы о специфических патологических явлениях, органических повреждениях и заболеваниях при высотных восхождениях — острой горной болезни и ее осложнениях в виде высокогорных острых отеков легких и мозга, а также о холодовых травмах (B. Kayser, Нидерланды; C. Clarke и A. Pollard, Великобритания; Z. Ryn, Польша; J. R. Morandeira, Испания и др.). При этом была подчеркнута опасность отрицательного влияния существенного и длительного кислородного голодания при подъемах на предельные горные высоты без применения кислородно-дыхательной аппаратуры, что наряду с сильным обезвоживанием и переохлаждением организма послужило одной из причин гибели 13 альпинистов разных стран на вершине К2 (8611 м) только в сезоне 1986 г. (B. L. Holt, Великобритания).

За период с 1971 по 1987 г. было организовано 114 польских экспедиций в Гималаи и Каракорум, в том числе 48 — на вершины высотой более 8000 м, с общим числом участников 986 человек, из них 34 (3,4 %) погибли, в том числе 20 (2,02 %) восходителей умерли от развития острых форм высокогорного отека легких (8), мозга (2) и высотной детериорации (10). У 72 (7,4 %) участников, помимо указанных выше специфических для условий высокогорья заболеваний и патологических состояний, наблюдались такие серьезные явления, как тромбофлебит (9), легочная эмболия (2), бронхопневмония (14), пневмония (10), обострение язвенной болезни (2) и др. (J. Serafin, Польша).

У 371 пешеходного туриста частота наступления острой горной болезни при подъеме на перевал Торонг-Ла (5400 м) в Непальских Гималаях составила 58 % (B. Kayser, Нидерланды).

По данным Z. Ryn (Польша), психологическое тестирование и психиатрическое обследование 44 альпинистов до, во время и после высотных восхождений позволили выявить у 11 из них симптомы органических повреждений мозга,

совокупность которых автор впервые предложил обозначать термином «высокогорная церебральная астения».

Анализ несчастных случаев со смертельным исходом в 83 британских экспедициях на вершины высотой более 7000 м за период с 1968 по декабрь 1987 г. показал, что из 533 участников погибли 23 человека, что составляет 4,3 %. Из них 70 % скончались вследствие аварий, 13 % — от отеков мозга и (или) легких и в 17 % случаев причины смерти выявить не удалось (A. Pollard, Великобритания).

Увеличение числа занимающихся альпинизмом и спортивным скалолазанием, повышение сложности преодолеваемых маршрутов и, следовательно, нагрузок на организм обусловили рост травматизма во время восхождений, соревнований и тренировок, что вызывает серьезную озабоченность и тревогу у спортивных врачей. Этой актуальной проблеме посвятили свои выступления представители Великобритании, ПНР и ЧССР. Ими отмечен рост числа случаев у восходителей и скалолазов экстракласса как острых микротравм, так и (особенно) хронических заболеваний опорно-двигательного аппарата в результате нарушения адаптационных возможностей при перенапряжениях. К таковым относятся повреждения связок, суставов и мышц преимущественно верхних конечностей, особенно кистей и пальцев рук (остеоартрит, надосный тендинит, «веретенообразный» отек пальцев и др.), а также локтевого сустава в виде асептического травматического периостита наружного надмыщелка плечевой кости с воспалением прилежащего к нему связочного аппарата локтевого сустава, что привело даже к появлению нового термина в спортивной медицине — «локоть альпиниста» по аналогии с терминами «теннисный» локоть и «локоть игрока в гольф».

Из остальных докладов следует выделить выступление L. Radlinger (Швейцария) о личном опыте подготовки высококвалифицированных восходителей с использованием различных тренажеров и отягощений. Большой интерес у аудитории вызвала демонстрация разработанных им упражнений (более 60) для развития силы пальцев, в том числе специального приспособления в виде деревянного бруска: конфигурация сделанных в нем отверстий для пальцев учитывает анатомо-функциональные характеристики кисти, что снижает травматизм пальцев на тренировочных занятиях.

Выступления по психологическим аспектам альпинизма свидетельствуют о крайне слабой разработанности этих вопросов.

Председательствующий на заключительном заседании доктор F. Dubas (Швейцария), Генеральный секретарь Международного общества горной медицины, отметил как положительный факт, что впервые подобное мероприятие проводится в социалистической стране и призвал к всемерному сотрудничеству с восточноевропейскими странами.

