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BRAIN AND HEART AT HIGH ALTITUDE

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When climbers hike in high altitude they can suffer from hypoxia. The brain, the autonomic control of the cardiovascular system, which can be evaluated, are affected in the process of activity to adapt to the changes of oxygen concentration in the extreme environment of high altitude.

In the hospital, many post-cardiac arrest patients received therapeutic hypothermia and continuous EEG monitoring to unravel the puzzle of who is more likely to survive. Patients with seizures or status epilepticus have poorer outcome (Resuscitation 2012).

According to a Mayo Clinic Expedition at the Everest base camp in 2012, data gathered on Everest base camp will provide answers of how to better care for patients.

During acute hypoxia, a cerebral swelling occurs early with shift of CSF after 40 minutes of hypoxia and can be studied by MRI. These changes occur in all subjects independently from their susceptibility to acute mountain sickness. Sleep alteration and its relation with periodic breathing increase with altitude as already known from earlier studies in Italy at Capanna Margherita by Mosso.

In high altitude, sleep architecture becomes progressively more disturbed and periodic breathing more frequent, while REM sleep is preserved. We have observed during a mountain medicine course in Gokyo region and Everest K2 Pyramid, the occurrence of sleep disturbances, dreams and nightmares, which may contribute to psychic homeostasis and adaptation to high altitude.

Brain and heart interaction at high altitude have been recently studied and represent an interesting field of clinical investigation.

THE RESPIRING BRAIN – THE REGULATION OF MITOCHONDRIAL FUNCTION AND SIGNALING BY HYPOXIA

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Mitochondria play an essential role in the regulation of cellular energy metabolism and signaling and as such for cell survival. Mammalian organs with high energy requirements, such as the brain, essentially depend on oxidative mitochondrial energy metabolism and thereby the availability of oxygen representing the energy substrate for cytochrome c oxidase (COX). COX is the terminal, often rate-limiting and highly regulated enzyme complex of the mitochondrial respiratory chain. We could show that the mammalian enzyme is regulated under hypoxic conditions what turned out to be a crucial mechanism for increased cell vulnerability. For instance, COX is enabled to sense the intracellular energy level (ATP/ADP ratio) by binding ATP to one out of thirteen subunits of the COX complex (COX subunit IV-1). This causes an allosteric inhibition of the enzyme at high energy level and thus plays an important role in adjusting energy production to cellular energy requirements.

However, in the brain under hypoxic conditions, a second isoform of this subunit, COX IV-2, is induced in brain cells causing a suppression of COX sensitivity to the cellular energy level and an increase of mitochondrial peroxide production. In turn, this affects brain cell survival during and after hypoxia and suggests a pivotal role of COX as an oxygen sensor for mitochondrial signaling and brain function. Moreover, this indicates a similar regulatory mechanism for other organs with high energy demand.

CHANGES IN PRESSURE AND VOLUME OF THE PULMONARY CIRCULATION DURING ACUTE EXPOSURE TO HIGH ALTITUDE AND PHYSICAL STRESS – RESULTS OF THE ADEMED EXPEDITION 2011

Bartz N.[1], Apel C.[2], Bertsch D.[3], van der Giet S.[1], Grass M.[1], Gschwandtl C.[1], Kühn C.[1], Müller-Ost M.[1], Risse J.[1], Schmitz S.[1], Timmermann L.[1], Wernitz K.[2], Küpper Th.[1,4]

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Background: At altitudes beyond 2500 meters, there is a risk to develop High Altitude Pulmonary Edema (HAPE). The risk grows with the increase of pressure of the pulmonary artery. The exact increase is not predictable yet because, besides the high altitude itself, the relevance of individual risks and behaviour (load, speed of ascent…) are still unclear.

Methods: We analyzed the systolic pulmonary pressure (PAPs) as well as the maximum regurgitation flow (v_{max}). Both are considered crucial factors for diagnosing a pulmonary hypertension by echocardiography. Measurements were performed at Lukla (2860 m), Gorak Shep (5170 m) and the summit of Kala Patthar (5675 m), all located in the Solo Khumbu region / Nepal. Echocardiographic data were correlated with workload (speed of ascent), load of backpack and probands (age, gender…).

Results: 33 male and female probands (20-65 years) were included in the study. A key finding of our study was that the difference in altitude of 500 meters between Gorak Shep and Kala Patthar led to a nearly doubled risk of suffering pulmonary hypertension (39,4% compared to 75%). Correlations with other factors like weight of the backpack, age, sex, body mass index and the probands' personal fitness were analyzed but there was no correlation with the pulmonary pressure. Even a very homogenous collective (age, weight of backpack, profile of altitude, body mass index) showed very different pulmonary pressures at altitude. The correlation between pulmonary hypertension and the altitude profile showed only low significance. The same is true for the correlation between heart efficiency and pulmonary hypertension. Preexisting Hypertension and previous heart diseases seem to have little impact on the pulmonary pressure. Nevertheless, given the relatively small number of probands having suffered from such previous diseases, a final statement cannot be made and would require further studies.

Conclusion: The pulmonary pressure increases significantly at high altitude. Nevertheless, the appearance of HAPE seems to depend mainly on individual factors independent from the parameters which were analyzed in the actual study.

INCREASE OF OXYGEN SATURATION IN SLEEPING MOUNTAINEERS DURING THE SECOND PART OF THE NIGHT AT A LONG TIME STAY AT HIGH ALTITUDE (3000M-6768M)

Brenner F. (lecture held in memoriam by M. Tannheimer)

Introduction: Measurement of oxygen saturation is a common tool to evaluate the distinctive hypoxia occurring during a stay at high altitude. As intermittent monitoring of the SaO_2 in sleeping mountaineers is a disturbing process for the test person and acquires additional effort, we approached this problem with continuous SaO_2 measurement. The aim of the study was to describe the trend of the saturation and to make a conclusion about the maximum decrease of the SaO_2 in sleeping mountaineers at high altitude in comparison with the daily saturation at rest.

Methods: A homogenous group of ten experienced mountaineers were equipped with pulse oxymeters that can memorize 72h of SaO_2 measurements. The data contains the heart rate, SaO_2, date and time. Every 4 seconds those four parameters are recorded and saved. This data collected for each mountaineer is transferred on a notebook at least every third day. While the mountaineers stay in Peru from 30.05.-30.6.2010 about 240.000 SaO_2 measurements per person have been collected. During ascents the group used ear clips as sensors, in the night they changed to finger clips. Every participant had to keep a diary to journalize special events or the periods in which they had been awake at night. To evaluate the sleeping saturation we extracted 2 hours of measurement before 12 a.m. (N1) and 2 hours afterwards (N2). To make sure that the subjects are sleeping we referred to their records in their diaries. In addition we extracted those measuring periods in which an increasing heart rate showed us the alertness of the test persons. As a reference each morning the SaO_2 of every test person at rest was measured.

Results and Discussion: An enormous decrease of the SaO_2 during sleep in comparison with the day SaO_2 at rest can be seen. In the first night after arrival in Huaraz (3050m) for example, the N1 night SaO_2 of the Group was MED 83,5%

(Min: 77%; Max: 86%) whilst the day saturation was 9%-points higher, MED 92,5% (Min: 91%; 96%). For the second part of the night we measured SaO_2 with MED 86,5 (Min: 84%; Max: 88%). These results lead us to compare the mean saturation of the N1 measurement in each subject with the correspondent N2 saturation in further nights. We surprisingly found, that in most cases the mean saturations in the second part of the night are significantly higher. This difference could be due to the circadian excretion of adrenocortical hormones. Exact calculations on the degree of saturation increase between N1 and N2 are in progress and could be discussed in the audience.