Е. Б. Гиппенрейтер

Юбилеи

УДК 612.014.482+616.3-001.28/:92 Касьян

Иван Иванович Касьян (К 70 летию со дня рождения)

11 февраля 1990 года исполняется 70 лет со дня рождения и 46 лет врачебной, научной и общественной деятельности доктора медицинских наук, полковника медицинской службы в отставке Ивана Ивановича Касьяна, одного из основоположников космической медицины.

В 1944 году И. И. Касьян по окончанию Архангельского медицинского института был призван в армию. В годы Великой Отечественной войны работал старшим врачом Аэродромного полка противовоздушной обороны.

Научной деятельностью увлеченно занялся еще в годы учебы в институте на кафедре физиологии.

С 1946 по 1955 годы И. И. Касьян занимался научной работой будучи начальником кабинета авиационной медицины, а затем физиологом укрупненной лаборатории авиационной медицины.

В 1968 году Касьян защитил кандидатскую, а в 1976 — докторскую диссертации.

В докторской диссертации он обобщил обширный экспериментальный материал, полученный во время полетов космонавтов на самолете Ту-104А в условиях кратковременной невесомости и во время полета их на различных космических кораблях типа «Восток», «Восход», «Союз».

Экспериментальные данные, полученные И. И. Касьяном совместно с другими сотрудниками на геофизических ракетах и первых ИСЗ, позволили обосновать безопасность полета человека в космос. В 1959 году он принял непосредственное участие в отборе первых советских космонавтов. На самолете Ту-104А в условиях кратковременной невесомости Иван Иванович совершил 420 полетов, в том числе 22 полета с Ю. А. Гагариным и в 141 параболическом полете провел исследования на себе.

Хорошая теоретическая подготовка, личное участие в изготовлении уникальной бортовой аппаратуры и владение широким арсеналом методических приемов исследований, позволили И. И. Касьяну выполнить ряд оригинальных работ по проблеме невесомости, имеющих важное значение для теории и практики космической медицины.

Труды И. И. Касьяна известны как у нас в стране, так и за рубежом. Он является автором 160 печатных работ, из них 7 монографий в соавторстве. Это — «Медико-биологические исследования в невесомости» (1968), «Невесомость» (1974), «Физиологические исследования в невесомости» (1983) и другие.

И. И. Касьян внес весомый вклад в разработку и создание целой серии бортовых приборов: «Левкой-3», «Резеда-5», эспандер ЭД-4, «Динамограф ДП-2».

За участие в разработке новой медицинской техники И. И. Касьян награжден одной золотой, четырьмя серебряными и двумя бронзовыми медалями ВДНХ СССР.

И. И. Касьян ведет большую общественную работу, являясь членом Комиссии по литературе о космосе Союза писателей РСФСР, членом бюро научно-методического совета по пропаганде медико-биологических знаний здорового образа жизни Московской организации общества «Знание». Он автор научно-популярных книг: «Первые шаги в космос», «Союз-Салют-6» — работа на орбите» («Байконур» — (2-й выпуск), «Три, два, один», «Четверо из космической семьи» и другие.

И. И. Касьян неоднократно участвовал в работах международных съездов, конференций и симпозиумов. Он страстный пропагандист и популяризатор космонавтики. С 1960 года систематически выступает с лекциями по линии Всесоюзного общества «Знание».

Советское правительство высоко оценило деятельность

Lékařské aspekty v horolezectví, Praha 1988

MUDr. Ivan Rotman, člen Lékařské komise Světové horolezecké federace

Ve dnech 20. - 23. října 1988 se v Praze uskutečnilo Valné shromáždění Lékařské komise světové horolezecké federace (UIAA) s mezinárodní konferencí o horské medicíně. Každoroční zasedání Lékařské komise UIAA a její vědecký program se od ustavení komise v r. 1981 uskutečnily poprvé v Československu a poprvé v socialistické zemi vůbec. Konferenci pořádal Horolezecký svaz ÚV ČSTV pod záštitou Zdravotní rady ÚV ČSTV a Československé společnosti tělovýchovného lékařství, s finanční podporou tělovýchovných jednot Alpin Praha, Lokomotiva Děčín, Slovan SBČS Praha, Vysokohorské sporty Brno, Tatran Kohoutovice Brno a dalších, jejíž členové se aktivně podíleli i na vlastním organizačním zabezpečení.

Za účasti téměř 200 autorů a posluchačů z 20 zemí bylo ve dvou tématických okruzích předneseno a prezentováno na 45 přednášek a posterových sdělení. Ze SSSR přijelo 12 účastníků, mezi nimi i čelný představitel sovětské horské medicíny profesor Eugen Gippenreiter a z ostatních socialistických států dalších 10 lékařů. Ze západních států se zúčastnilo 43 vědců a lékařů. Nejvíce bylo účastníků z Anglie (9), mezi nimi i profesor James Milledge, známý fyziolog z Harrow, z Itálie (7) a z NSR (6) s profesorem Paulem Bernettem, ředitelem Kliniky pro sportovní traumatologii Technické univerzity v Mnichově a současným presidentem Mezinárodní společnosti pro horskou medicínu. Z Československa bylo 130 účastníků, mezi nimi akademik Ctibor Dostálek, ředitel Ústavu fyziologických regulací ČSAV, profesor MUDr. Zdeněk Fejfar, Dr.Sc., z IKEMu a za Společnost

tělovýchovného lékařství a Zdravotnickou radu ÚV ČSTV docent MUDr. Miroslav Kučera, Dr.Sc., a docent MUDr. Jan Jarolímek, CSc.

V úvodních projevech, zabývajících se současnou problematikou horolezectví ve světě a mezinárodní spolupráce v oblasti horské medicíny (Rotman, Lékař a tělesná výchova, v tisku), vystoupili MUDr. Jaromír Wolf (místopředseda Světové horolezecké federace), Dr. Charles Clarke (předseda Lékařské komise UIAA), docent Miroslav Kučera a profesor Paul Bernett.

Ve chvíli, kdy Jaromír Wolf hovořil o vývoji vztahu člověka k velehorám, o etice v horolezectví, o 13 úmrtích na 2. nejvyšší hoře světa K 2 v r. 1986, nevěděl ještě nikdo z posluchačů, že v uplynulých dnech právě československé horolezectví zaplatilo za své letošní úspěchy při výstupech na himalájské vrcholy sedm lidských životů. Při barometrickém tlaku 253 mm Hg na vrcholu Everestu činí parciální tlak kyslíku v alveolárním vzduchu P_{AO2} 35 a P_{aO2} 28 mm Hg a parciální tlak oxidu uhličitého v alveolárním vzduchu se vyrovnává s hodnotou P_{aCO2} 7,5 mm Hg. Výška Everestu tak fyziologicky představuje právě nejvyšší výšku na zeměkouli, dosažitelnou člověkem bez kyslíkového přístroje. Dospěl vývoj vztahu člověka k horách od Mojžíšova mysticismu přes vědecké poznání nakonec zpět k iracionálnímu lidskému jednání?

<u>Úrazy a poškození zdraví u horolezců</u>

Borislav Aleraj (Záhřeb) referoval o 72 úrazech v Julských Alpách v letech 1946-1985. Ve většině případů se jedná o úrazy hlavy (58%). Zemřelo 22 osob (64% na poranění mozku). Po roce 1966 bylo zavedeno používání přilby a počet vážných a smrtelných úrazů hlavy se snížil. Statistickou nevýznamnost rozdílu mezi obdobím před rokem 1966 a po roce 1966 třeba vysvětlit malým

počtem případů, ale i lepším znalostem a dovednostem, zlepšení jištění a současnou dokonalejší evidencí i méně závažných úrazů. Riziko úrazu se odhaduje na 3 úrazy na 1000 výstupů, riziko smrtelného úrazu na méně než 1 úmrtí na 1000 výstupů.

Jenny a Burtscher (Innsbruck) analyzovali úrazy v rakouských Alpách v letech 1985-1987. Počet úrazů se zvyšuje (z 2832 na 2988), avšak počet smrtelných úrazů klesá (z 283 na 242), což lze přičíst zkvalitnění letecké záchranné služby. Zatímco podíl členů svazu na celkovém počtu noclehů na chatách činí 30%, jejich podíl na úrazech jen 11% (zkušenost, trénink). Většina úrazů se týká lyžařů - v r. 1987 82%. Při skalním lezení došlo ke 119 úrazům (4%), při lezení v ledu ke 27 úrazům (1%). U 242 smrtelných nehod bylo úmrtí způsobeno ve 31% pádem a 29% kardiovaskulárním onemocněním. Počet úrazů při skalním lezení se oproti roku 1986 snížil z 231 na 119(!), zájem horolezců se zřejmě přesunul z hor do dobře zajištěných nevelehorských skalních oblastí, s menším ohrožením zvraty počasí. Výskyt úrazů hlavy se zvýšil na 32% (nejčastější zranění při lezení), prevděpodobně v důsledku nenošení přilby. 54% se zranilo v terénu III. a IV. stupně obtížnosti a potvrzuje to nezkušenost mladých lezců v terénu střední obtížnosti.