THE SPORTSWOMAN IN SPORT CLIMBING – RECOMMENDATIONS FOR ATTENDANCE IN SPORTS MEDICINE

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In the last decades sport climbing developed into a popular recreational and international competitive sport with an increasingly proportion of sportswomen. During pregnancy the international recommendations accentuate the benefit for regular sport activity. In this context sport climbing is wrongly associated with a high risk potential. This review gives advice for attendance in sports medicine for gender specific injury rate und sport climbing in pregnancy.

We found no significant gender specific differences for injury rates - but there were gender-specific specific climbing habits influencing the risk potential. Sportswomen prefer the toprope climbing and rather second lead than the lead climbing. The medical attendance of sportsman and sportswoman can be carried out gender unspecific and should be rather related to the athlete, the athlete profile and the individual climbing level with the involved risk factors.

Furthermore we found the tendency that sport climbing can safely be done during pregnancy. Recommendations should be a risk minimization through a change from lead climbing to toprope climbing in the hall. Furthermore vertical, possibly known routes, about 2 degrees under the limit of performance should be preferred. Generally the individual abilities of the sportswoman should be taken into account.

NOISE EXPOSURE AND HEARING THRESHOLD AT ALTITUDE IN NON-ACCLIMATIZED AND ACCLIMATIZED PERSONS – RESULTS OF THE ADEMED EXPEDITION 2011

Fehrenbacher K.[1], Apel C.[2], Bartz N.[1], Bertsch D.[3], van der Giet M.[1], van der Giet S.[1], Grass M.[1], Gschwandtl C.[1], Kühn C.[1], Müller-Ost M.[1], Porath S.[1], Risse J.[1], Schmitz S.[1], Timmermann L.[1], Wernitz K.[2], Küpper Th.[1,4]

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Occupational noise induced hearing loss is still one of the most frequent occupational diseases. Thresholds of noise levels to protect worker from loosing their hearing capabilities have been established. Actually 80 dB(A) is considered as action level where noise protection becomes mandatory. However, all investigations done so far to establish such levels were performed at (or at least near) sea level in normoxic conditions since such conditions are found at the most common working places.

Nowadays there are several working situations in hypoxic conditions such as construction or maintaining at high altitude, helicopter rescue in the mountains, or in rooms equipped with systems for isobaric hypoxia for fire protection. Here the noise level may also exceed a certain limit, but the impact on the human may differ in „HyPoBAR" and „NORMOBAR" conditions. The existing thresholds to avoid noise induced hearing damage do not take into account that hearing is an energy consuming process and that the inner ear gets its oxygen supply via a quite long distance by diffusion. Therefore the inner ear may be at risk for "energy exhaustion" even at lower noise levels than in normoxic conditions.

We investigated this problem in a two-step study with subjects hiking at high altitude (hypobaric hypoxia up to about 5600m) in the Solo Khumbu region to get data about acute exposure as well as the effect of acclimatization. The subjects performed a standard audiometry before and after an exposure to random noise of 90 dB(A) for 10 minutes. For physical

(mechanical) reasons the noise levels had to be increased by every 1000m of altitude. The second part of the study will check non-acclimatized persons at similar "altitudes" (so called corresponding altitudes) in isobaric conditions by an indentical procedure except the increase of noise levels since there is no mechanical difference in the transmission of sound in different but isobaric conditions..

Preliminary data of the Solo Khumbu-group suggest that the ears are at risk in acute hypobaric hypoxia. Although there is a variance between the individuals there is a significant temporary threshold shift in most subjects. After acclimatization this shift does not show significant differences compared to the measurements before acclimatization at the same altitude which suggests that acclimatization does not provide protection to the inner ear.

TACTICAL TRAINING FOR BEGINNERS IN SKI TOURING

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Introduction: In contrast to many endurance sport-disciplines a special tactical problem exists in ski touring: The intensity of exertion must be arranged over a space- or time-distance, which can be estimated only roughly, e.g. depending on terrain-profile, type of snow, weather/wind. To reach the destination without exhaustion and with metabolic reserves to ski down, the athlete has to learn how to manage his intensity of exertion. So we conceived a special tactical training-program in the region of Berchtesgaden.

Methods: A standard test track (beginners level, height difference: 726 m) was fragmented in 10 percentage checkpoints, depending on steady exertion of an experienced athlete. By this system, the distances between the 10%-checkpoints vary, but the desired time intervals of the performing subj. (depending on steady exertion) should not. Using this exertion-related feedback 10 subj. (1 f, 9 m) should arrange their walking-speed autonomously until the upper destination. After reaching the destination-hut, all subj. received a feedback-paper with data about heart rate and time accuracy.

Results: All subj. reached the upper destination without exhaustion. By interviews 9 of 10 subj. were interested in participating such a tactical training again (1 case without answer). In repeated experiments a learn-effect resulted: better steadiness of the time intervals and better performance (total time:*1st: 104 ± 19 min, 2nd: 90 ± 14 min, n = 5*), even the beginner reached the upper destination with adequate times between the intervals and heart rate variations. Heart rate: Mean of all values: 149 ± 16/min, 1st/5th/last interval (138/146/158 /min). After a recreation break in the destination hut 9 subj. were able to ski-down without problems, 1 beginner (marathon runner without skiing experience) was not by missing technique.

Conclusions: We were very contented with the acceptance of our subj. to this new training principle. All (including the inexperienced subj.) reached the upper destination without previous exhaustion and with a sport-adequate exertion. Only a few repetitions allow to learn a better exertion management by feedback of the percentage points. So we are sure, that this learned ability can be transferred into unknown terrain to sustain a better exertion management. We hope that this exertion-orientated training principle will especially help beginners in ski touring to avoid previous exhaustion and by this to spend a safer feeling for alpine skiers to discover the joy of ski touring.

Acknowledgment: Thanks to Alpines Gesundheitsforum Berchtesgaden for organisatoric and financial support.

TRIP PREPARATION AND MEDICAL SAFETY MANAGEMENT OF TREKKERS IN THE SOLO KHUMBU / MT. EVEREST REGION, NEPAL – RESULTS OF THE ADEMED EXPEDITION 2011

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Background: The field study was performed to get data about the actual situation concerning trip preparation and safety management of trekkers.

Methods: A standardized questionnaire was handed out to trekkers in the Solo Khumbu region / Nepal.

Results: 366 participants (215 male, 148 female), mean age 38.8 years (18 to 74 years) from a total of 37 nations participated (most common: Great Britain (UK 14,2%), Germany (D 13,9%), Australia (AUS 12,6%), USA (12,3%), Canada

(CA 5,7%), Switzerland (CH 5,7%)). 44.2% didn't have any trekking experience, 39% trekkers were never above 3000m, 80.1% had no medical knowledge. 68.4% were on an organized (commercial) trekking trip while 27.1% organized their trip by themselves.

Group 1 (commercial trekking, N = 250): 88.8% received general information concerning the trekking route and its altitude profile; 71.6% said they were informed that the tour would require certain technical and physical requirements (whether they fulfilled these requirements was checked in 19.6%). 64% of the participants were informed about recommended vaccinations and 62.8% were guaranteed first aid throughout the whole trip. 58% said that their tour guide knew about their preexisting illnesses. 34.4% reported an unexpected medical event / emergency in their group during the actual trip

Group 2 (individual trekking, N = 101): 81.2% sought general information (about half of them from a doctor for travel medicine or a friend, about 60% were searching the internet or literature for information). About 40 – 50% (depending on the type) informed themselves about recommended vaccinations. 68.3% checked regularly whether they were good acclimatized, 57.4% said they were able to perform first aid, 30.7% had knowledge about rescue strategies. However, 46.5% suffered from altitude based problems and 17.8% experienced an emergency. 41.6% thought about an emergency plan before they started the trip and 63.4% planed how to pay repatriation if necessary

Conclusions: It is important to address people who book their tour with an operator to give them travel medical advice before (!) the finish booking, to emphasize on vaccinations, to teach more first-aid or advise to take a first-aid-class before going. Travel medical advice should include topics like travel insurance and repatriation. It is important to take enough time to acclimatize well to prevent altitude problems and emergencies

DRUG USE IN THE MOUNTAINS

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There is along history of the use of proven or potential performance enhancing drugs in mountaineering. It appears that this behaviour is increasing, becoming more accepted and even encouraged by some organisations. Potential interactions between these drugs and with drugs being used for pre existing conditions are causing increasing potential problems.