M. Townend (Anglie) se zabýval úrazy v Jezerní oblasti Cumbrii. Návštěvnost rychle stoupá a počet úrazů se v r. 1987 zvýšil o 66% ve srovnání s r. 1978 resp. o 150% vzhledem k r. 1968. Během posledních 10 let se počet smrtelných úrazů u turistů zvýšil o 260%. U horolezců počet úrazů nestoupá a počet smrtelných úrazů se snížil na 20% stavu r. 1978. Vývoj úrazovosti při lezení v ledu lze obtížně hodnotit pro velké kolísání, dle podmínek k lezení. V 50% případech bylo nutné hodnotit lezeckou výstroj jako nedostatečnou, nejčastěji chyběla přilba; "je trochu

na pováženou, že dnešní lezci považují holá stehna a magnézium za důležitější než přilbu".

Počet ošetřených pro kardiovaskulární onemocnění se během 10 let zvýšil o 600%, počet úmrtí o 1000%.

O praktických aspektech letecké záchrany v horách hovořil Bruno Durrer (Lauterbrunnen). Ve Švýcarsku dochází ročně k 900 až 1200 úrazům v horách, z nichž 90% je ošetřeno vrtulníkovou záchrannou službou, disponující 15 vrtulníky s nepřetržitou službou. Kterékoli místo ve Švýcarsku je lékařem dosažitelné během 15 minut letu.

Bengt Kayser () analyzoval 353 dotazníků, sledujících výskyt příznaků akutní horské nemoci při přechodu sedla ve výšce 5400 m (Thorong-La, Nepál). Výskyt příznaků byl zjištěn v 58%, byl přímo úměrný rychlosti výstupu a indexu tělesné hmotnosti (tělesná hmotnost/tělesná výška^2). Ženy měly více příznaků a příznaky byly závažnější. Preaklimatizace a tělesný trénink u osob starších 35 let chránily před výskytem horské nemoci. Nebyl nalezen vztah ke kouření, užívání kontraceptiv, ani k předchozímu pobytu ve velehorské výšce.

Charles Clarke (Londýn) pojednal souhrnně o vysokohorském mozkovém otoku (VMO), závažné a často smrtelné formě akutní horské nemoci. V současné době se rozeznávají dva typy - VMO vznikající během aklimatizace a VMO v extrémní výšce. VMO je třeba odlišit od ostatních mozkových poruch způsobených chronickou hypoxií, např. mozkové cévní příhody a psychických poruch.

K VMO dochází zřídka pod 3500 m. Postihuje obvykle osoby ve věku 15-45 let, zpravidla předcházejí několikadenní příznaky horské nemoci. Projevuje se silnou bolestí hlavy, která se

zhoršuje při kašli, při sehnutí a při námaze. V časné fázi se vyskytují i psychické změny od podrážděnosti až po halucinace a stavy zmatenosti. Později dochází k poruchám vědomí. Časným klinickým příznakem je ataxie s vrávoravou chůzí, setřelá řeč a dvojité vidění. Časté je nepravidelné, periodické dýchání, zvláště v noci. Lze najít edém papily, nystagmus, obrny mozkových nervů, pyramidové příznaky a ztuhlou šíji. Průběh může být akutní a k bezvědomí dojde během několika hodin, anebo pomalejší, trvající několik hodin. Jakmile se dostaví koma je úmrtnost vyšší než 60%. V léčení má zásadní význam časná diagnóza a okamžité jednání: sestup pod 3500 m a podávání kyslíku. Dexametazon stabilizuje cévně mozkovou bariéru, u těžké akutní horské nemoci je vždy indikován a podává se v počáteční dávce 16 mg denně. Sedativa a silná analgetika jsou nevhodná. Acetazolamid zmírňuje bolest hlavy jen u lehkého VMO. Je třeba zajistit okamžitý sestup resp. transport i za nepříznivých podmínek, alespoň o 500 m.

Druhá forma VMO se vyskytuje u již aklimatizovaných osob, nepoužívajících umělý kyslík, v extrémní výšce (kolem 8000 m), kde vzniká zcela náhle, bez varovných příznaků. Smrt může nastat velmi rychle.

Pravidelné vyšetřování očního pozadí je jedinou možností, jak odhalit časné stadium.

Sergej Prjanikov (Alma-Ata) referoval o příznivém účinku fenothiazioného preparátu aethaperazinu (chlorpiprasin, neuropax) v dávce 3 x 10 mg p.o. při mozkovém otoku ve výšce 7000 m. Předcházela aplikace 30 mg Lasixu, 0,5 mg Corglyconu a 60 mg prednisolonu i.v.

Zdzislaw Ryn (Krakow) popisuje u horolezců ve velkých

výškách tzv. vysokohorskou mozkovou asténii, projevující se ve 3 formách: charakteropatické (poruchy emocí), encefalopatické (ložiskové mozkové poškození) a neuroplegické (periferní obrny). Patologický EEG zjistil před expedicí ve 3 z 38 případů, ve výšce v 6 z 12 případů a po expedici ve 12 z 23 případů.

Charakteropatický typ zjišťuje v 50% případů (agitace, podrážděnost, výbušnost, sklon k pití alkoholu). U encefalopatického typu (40%) zjišťuje asymetrii šlachových reflexů, nystagmus, poruchy zorného pole a ložiskové abnormality v EEG.

Zmíněnou nosologickou jednotku je třeba odlišit od organických duševních poruch traumatické, toxické, zánětlivé a cévní etiologie. V etiopatogenezi nutno brát v úvahu chronickou hypoxii, poruchy prokrvení a vysokohorský otok mozku.

Jan Serafin (Varšava) se zabýval lékařskou problematikou polských expedic do nejvyšších hor. V letech 1971-1987 se do Himalájí a Karakoramu uskutečnilo 116 expedic s 986 účastníky, 48 expedic směřovalo na vrcholy přes 8000 m. 38 osob zahynulo (3,84%), dalších 96 osob (9,7%) prodělalo závažná, život ohrožující onemocnění. V průměru připadá jedno úmrtí na každou 3. expedici. Příčiny a mechanismy smrtelných nehod: vysokohorský mozkový edém (2), vysokohorský plicní edém (2), vysokohorské vyčerpání - deteriorace (6), plicní embolie (1), srdeční infarkt (1), pád v důsledku extrémního vyčerpání (3), lavina (8), pád do trhliny (1), pád při sestupu (1), utonutí (1), nezvěstnost po zvratu počasí v lehkém terénu ve výškách 6800-7100 m (6). Na smrtelných úrazech se v 8 případech podílely tyto příčiny: stěnový výstup za nejistého počasí, nesprávný výběr trasy po ledovci, nesprávné jištění a nesprávná manipulace s materiálem.

Při podrobnější analýze poukázal Serafin na případy

nedostatečné aklimatizace, nepřítomnost lékaře na expedici, zatajení nemoci, nedostatečné vybavení výškových táborů (chyběl kyslík, léky, nebylo spojení se základním táborem), nerespektování rozhodnutí lékaře, nouzové bivaky v extrémních výškách. Společné pro mnoho tragédií byly 3 znaky: výstup bez kyslíku, příliš dlouhý pobyt v extrémní výšce a pomalá rychlost výstupu.

V průběhu expedic bylo nutné léčit mj. tato onemocnění: bronchitidy a pneumonie (v 8 ze 14 případů byl průběh velmi vážný a vyžadoval intenzivní léčbu s podáváním kyslíku), tromboflebitis (11 případů, v 5 případech velmi vážný průběh - ve dvou případech plicní embolie), masivní krvácení ze zažívacího traktu (2 případy, z nich 1 se týkal expedičního lékaře - příliš brzký příchod do základního tábora, nedostatečná aklimatizace, rychlý výstup na vrchol, příliš mnoho nemocných,...), tříštivé zlomeniny dolních končetin (4 případy, ve 2 provedena ostesyntéza v základním táboře).

Současný trend malých, lehkých, expedic, bez kyslíku a bez lékaře, jakkoli je považován za sportovní, je velmi nebezpečný.