For several years the UIAA has struggled to produce an advice sheet on this subject whilst struggling with the associated ethical aspects. We think we may now have reached a stage when we can make a statement. This talk will outline the dilemmas and pitfalls of our work.

DIABETES: PERSONAL PRACTICAL EXPERIENCE OF MANAGEMENT OF DIABETES IN THE FIEID

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With the global increase in Diabetes doctors are increasingly likely to have to advise Diabetic mountaineers. Diabetes is not a contraindication to being active in the mountains but necessitates the acquisition of an extra skill set in addition to normal mountaineering skills.

This talk will look at the very practical aspects of diabetes self care in a potentially hostile environment, sources of advice and peer support groups.

NECESSITY OF CLOTHING BEHAVIOUR REGARDING HEAT AND COLD DURING TREKKING ABOVE THE SNOW-LINE – RESULTS OF TEMPERATURE-MEASUREMENTS (DAY/NIGHT) INSIDE AND OUTSIDE OF THE TENT

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Introduction: Concerning trekking above the snow-line, most people think about coldness. For experienced mountaineers it is clear, that in the cold environment and full sunshine, combined with internal metabolic heat-production, heat exposure exists too. Therefore we measured air-temperature under realistic conditions.

Methods: During a DAV-trekking in Nepal, 8 days in tents (4850-5780 m, 29.4.-06.5.2013) temperatures (° C) were measured continuously by 2 LOG 32 systems (70 g, each; http://www.fkr.de/6523/DB_log32_DE.pdf): Inside tents and outside tents in shade at ground level.

Results: Lowest/highest temperatures in the tent: -15/+43° C, lowest/highest temperatures outside: -9/+24° C. Further results: see table 1, 2 & 3.

Table 1. *M = mean, Cint = temperature in the tent; Cext = temperature outside, Corr. time = Corresponding time for Min (minima)/Max (for maxima), Diff. °C = mean intra-day difference, Difference °C = Difference outside – inside, min = minute, n = 7*

		in tents					Outside tents		Difference °C	
	Height	Cint	Corr. time	Cint	Corr. time		Cext		Intern minus extern	
	m	Min		Max		Diff °C	Min	Max	Min	Max
M	5220	-6.1	4:55	26.7	14:50	32.8	-2.7	8.1	- 3.4	18.6
s_D	480	5.7	11 min	3.5	11	2.2	6.6	1.8	1.0	5.2

Table 2. *Rel. humidity %) at corresponding times, abbreviations see table 1, n =7*

	Inside tents				Outside tents	
	Rel.h.	Corr.time	Rel.h	Corr.time	Rel.h	Rel.h
					Min	Max
M	85 %	4:55	30 %	14:50	52 %	63 %
s_D	3	11 min	3	11 min	4	3

Table 3. *Temperature (° C) outside in shade at ground level (n = 6)*

	CMin	Min	Cmax	Max
M	-2.4	5:41	14.9	14:14
s_D	6.4	1:00	3.0	1:04

Discussion and conclusions: Our centigrade-values are not identical with effective-temperatures, e.g. from Yaglou, they are not calculated depending on radiation, wind velocity etc. Diffuse infrared radiation might influence the measured values more in shade outside than in the tents. The negative difference between minimum in tents and outside (ca. 4:55, before sunrise) could be caused also by the outside measurement-point at ground level. However: Our values show distinct variabilities depending on outside/inside and during the day, demonstrating, that heat exposure might occur above the snow line even in heights > 5000 m. The maximal outside-value (+ 23.5° C) indicates a surprising temperature in great height and the necessity of clothing behaviour also to warm conditions, particularly in combination with metabolic heat-production and warming up by sunshine. Finally these orientating values show the necessity to adapt actual clothing behaviour to differing climate-conditions. Especially beginners in similar expeditions should regard this.

COGNITIVE PERFORMANCE IN HIGH MOUNTAINS AND SIGNS OF ACUTE MOUNTAIN SICKNESS IN CLIMBERS AND TOURISTS

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Introduction: Exposure to high altitude causes a lot of changes in human organism due to many environmental stressors. The most important of them is hypoxia which disturbs functions of all organs and systems. Heavy physical exercise undertaken by climbers who attempt to be better than others increases oxygen deficit. Central Nervous System /CNS/ is characterized by high metabolism and sensitivity to hypoxia.

Aim: The goal of present study was to determine if environmental conditions of high mountains and very high mountains /3200 - 5600 m/ disturb cognitive performance and well-being of mountaineers,

Second goal was comparison of effects of these conditions on cognitive performance with effects of pure hypoxia on cognitive performance in hypobaric chamber.

Third aim was to assess prevalence of symptoms of Acute Mountain Sickness and to determine if these symptoms affect cognitive performance.

This has a great importance for life and health of climbers in view of dangers, like avalanches and risk of falling down and prevalence of Acute Mountain Sickness /AMS/.

Methods: Cognitive performance and symptoms of Acute Mountain Sickness were studied in 28 healthy climbers and tourists in hypobaric chamber and high mountains: French Alps /3600 m/ and Caucasus/2200-5642 m/. Before departure the climbers completed a questionnaire including variables such as sex, age, height, weight, health, previous high altitude experience and knowledge of AMS. They also performed physical exercise on a bicycle ergometer to estimate their maximum oxygen uptake.(VO2max). Cognitive performance was assessed through use of portable hand-held computer PSION Organizer II.

Program used in the study was specifically designed for field research under adverse environmental conditions. It included some cognitive performance tasks: choice reaction time and two versions of Sternberg memory probe. There was also some programs for collecting subjective questionnaire type data as a sleep diary, alertness and mood scales. Prevalence of symptoms of Acute Mountain Sickness /AMS/ was studied using Environmental Symptoms Questionnaire /ESQ III/. Climbers who were scored 0.7 and over in classification of cerebral form of AMS /AMS-C/ or 0.6 and over in classification of respiratory form of AMS /AMS-R/ were considered to suffer from AMS.

Results: An average maximum oxygen uptake of studied subjects was 54.6 ± 6.4 $ml \cdot kg^{-1} \cdot min^{-1}$.No significant decline in cognitive performance was observed in any test, besides an increase in the number of errors both in choice reaction time at 4600 m and Sternberg memory probe at 4200 m and 4600 m in mountains. The time per response even decreased at 2100, 4300 4200 and 4600 m in Sternberg memory probe. At 5500 m in hypobaric chamber number of errors both in Sternberg memory probe and choice reaction time increased. Alertness and mood were found to be unrelated to altitude exposure. Sleep disturbances occurred over 2200 m while insomnia was observed at 4200 m. Prevalence of AMS in nonacclimatizated mountaineers was 67% at 5642 m and 42% at 3600 m with predominance of respiratory form /AMS-R/. At 4200 m in acclimatized climbers prevalence of AMS was only 22%. During 1-hour stay in hypobaric chamber at “altitudes” up to 5500 m with short period of physical exercise at 4000 m 50% of climbers showed some symptoms of AMS.