Andrew Pollard a Charles Clarke (Londýn) analyzovali smrtelné nehody při britských expedicích na vrcholy 7000 m a vyšší v letech 1968-1987. 83 výprav se zúčastnilo 533 horolezců, 23 z nich přišlo o život (4,3%, resp. úmrtí na každé 5. expedici). Ve výšce nad 6500 m zemřel dvojnásobný počet horolezců než pod 6500 m. Z toho je nutno usuzovat, že na mnoha úrazech se podílí hypoxie s následným chybným úsudkem, dezorientací a vyčerpáním. Použití kyslíku v krajní nouzi by ve většině případů jistě snížilo počet úmrtí. Výzva k respektování těchto skutečností a ke snížení nepřijatelně vysoké rizikovosti a úmrtnosti v extrémních výškách je velice naléhavá.

Karol Gurský (Prešov) sledoval úrazy v horách na Slovensku v letech 1980–1983. V zimních obdobích došlo k 11 807 úrazům, v letních k 6 786 úrazům. K nejvyššímu počtu lyžařských úrazů dochází během prvních pěti sjezdů. Nejčastějším mechanismem úrazu při horolezectví byl pád (77,1%), následovalo vyčerpání a zasypání lavinou. Na základě zjištění, že příčiny úrazů jsou v 88.4% subjektivní, navrhl protiúrazová opatření v zúčastněných organizacích.

Ivan Rotman (Děčín) rozebral mechanismy a příčiny smrtelných nehod v československém horolezectví v posledních 30 letech. Od r. 1958 do r. 1987 došlo k 265 úmrtím členů Horolezeckého svazu. Ke 158 úrazům (59.6%) došlo pádem, ke 41 (15.5%) lavinou, ke 26 (9.6%) vyčerpáním a podchlazením, ke 14 (5.3%) při zemětřesení, a k 10 (3.8%) po pádu skal. V 16 případech se jednalo o zasažení bleskem (4), akutní horskou nemoc (4), mozkovou příhodu (1), srdeční infarkt (1) a neznámé příčiny (6). Nepozornost, nezkušenost, únava, přecenění vlastních schopností, nedostatečné jištění, nenošení přilby, sólovýstupy, výstupy za nepříznivého počasí a nedostatečná výstroj způsobily 217 úrazů (81%), pád skal, zemětřesení a zasažení bleskem byly příčinami jen 34 (12,8%) úrazů. Protiúrazová opatření mají především metodický, výchovný a organizační charakter.

Edvard Ehler (Pardubice) zpracoval přehled problematiky úrazů způsobených zasažením bleskem (vznik blesku, účinky na lidský organismus, na jeho jednotlivé orgány, léčení a prevence. Úmrtnost se odhaduje na 20–30%.

Rotman a spol. (Děčín) se pokusili o počítačovou analýzu faktorů, které by mohly hrát roli v etiopatogenezi syndromů přetížení a poškození prstů při extrémním lezení. Při klasickém statistickém zpracování některých parametrů u souboru 100 lezců vyšetřených v roce 1987 (Rotman a spol., Davos 1988) bylo zjištěno, že pouze 24 lezců ze 100 vyšetřených si nestěžovalo na zdravotní potíže v oblasti horních končetin. U 69 lezců se jednalo o dlouhotrvající potíže, které u 51 osob postihovaly pouze prsty. Kloubní deformity (vřetenovitá zduření a uzly) a flekční kontraktury se vyskytly ve 44%. Nejčastěji byl potižen 3. a 4. prst, zejména jejich proximální interfalangeální klouby. Oba příznaky – bolest a/nebo deformity a kontraktury byly pozorovány u 52 ze 69 lezců (75%), zvládajících vyšší stupně obtížnosti (7+ až 10– dle UIAA). Tito lezci byli o něco starší (23.9±5.1 vs. 20.9±3.5; $p<0.05$), méně často lezli po skalách (v létě 3.0±1.6 vs. 3.5±1.5 dni v týdnu, n.s.; v zimě 1.2±0.9 vs. 1.8±1.3, $p<0.05$), zato častěji prováděli speciální silový trénink (2.8±1.8 vs. 1.4±1.1 dni v týdnu, $p<0.01$) než lezci bez potíží a patologických nálezů a při potížích méně často přerušovali trénink a lezení resp. zachovávali klidový režim při léčení. Výkonností (dosaženým

stupněm obtížnosti) se však obě skupiny nelišily (8±0.8 resp. 8−±0.9, n.s.).

U tohoto souboru bylo sebráno celkem anamnestických a objektivních 19 100 údajů a nálezů, které byly zpracovány počítačovým programem GUHA, vyhledávajícím statisticky významné souvislosti mezi antropometrickými parametry, profesionálním a sportovním zatížením, způsobem tréninku (a dalšími) a lokalizací subjektivních potíží a objektivních změn na prstech. Kromě potvrzení známých skutečností (např. starší lezci s vyšší tělesnou hmotností a starší, kteří často lezou a trénují mají potíže významně častější), byly zjištěny i další někdy rozporné statistické závislosti, např. skupina starších, lezoucích poměrně často v zimním období a nedosahujících nejvyšších stupňů obtížnosti, jakož i skupina starších, lezoucích často v létě a intenzívně trénujících, nemá významně časté subjektivní potíže (bolest), avšak mají objektivní nálezy na mezičlánkových kloubech prstů (deformity). Naskýtá se několik způsobů vysvětlení: disimulace, vrozená anatomie nebo chyby při vyšetření (?).

Závažným, již známým, zjištěním je skutečnost, že nekvalifikovaný specializovaný silový trénink prstů nezvyšuje výkonnost lezce, naopak má za následek zvýšený výskyt potíží a poškození. Ukazuje se však že se v etiopatogenezi těchto poškození účastní zcela jistě řada dalších faktorů, především genetických (biotypologických), predisponujících k vysoké výkonnosti při extrémně obtížném lezení resp. způsobujících vyšší zranitelnost pojivové tkáně při přetěžování.

Dalším sledováním sportovních lezců Staňkem a spol. byl vytvořen soubor 103 mužů ve věku 23.5±5.2 let, ve kterém bylo bez potíží a objektivního nálezu pouze 19 lezců (18,4%). 18 osob bylo v roce 1988 vyšetřeno již podruhé a u 13 z nich (72,2%) bylo zjištěno zhoršení nálezu. Lezci s potížemi a/nebo s nálezy na prstech byli starší (24,1±5,3 vs. 20,5±3,8, p<0,01), nelišili se frekvencí lezení (v létě 3,1±1,4 vs. 3,5±1,6 dni v týdnu,n.s.; v zimě 1,2±0,9 vs. 1,5±1,3, n.s) od lezců bez potíží a nálezů na prstech, avšak častěji prováděli specializovaný silový trénink prstů (3,1±1,6 vs 2,0±1,6 dni v týdnu, p<0.05). Lezci s potížemi a deformitami prstů však dosahovali vyššího stupně obtížnosti − 8±0,8 dle stupnice UIAA než lezci bez potíží 7−±0,8 (p<0.01).

Velmi obtížné a dlouhodobé léčení stavů přetížení jen zdůrazňuje význam prevence těchto poškození, týkající se především struktury, frekvence a intenzity tréninku. Účinná prevence předpokládá zaměření výchovy sportovce na sebepoznávání a sebekontrolu a vytvoření individuálního tréninkového systému, respektujícího schopnosti jedince a přispůsobující jeho životní styl k tomuto účelu. Neméně důležité je definovat a ověřit biotypologická kritéria vhodného výběru pro tento sport.

Steven Bollen (Anglie) zjistil u 87 sportovních lezců s výkonností dosahující minimálně 7. stupně obtížnosti dle UIAA celkem 115 poranění měkkých tkání pohybového ústrojí. Pouze 11 osob neudávalo žádné obtíže (12,6%). K polovině poranění došlo při tréninku. Jen ve 12 případech (10,4%) byly potíže lokalizovány na dolní končetině (zpravidla adduktory stehna). V oblasti ramenního kloubu se jednalo nejčastěji o poškození manžety rotátorů, v oblasti loketního kloubu tendinitis nebo tzv. "lezecký loket" z přetěžování předloktí v pronaci a semiflexi. Polovina poranění horní končetiny postihovala ruku a zápěstí, nejčastěji proximální interfalangeální kloub 3. a 4. prstu (26,9% resp. 46,3% poranění ruky). Zánět úponu m. flexor digitorum superficialis, tzv. "lezecký prst", je vyvoláván přetížením šlachy při držení drobných chytů při flektovaných proximálních a extendovaných distálních mezičlánkových kloubech.
Another apparently unique injury affecting climbers is avulsion of the A2 pulley from it's attachment to the proximal phalanx, causing bow stringing of the flexor tendons.