Conclusions: There appear to be no harmful effects on cognitive performance of healthy and fit climbers under conditions of short stay in high mountains up to 5600 m, despite prevalence of moderate symptoms of Acute Mountain Sickness, which is 67% at 5600 m with predominance of respiratory form. Hypoxia increases number of errors in cognitive performance tasks during 1-hour stay in hypobaric chamber at “altitudes” up to 5500 m.

Alertness and mood are related to the danger, not to the altitude exposure. Activation of sympathoadrenal system probably enables resistance of cognitive performance against hypoxia and other environmental stressors in high mountains.

CARDIOVASCULAR CHANGES AND ACUTE MOUNTAIN SICKNESS IN MT. OLYMPUS WINTER CLIMBING

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Introduction: Climbing at high altitude causes hypoxaemia in the human body due to the decrease of the atmospheric pressure. Thus the partial pressure of oxygen (PO_2) drops as we advance in altitude. The effect in human physiology is prominent in the cardiovascular system with tachycardia and decrease in oxygen saturation in the arterial blood (SaO_2). Acute Mountain Sickness (AMS) may appear as a pathological entity in high altitude.

Our progressive study aimed at revealing changes in oxygen saturation (SpO_2) and heart rate (HR) together with a possible onset of AMS during a winter ascent of Mt. Olympus.

Mt. Olympus with its top peak Mytikas (2918m) is the highest mountain in Greece and this is the first time such a study takes place in the Hellenic mountains.

Objective: 31 climbers (average age 39.4±8.7y, average BMI 24.0±2.5kg/m^2) with good physical condition and free cardiovascular history made a three day scheduled ascent (23-25/03/2012) to Mytikas peak (alt:2918m, BP:542mmHg, PPO_2: 113mmHg).

Methods: Day 1: The team entered the National park of the mountain at 950m and spent the night at Kakalos refuge (2650m). Day 2: summit attempt and spent 2nd night at the same refuge. Day 3: Descent. Heart Rate (HR) and oxygen saturation measurements (SpO_2) were taken with a portable pulse oximeter at sea level, at 2650m (during arrival), at 2650m (during departure) and at the summit (2918m). Acute Mountain Sickness (AMS) was screened with the use of Lake Louise Consensus Scoring System for Acute Mountain Sickness-LLS score.

Results: There was a drop in oxygen saturation (SpO_2) in all of the climbers while heart rate (HR) was raised. Five people displayed symptoms of mild AMS (3 ≤ LLS score < 5).

	Sea Level	2650m (arrival) 1st day	2650m (depart) 2nd day	2918m (summit)
Oxygen Saturation, % (mean+/-SD)	97.5 ± 0.8	92.7 ± 2.1	93.7 ± 3.1	91.8 ± 2.6
Heart rate, min^{-1} (mean+/-SD)	79.6 ± 12.3	93.7 ± 10.2	89.0 ± 12.2	90.7 ± 13.4

$P < 0.05$ compared to sea level measurements

Conclusions: Climbers at Mt Olympus(2918m), exhibit hypoxaemia and tachycardia even symptoms of AMS near the summit especially when spending their first night above 2500m. With AMS incidence: 16% our results should be considered with caution by climbers even in low altitude mountains.

FIRST AID KNOWLEDGE AND EMERGENCY MANAGEMENT WHILE DOING VIA FERRATES

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Background: The popularity of doing via ferratas in the region of the European Alps has increased a lot. We have analysed the pattern of injuries from accidents, which have occurred on via ferrata, and First Aid (FA) knowledge from the persons on such alpine routes. The aim was to create specific FA courses for those sports persons. FA in the mountains differs to the first aid in urban regions because the conditions in the wilderness are completely different to the cities. Consequently the FA knowledge should be adopted to such conditions. Additionally the time which the rescue service needs to reach the patient is much longer than in urban regions. Therefore the victims depend on the FA knowledge of their companions. Because of the rising popularity of the via ferratas – pushed by tourism bureaus which promote them as easy and safe alpine adventure which brings more and more people with less experience in climbing and mountaineering – the number of accidents while doing via ferrata showed an extreme increase during the past few years. Preventive strategies are therefore necessary.

Methods: A total of 391 questionnaires could be collected at the Fiderepass Hut (2070 m, Allgäu Alps, Germany) and the Tuckett Hut (2272 m, Brenta, Dolomite Alps, Italy). The participants were asked for demographic characteristics, overdue injuries and accidents while doing via ferrata. Then 18 questions about first aid in a wilderness region were asked. At the end the participant had to estimate their own first aid knowledge. The questions about FA were similar to those of a previous study and had been evaluated at a group of physicians trained in Alpine Medicine.

Results: 391 of 430 questionnaires could be evaluated (return rate 90.0%). FA knowledge of via ferrata climbers does not meet the demands, e.g. many participants were able to make the diagnosis a myocardial infarction – an extremely rare event in the mountains – but couldn't handle the initial treatment of a fracture, which is more likely while doing via ferrata. Details about all the different topics are summarized in fig.1 and will be discussed together with the collective data during the lecture.

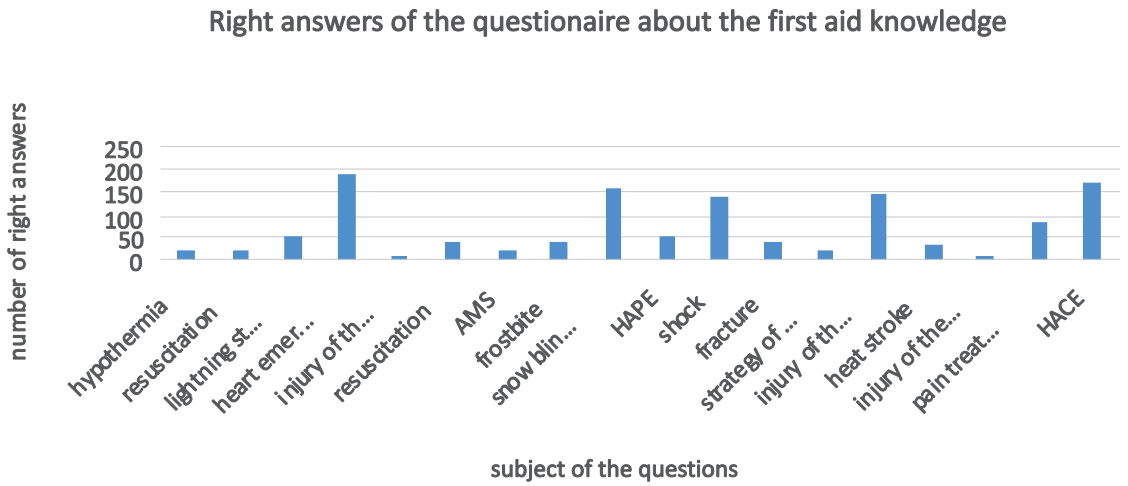

Fig.1: *Summarized results of the questionnaire*

Conclusion: Most people who do via ferratas don't meet the minimal requirements of the specific FA situation on such routes. Specific FA courses are mandatory.

THE SUGGESTED MEDICAL CHECK „G28 – WORK IN HYPOXIA" IN GERMANY – ANALYSIS AND CRITICAL REMARKS

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Recently the insurances in Germany have published a suggested concept how to take care for employees who work in hypoxic conditions. Partially these suggestions take the concept of UIAA MedCom into account. However, there are several details which are not evidence based and some simply ignore basic physiology.

The paper focuses on altitude disease, although this should not be a problem for such employees who are exposed to mild hypoxia for a limited time only. The authors make an artificial construction when they state differences between isobaric and hypobaric hypoxia. Since decades it is well established that such differences may be relevant well above 6000m only (e.g. [1], [2]). In consequence the data which were established over more than a century should be used to answer the actual questions in occupational medicine. In fact, all the actual problems may be solved with the standard handbooks published in the late 19th century [3], [4], [5].