Bollen a Bowker (Anglie) studovali otázku, zda přetěžování prstů při extrémně obtížném lezení vede k předčasnému opotřebení kloubů prstů a rozvoji osteoartrózy. U 20 dobrovolníků, kteří po dobu 5 let lezli cesty obtížnosti 9- (UIAA) nebo nejméně 20 let cesty obtížnosti 6+, zhodnotili RTG snímky jejich prstů. Změny se objevují kolem 30. roku věku ve formě malých osteofytů, zduření měkkých tkání kolem proximálních interfalangeálních kloubů a ztluštění corticalis článků prstů. S věkem změny progredují a po 40. roce věku je obraz osteoartrózy úplný. Soubor vyšetřených je však dosud malý, takže na položenou otázku nelze dát definitivní odpověď, avšak je jisté, že starší lezci své prsty ~~své prsty~~ sotva přetěžovali, když lezli daleko snazší cesty.

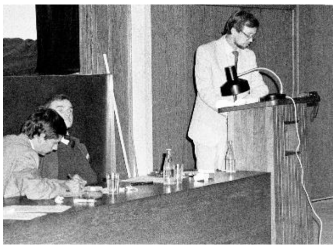
Jan Serafin (Varšava) sledoval 58 horolezců, léčených pro stavy přetížení na ortopedické klinice v letech 1978-1988. Vždy šlo o případy nadměrné zátěže bez předchozího tréniku. Nejčastěji byla postižena Achillova šlacha (lezení v ledu), 4. a 5. bederní obratel, sakroiliakální kloub, 2. a 3. záprstní kost nohy a patelární šlacha (nejčastěji při expedicích a trekingu).

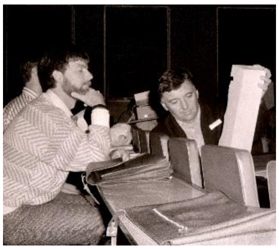
G. Martinez Villen a spol. (Zaragoza) se věnovali specifické traumatologii u lezců: zlomeniny hlezna, tenosynovitis šlach prstů u extrémních lezců, poškození, na kterých se účastní horolezecká výstroj a výzbroj.

J. R. Morandeira a spol. (Zaragoza) se zabývali problematice místního poškození chladem u 97 omrzlých horolezců. Zjistili, že při velmi nízkých teplotách a nízké vlhkosti vzduchu se na vzniku

nekrotických lézí účastní převážně kryogenní účinek chladu a vazomotorická složka stojí v pozadí. Výskyt trofických a funkčních následků je nízký, i když někdy je nutné provést amputaci. V teplotách nad bodem mrazu, ve vlhku a při dlouhé expozici chladu vznikají hluboké vaskulární léze zanechávající závažné funkční a trofické následky. Mezi těmito dvěma extrémy existují i smíšená poškození.

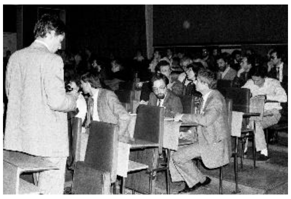
UIAA Mountain Medicine Conference Praha 1988







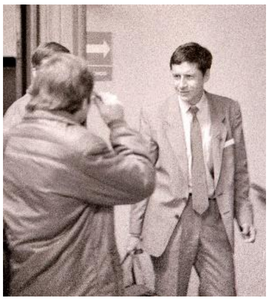

















THE ACTIVITIES OF THE MOUNTAIN RESCUE
SERVICE IN CZECHOSLOVAKIA



















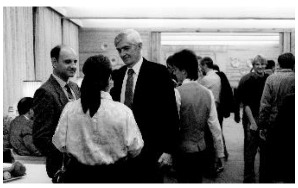


























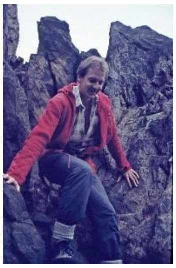


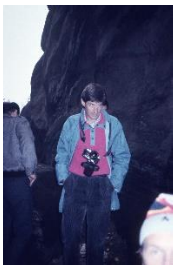
































Pictures in higher resolution are available at i.rotman@volny.cz