Some statements are simply wrong, e.g. that below 13% isobaric oxygen there is a high risk for acute problems. In fact the time of useful consciousness is unlimited up to 5000m rsp. 10.5% O2. The lecture will discuss such topics of the paper which causes trouble in the practical use and will give evidence based solutions.

The most important facts for work in isobaric hypoxia are as follows: anybody who does not suffer from a severe disease of heart, lungs, or red blood cells – e.g. insufficiency NYHA III/IV – is able to work in such hypoxic rooms. The most important safety advice is to leave such rooms whenever the employee should feel uncomfortable.

References

1. Savourey G, Launay JC, Besnard Y, et al. Normo- and hypobaric hypoxia: are there any physiological differences? Eur J Appl Physiol 2003; 89(2): 122-6
2. Barcroft J. Respiratory function of the blood. Part I. New York: Cambridge University Press; 1925.
3. Bert P. La pression barométrique. Paris: Masson; 1878.
4. Mosso A. Der Mensch auf den Hochalpen. Leipzig: Verlag von Veit & Comp.; 1899.
5. Zuntz N, Loewy A, Müller F, et al. Höhenklima und Bergwanderungen in ihrer Wirkung auf den Menschen. Berlin: Deutsches Verlagshaus Bong & Co; 1906.

WORK IN HYPOXIA: THREE DIFFERENT SITUATIONS, THREE DIFFERENT SOLUTIONS

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Background: A more and more international economy increasingly faces "exotic" working conditions which require specific solutions. Three different situations of work in hypoxia at high / extreme altitude and the strategy to avoid AMC, HAPE, or HACE will be presented.

Situation 1: The astronomers of the European South Observatory, located at the Chajnantor plateau (Atacama Desert, Chile) at 5,041m. The employees travel there by car from sea level in about 2 hours.

Situation 2: A German company has to built a hydropower station near Lin zhou Villag (Tibet, ~80km from Lhasa) at 4005m. Access from Germany by aircraft to Lhasa and then by lorry (~4 hrs). Sometimes internet available, satellite phones forbidden in Tibet, no ambulance helicopter.

Situation 3: Soldiers and rescue personnel for operations at 4,000 to 4,700m (Afghanistan), altitude of camps: 459m (Kunduz), 486m (Marsa al Sharif).

Solutions / advices: Similar in the three situations is the acute exposure of people to high altitude / hypobaric hypoxia. While the astronomers work (mainly) in a confined space the others don't. The atmosphere in the observatory was set at 27% oxygen, corresponding physiologically to an altitude of ~3,000m. The workers were pre-acclimatized in isobaric hypoxia before departure. Acetazolamide may be additionally used. One employee did not follow this strategy and sufferend from severe pulmonary hypertension and high altitude pulmonary edema (HAPE) at the construction site. The soldiers cannot acclimatize properly for safety reasons. Members of special forces sleep in isobaric hypoxia to keep acclimatized. Details about the different strategies to avoid altitude disease and to maintain optimal performance will be given and discussed.

THE ADEMED EXPEDITIONS 2008 AND 2011 – FIRST RESULTS

Küpper, Th.[1,4], Gschwandtl, C.[1], Apel, C.[2], Bartz, N.[1], Bertsch, D.[3], van der Giet, M.[1], van der Giet, S.[1], Grass, M.[1], Kühn, C.[1]; Müller-Ost, M.[1], Risse, J.[1], Schmitz, S.[1], Timmermann, L.[1], Wernitz, K.[2]

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In 2008 and 2011 scientific expeditions which were included in a teaching concept were performed to the Annapurna and to the Solo Khumbu / Nepal. The scientific programme focused safety management and First Aid knowledge of trekkers, dental problems of trekkers, molecular studies concerning oral flora and the risk for gingivitis or parodontitis, MMP-8 as a possible marker for gingival problems, water hygiene, trekking with preexisting diseases, pulmonalarterial pressure during sleep at altitude and during ascent to extreme altitude with different loads and speed, and others.

The teaching concept aimed to enable students to organize a scientific expedition to remote regions. The lecture introduces the philosophy of the concept and summarizes the first results which are not presented otherwise during the actual conference.

MEDICAL AND COMMERCIAL ETHICS IN ALTITUDE TREKKING

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With two actual cases the problem of commercial trekking and the inacceptable lack of safety management of such sojourns will be discussed. Both cases happened during the ADEMED Expedition 2011 (www.ademed.de):

While visiting the Himalayan Rescue Association's (HRA) rescue post in Pheriche (4200 m), a Norwegian climber staggered in carrying a porter, more dead than alive, over his shoulder. The porter, from the lowlands of the Terai, had been working for an American trekking group that had ascended rapidly to Lobuche (4940 m). After leaving from Pheriche, the porter had developed high altitude pulmonary edema (HAPE), which was correctly diagnosed by group members. But instead of giving him appropriate treatment and arranging evacuation, they simply distributed his load to other porters and continued their ascent. The sick porter was left to fend for himself with life-threatening HAPE. Fortunately, the Norwegian who came across him several hours later was strong enough to carry him down the 400mto Pheriche and in doing so saved the porter's life.

For the second case we were contacted at Gorak Shep (~5300m): He had dyspnea at rest, an oxygen saturation of 57%, a pulse rate of 118/min, and was too ataxic to even attempt standing. He was in imminent danger of death. Three physicians from the Aachen group gave independent but identical advice. The trek leader followed the advice for the two AMS patients, but ignored advice on the recognized standard of care for HAPE and HACE or the practical offer of oxygen and a hyperbaric bag as the patient's descent was organized. He was eventually put on a horse to descend to Pheriche in a snowstorm: a severely ill man who had never ridden before, on a steep path without medical support. He was given no additional warm clothes. Again we had to counsel a worried group of students who witnessed a helpless person disappearing in the freezing mist.

Similar problems were reported by Heggie: In 2011 there were 78 travellers and about 170 porters dying at Mt. Kilimanjaro, technically a very easy although a high summit. On both ADEMED Expeditions (2008 and 2011) we observed an uncontrolled intake of drugs by trekkers, often encouraged to do so by the tour guides. Summarized things are still the same since Shlim has published his data in 1992: in the moment of booking an organized trip, the individual risk to die by altitude disorders increases by 5!

MUSCULAR STRENGTH AT HIGH ALTITUDE

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Objective: Although many studies have been done so far concerning exercise at altitude or in hypoxia, so far the different types of muscular strength (maximal strength (F_{max}), static endurance power (F_{stat}), and dynamic endurance power (F_{dyn})) were never investigated. It may be expected that F_{max} which is based on anaerobic metabolism is the same in hypoxic environment than at sea level while F_{dyn} – at least partially depending on aerobic energy metabolism – should be impaired at altitude or in hypoxia.

Methods: 16 healthy non-acclimatized adults were tested at sea level (SL), at moderate altitude (3000m, MA), and high altitude (4560m, HA), respectively. At each altitude the following data were obtained: 1. Maximal force of the arm-shoulder-system (flexors); 2. Dynamic endurance power of the arm-shoulder-system (flexors); 3. Static endurance power of the arm-shoulder-system (flexors); 4. Static holding power of the abdominal muscles; 5. Static holding power of the back muscles; 6. Maximal force of hands and fingers (Martin Vigorimeter).

Results: F_{max} of the arms showed interindividual variability at SL, MA, and HA. Compared to LA there was no significant change of maximum force at MA (-0.6 kg rsp. -1.1%, n.s., dominant arms). At HA there is a highly significant decrease of F_{max} of the arms for about -3.74 kg rsp. 6.8% ($P<0.0001$) compared to LA and a less pronounced but also highly significant decrease compared to MA (-3.14 kg rsp. 5.8%; $P<0.005$). F_{stat} of the arms was interindividually different as it was the maximum power, but there was no significant difference between the dominant and the other arm. At LA the mean duration for which the load could be fixed was 151.9 sec. (+/-95.1). At MA there was a decrease of -12.9 sec. rsp. 8.5% ($P<0.03$) and at HA of -57.0 sec. rsp. 37.5% ($P<0.002$) compared to LA. In contrast to F_{stat} there was no significant difference of F_{dyn}

between LA, MA, and HA. At LA the mean total workload was 325.6 Nm (+/-93.4). At MA there was a decrease of 8.6 Nm (n.s.), and at HA of 20.2 Nm (n.s.). The measurement of F_{max} of the hands and fingers were precise and reliable as found by other authors. In average F_{max} of the hand at LA was 1.02 bar (+/-0.26). At MA there was a decrease to 0.89 +/-0.24 bar (-12.7%, P<0.001) and at HA to 0.88 +/-0.21 bar (-13.7%, P<0.001). The difference between MA and HA was not significant.

Conclusions: Contrary to the hypothesis F_{max} is decreased at altitude while F_{dyn} is not impaired. This should be taken into account when muscle training or high workload should be planned at altitude. For training purposes the load should be decreased according to the respective altitude exposure, e.g. -5% for altitudes between 3,000m and 5,000m. The underlying mechanism will be discussed in the lecture. Further investigations are necessary to compare altitude / hypobaric hypoxia with the effects of isobaric hypoxia.

ACETAZOLAMIDE AND SULFA ALLERGY. IS SULFA ALLERGY A PROBLEM AT ALTITUDE?

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Travelling to high altitudes and climbing a few thousands peaks is more common each year. Increasing number of tourist in mountain environment gives a deceptively conviction that mountains are much easier reachable for every individual. It can be a cause of many health troubles.

Among travellers to altitude there are people with sulfa allergy, by whom acetazolamide is contraindicated as pharmacological support of acclimatization and for treatment. It can be a cause of health problems at altitude.

In such a situation dexamethasone may be used as an alternative. Herein, are presented two cases of patients with sulfa allergy who were seen at the Himalayan Rescue Association aid post in a very remote area in Manang in Nepali Himalaya at 3500 m over sea level with acute mountain sickness.

It is to postulate that people with sulfa allergy, who cannot use acetazolamide should not choose high mountain as the first altitude destination and pay special attention to rules of acclimatization and first symptoms of the altitude mountain sickness.

EFFECTS OF ALTITUDE EXPOSURE ON TOTAL HAEMOGLOBIN MASS IN FEMALE KAYAKERS

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Introduction: Haemoglobin is one of the key determinant of maximal oxygen uptake. Many studies indicate that natural altitude training may lead to an increase in total hemoglobin mass (tHb-mass), although the reported results are contradictory. The aim of this study was to examine the impact of 3-week classical altitude training on tHb-mass.

Methods: Six elite female kayakers (age: 20.5±7.8 years, height: 1.71±0.03 cm, body mass: 68.4±3,01 kg) participated on the study. They stayed at 2011 m and trained at 1700-3100 m above the sea level during 17days. The following indices were measured: tHb-mass by optimised CO-rebreathing method according to Schmidt and Prommer, haemoglobin concentration (Hb) and hematocrit (Ht) in venous blood using a hematological analyser Advia 120; plasma volumes were also computed. All measurements were taken at baseline and on the second day after training camp. Differences in mean changes between consecutive measures were analysed using Wilcoxon's signed-rank test ($p<0.05$).

Results: After training camp, the tHb-mass and Hb increased significantly ($p<0.05$) on average, by 3.2% and 3.1% respectively. Individual responses of these indices varied from 0.4% to 7.7% for tHb-mass and from 0.7% to 5,6% for Hb. Mean value of PV remained on the same level on the second day after training camp, but varied individually from -6.0% to 4.1% .

Conclusions: The tHbmass responds to training under hypoxia conditions.

Despite the lack of significant changes in mean value of plasma volume, high individual variability of this parameter indicate that tHb-mass is the better indicators of evaluation of the effect on altitude exposure than Hb.

References:

1. Kanstrup IL, Ekblom B. (1984) Med Sci Sports Exerc 16: 256-262.
2. Pottgiesser T, Garvican LA, Martin DT, Featonby JM, Gore CJ, Schumacher YO. (2012) Int J Sports Physiol.Perform.7:79-83.
3. Robertson EY, Saunders PU, Pyne DB, Aughey RJ, Anson JM, Gore CJ. (2010) Med Sci Sports Exerc 42: 394-401.
4. Wachsmuth N.B., Völzke C., PrommerN., Schidt-Trucksäss A., Frese F., Spahl O., Eastwood A., Stray-Gundersen J., Schmidt W. (2013) Eur.J.Appl. Physiol. 113:1199-1211.

TRAINING METHODS OF STRENGTH AND ENDURANCE TRAINING IN ROCK CLIMBING

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In order to conduct an effective training process and to outline the decisive performance factors a characteristic of climbing as a physical activity is necessary. This should include workload parameters, bioenergetics and athletic profile of elite climbers. On this basis proper training exercises and methods could be designed. Different types of climbing vary in intensity, duration, methods used for protection and terrain. This may set different physical, mental and technical demands and may provoke different physiological responses. Nevertheless the performance limiting factors and training methods may be considered the same. Only the levels and proportions of development of the decisive abilities would be different.

A Very important characteristic of the workload is that more than 1/3 of the time is spend in immobilized positions and that climbing involves intermittent isometric contractions (Billat et al. 1995, Ferguson and Brown 1997). This may be the explanation of the nonstandard physiological responses. A unique physiological response is that heart rate disproportionally rises in comparison to oxygen consumption (Sheel 2004) and heart rate should not be used for monitoring as it is done in other sports.

Among the very important training goals are: specific strength and strength endurance of the forearm flexors, explosive strength of the arm flexors, strength endurance of the shoulder girdle, core maximal strength and other (Grant et al. 1996, Michailov et al. 2009, Berrostegieta 2006, Muehlbauer et al. 2012).Bouldering as a specific exercise is highly effective and develops strength in unity with sports technique. Though, the necessary workload cannot always be achieved because of difficulties of coordinative nature. Thus special-preparatory strength exercises are widely used. Campus board training is a proven in practice extraordinary tool for developing explosive strength, strength gradient, intramuscular and intermuscular coordination. System Training is a special form of strength training used to improve intramuscular coordination. For endurance training mainly interval methods for developing aerobic and anaerobic capabilities are used in the form of long bouldering or traversing, top rope and lead climbing.

Training methods should be consistent with kinematics and dynamics of climbing. Nevertheless general preparation should not be underestimated.

THE IMPORTANCE OF AEROBIC CAPACITY IN ROCK CLIMBING

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Objective: In regards to performance diagnosis in sport climbing the main objectives of the study was to verify some sport-specific tests, to identify suitable physiological indicators as well as to broaden the existing knowledge on physiological responses to sport climbing.

Methods: Eight elite sport rock climbers (best redpoint achievement: 8a - 9a French grading system) performed two sport-specific strength endurance tests until exhaustion. Climbing pace was steady (2 hand moves per 5 sec) in order to allow comparison between subjects. The technical difficulty was decreased to minimum to ensure greater tests' validity. The subjects traversed near the ground (changing left and right direction) on a slightly overhanging indoor climbing wall (inclination: 12 degrees from the vertical). Test 1 was shorter in duration and more intensive than test 2. This was achieved through a single difference in conditions: smaller hand holds in test 1. Oxygen uptake ($\dot{V}O_2$), ventilation (VE) and heart rate (HR) were continuously measured. Respiratory exchange ratio (RER) was also calculated. Data were expressed as peak values (HRpeak, $\dot{V}O_2$peak) and as averages (HRavg, $\dot{V}O_2$avg). Pre climbing and three min post climbing blood lactate (La) samples were taken. After test 2 La clearance was followed at the 10th and 20th min after the exercise. Additionally the maximal strength during "crimp" and "open" finger grip position and anthropometric parameters were registered.

Results: The climbers who possessed 8c level and above climbed longer, had higher $\dot{V}O_2$ values and slightly better La clearance in both climbing trials. Their maximal strength (crimp grip position) and relative strength (crimp and open hand grip position) were also higher. $\dot{V}O_2$peak significantly correlated with test performance in the shorter climb (r = 0.80) and |O2avg significantly correlated with test performance in the longer bout (r = 0.85). The exercise duration of test 1 correlated stronger and significantly with outdoor performance (r = 0.95). Despite HRpeak and $\dot{V}O_2$peak values were higher and VE and RERpeak values were significantly higher during the longer climb, the HRavg and $\dot{V}O_2$avg values were similar.

Conclusion: Non-standardly during maximal workloads of different intensity $\dot{V}O_2$avg and HRavg may not differ. Sport-specific strength endurance is a major factor of performance in sport climbing. A new finding is that specific aerobic abilities highly determine climbing duration. Nevertheless, most likely the short-term endurance is more important than the ability to sustain on longer routes with easier moves. The climbing tests used in this study proved to be applicable for strength endurance diagnosis.

INTERMITTENT HYPOXIC TRANINING AT LOW ALTITUDE AND IMPACT ON EPO AND VEGF

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Intermittent hypoxic training (IHT) is a no-invasive, no-pharmacological method enhancing performance, using the adaptive changes to decreased oxygen content in air. Erythropoetin (EPO) and vascular epithelium growth factor (VEGF) are very important factors in endurance sports, enhancing oxygen transport capacity and delivery to the working muscles.

Aim of the study was to evaluate, if altitude training stimulates synthesis of both EPO and VEGF, which among many other factors are products of expression of hypoxia inducible factor (HIF).

Methods: Intermittent hypoxic training was performed in 12 runners of national track and field team (age 25±1 yrs, BMI 19.8±0.5 kg/m^2) using a four person hypoxicator delivered by Go2Altitude (Australia). Each IHT session took approximately one hour and consisted of subsequent periods of breathing with hypoxic and room air. The length of those intervals is essential in IHT and is determined with hypoxia tolerance test performed before the first IHT session. According to the results of hypoxia tolerance test the time of breathing hypoxic air was determined ranging from 3 to 8 minutes with rest intervals of breathing room air of 2 to 4 minutes. Number of intervals creating the single IHT session was set so that each subject in total breaths hypoxic air for 35 to 40 minutes; the total hypoxic dose was the same in all subjects. In first three IHT sessions the air of 14% oxygen concentration was used (usually corresponding to saturation of 85%) and in consecutive days it was gradually lowered to the value resulting in oxygen saturation in subjects` blood of 78-80%. The minimum oxygen concentration used was 11.5% what represents the altitude of approx. 4800 meters above sea level. Blood samples for determination of EPO and VEGF concentrations were obtained from antecubital vein in the morning in the fasting state before, in 5th and 14th day of IHT. Concentrations of EPO and VEGF were determined using the ELISA tests.

Results: Blood concentration of EPO increased significantly after 4 days of IHT (from 6.7±1.2mIU/ml to 11.7±0.9 mIU/ml, P<0.001) and remained elevated till the end of IHT (9.8±0.9mIU/ml).Also VEGF levels responded to IHT demonstrating the significant increase from 22.5±6.0 pg/ml to 366.0±49.2 pg/ml, P<0.001.

Conclusion: Altitude training at sea level with IHT method was well tolerated by all athletes and showed positive impct on molecular level on some important factors involved in exercise metabolism. Thus, IHT can be considered as a recommended option to be combined with classic altitude training.

CHANGES OF OXYGEN SATURATION DURING EXERCISE AT HIGH ALTITUDE

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Objective: The aim was to assess changes of oxygen saturation and heart rate during submaximal exercise at high altitude.

Methods: 7 well acclimatized mountaineers (men, age 34.5 y.) performed a step test at 5100m altitude (K2 base camp). Participants steps up and down on a platform at a height of 30 cm. Duration of exercise was 10 min. Firs 5 minutes at a rate of 15 steps per min (the metronome was set at 60 beats per min) and next 5 min at rate of 30 steps per min (120 beats per min). We measured oxygen saturation and heart rate at rest, during the exercise and 15 minutes recovery period.

Results: Resting heart rate (HR) and oxygen saturation (SpO_2) was 76.9 bpm and 84.4%. At first level- 109.6 bpm and 80.6%, at second level- 139.7 bpm and 79.0% respectively. The difference of SpO_2 between resting and firs level is -3.86% (SD 3.72, P=0.033) and resting and second level is -5.43 (SD 2.65, P=0.002). Exercise was well tolerated by the participants. Nobody complained of exhaustion or shortness of breath. SpO_2 returned to resting level at 5-th min but the heart rate remained increased even after 15 min of recovery.

Conclusion: Submaximal exercise at high altitude decreases significantly oxygen saturation in well acclimatized persons. Even without serious symptoms, this modifies pattern of walking and probably reduces the physical performance.

"SLEEP OF DEATH" IN ALTITUDE MOUNTAINNEERING

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Fatigue is a common symptom when humans stay too long too high and it may be a sign for a significant energy loss ("sleep of death"). Such symptoms may indicate a dangerous situation for the mountaineer. Of course, several factors can cause fatigue. But sometimes it may put an unresponsive climber at risk when he or she is not aware of a dangerous situation. This may be a theoretical problem in many situations, but it becomes critical for the whole team when the conditions become worse.

To realize fatigue in climbing may help to prevent serious accidents or a disaster. It is the responsibility of any team member (especially the team leader) to be aware. Push your ascent straight up in the so-called "death zone" and keep the period within this altitude as short as possible, even if you are perfectly acclimatized. Here you often have to handle a combination of several confounding risk factors as there are hypoxia, exhaustion, cold, fatigue, dehydration, hypothermia, and insomnia.

Some months ago such an incident has happened during an Iranian expedition to Broad Peak and has lead to the death of three expedition members.

FROSTBITE AND ITS COMPLICATIONS IN THE MOUNTAINS OF IRAN

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The incidence of frostbite in Iranian mountaineers is surprisingly high. Correct identification of frostbite just that care and treatment can reduce the incidence of morbidity. Increase of our scientific knowledge about the disease will enhance our ability to treat it properly. Surgical treatment of patients with cold extremities amputation does not rush. Patient needs support of mental problems. The lecture deals with:

- attempt to apply the best and most effective ways to treat
- proper understanding of the best methods of treatment
- introduce students to the correct patient and surgical residents
- emphasis on amputation surgery is the last step in the treatment process
- prevention and prevention of unnecessary concern for patients
- patients attention to psychology and psychoanalytic treatment if needed
- reduce unnecessary costs to the patient
- treatment as soon as possible to avoid wasting time and to improve outcome
- consequences of non-referral of patients to centers of higher medical level
- findings about the lack of efficient methods in the course of diagnosis and treatment, such as radiology, angiography, ultrasound and others.

Details about incidence and specific problems of frostbite in Iranian mountaineers will be given.

A SURVEY OF THE FECAL CONTAMINATION OF DRINKING WATER IN SOLO-KHUMBU REGION, HIMALAYA, "NEPAL" – RESULTS OF THE ADEMED EXPEDITION 2011

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Background: Nepalese doctors suspect drinking water to be responsible for diarrhea in Solo-Khumbu.

Study objectives: To determine if drinking water is contaminated with fecal pollution.

Methods: From 10/14/2011 to 11/05/2011 samples of sources of drinking water used by locals, porters and tourists were collected including wells, fountains and storage containers. The analyses were realized with the DelAqua Dual Incubator which is utilized by several international NGOs to monitor drinking water quality in the fields. The samples were incubated at two different temperatures: at 37°C to detect total coliforms and at 44°C to prove thermotolerant bacteria. The group of total coliforms includes fecal bacteria as well as bacteria found in the environment, whereas thermotolerant coliforms reliably indicate fecal contamination. Furthermore at 37°C we distinguished between bacterial (without further differentiation) and total coliform growth of colonies. The samples (n=80) were collected at altitudes from 2,608m to 5,180m.

Results:

1) All samples that were incubated at 44°C turned out negative.

2) In total 46 out of 80 samples (58%) were tested positive at 37°C. Out of these 46 samples, 24 contained total coliform bacteria (52% of the positive tested ones, 30% of all samples).

in 2,500-3,000m, n=10 samples, 8 samples positive (80%), including 6 total coliform (60%);
in 3,000-3,500m, n=12 samples, 8 samples positive (67%), including 5 total coliform (42%);
in 3,500-4,000m, n=23 samples, 13 samples positive (57%), including 3 total coliform (13%);
in 4,000-4,500m, n=21 samples, 10 samples positive (48%), including 6 total coliform (29%);
in 4,500-5,500m, n=14 samples, 7 samples positive (50%), including 4 total coliform (29%).

No bacterial contamination was found in the public water wells in the settlements of Tengboche, Phortse, Machherma, Lhabarma, Thore and Thare, but samples taken from the lodges (container or barrel) were tested positive on total coliforms and not further differentiated bacteria.

Conclusion: a) No thermotolerant bacteria were detected. Therefore there was supposedly no fecal contamination in the tested drinking water which could pose harm to human health. Further causes for the incidence of diarrhea in Solo-Khumbu should be analyzed.

A major problem is seen in the unstable access to safe drinking water (e.g. frozen tubes – water taken from puddles which are located next to pack animals)

With lower altitude more bacteria have been proven, especially the total coliform contamination increased remarkably underneath 3,500m. The found total coliforms could refer to vegetation, soil or sediment.

The results indicate that hygienic problems might occur due to the water storage in canisters, not because of the wells as we found a contamination with total coliforms/not further differentiated bacteria in six storage containers.

NEOCYTOLYSIS IN VIVO AND IN VITRO SURVIVAL OF NEOCYTES

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Neocytolysis in vivo is a process of specific lysis of young red blood cells, that is associated to a decrease in EPO plasma level, and takes place whenever a fast red cell mass reduction is required. For instance when polycythemia due to high altitude acclimatization must be abrogated upon return to normoxia, a rapid reduction of the number of circulating RBCs is obtained by a decrease in EPO synthesis and lysis of neocytes. Why the latter are specifically destroyed has not yet fully elucidated.

To understand the target selectivity of the erythrolysis, we have investigated the in vitro survival kinetics of human red cells separated into age ranked subsets, i.e. young, middle aged and old.We have cultured them in medium with or without 10% autologous plasma and analysed the number and the viability of red cells recovered form the cultures at different times. At each time point, the young red cells showed a survival rate lower than the other subsets either in the absence or presence of plasma. Addition of erythropoietin (EPO) at physiological doses to the culture medium increased the survival rate of young red cells. This effect was observed in medium enriched by autologous plasma and enhanced by coculture with autologous adherent cells. In vitro, EPO seemed to have no effect on the other red cells subsets. It is likely that this hormone may act as a survivalfactor on young red cells.

The expression of proapoptotic and antiapoptotic molecules Bak and Bcl-X_l on the red cells subsets was also investigated and turned out to be moderately higher in young than in middle aged and old red cells. This suggests that neocytes are more sensitive than the other red cells to changes of survival factors, such EPO, which may occur *in vivo or in vitro*.

EFFECT OF SILDENAFIL ON EXERCISE CAPACITY IN OLDER ADULTS AT MODERATE ALTITUDE

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Introduction: We hypothesized that the use of a phosphodiesterase type 5 inhibitor such as sildenafil, by enhancing exercise capacity and peripheral oxygenation, may improve the capacity for vigorous mountain recreation at moderate attitudes for those ≥60 years of age.

Objective: The purpose of this study was to generate preliminary data that may support further studies to address whether or not sildenafil increases the exercise capacity in older persons at moderately high altitude.

Methods: This study utilized a randomized, double-blind, placebo-controlled, cross-over design to examine the effects of 50mg sildenafil vs. no sildenafil on exercise capacity as measured by maximum oxygen consumption ($\dot{V}O_2$max) and peripheral arterial oxygenation as measured by pulse oximeter (SpO_2) during a maximal cardiopulmonary cycle exercise test in a hypobaric chamber at a simulated altitude of 2750m. Each subject underwent a baseline cardiopulmonary exercise test on a cycle ergometer at 1400m. Twelve healthy male (n=8) and female (n=4) volunteers 60 years of age or older who were regularly active in self-propelled mountain recreation at moderate altitudes were recruited from the local Salt Lake City, UT community (altitude ~1400m).

Results: Statistical analysis via Wilcoxon signed rank (non-parametric) testing yielded no significant difference between $\dot{V}O_2$max 1400m baseline mean ± SD (37.14 ± 9.29 mL/kg/min) vs. 2750 m placebo mean ± SD (35.79 ± 7.70 mL/kg/min) (*P*=0.11). Comparing placebo mean vs. sildenafil mean at 2750 m, no significant differences were noted with $\dot{V}O_2$ (*P*=0.18), oxygen pulse (*P*=0.67), or cardiac index (*P*=0.64).

Conclusions: No statisticallysignificant differences were seen with any of the comparisons of 1400m vs. 2750m or placebo vs. sildenafil at 2750m. The lack of sufficient hypoxic stress between 1400m and 2750m may have accounted for the observation that sildenafil did not result in apparent physiological benefits during exercise in healthy subjects over 60 in this study.

RELATIONSHIP BETWEEN CLIMBERS' SPORTS LEVELS AND SPECIFIC ENDURANCE, SPECIFIC STRENGTH, AND ANTHROPOMETRIC PARAMETERS - ANALYSIS OF CASES

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Purpose: A main objective, was determination which factors motor, physiological and anthropometrical favors the elite rock climbers

Methods: Research was conducted within to the group of 6 climbers. From that group one climber was selected and named Number 1 - the level 9a RP. The other climbers represented the level 8a - 8b+ RP. Result of the best one was normalized. Standardization was carried out on average and SD of 5 other climbers. All participants climbed in two passages in given rhythm. Rout "one" - grip smaller and rout "two" grip - greater. Oxygen uptake and heart rate were continuously measured. Respiratory exchange ratio (RER) was calculated. Data were expressed as peak values (HRpeak, $\dot{V}O_2$peak and RERpeak) and as averages (HRavg, $\dot{V}O_2$avg and RERavg). Blood lactate concentration was taken before the end of 3rd minute after climbing these two routes. Additionally, concentration blood lactate was measured in 10 min and 20 min after the second rout.. During the research the maximum strength of specific fingers "crimp" was measured. Before the research such anthropometrical factors were measured: height, body mass, BMI, skin fold, arm span, „ipe nidex", circumference forearm, arm, thigh, calf.

Result: The best participant climbed for the longest time on the rout one. In conducted research , during the first rout considerable differences were noticed to the benefit of the best climber - $\dot{V}O_2$peak (2,1 SD) and $\dot{V}O_2$ av (0,97 SD), RER peak (1,33 SD), RER av (2,1 SD) and La max (2,17 SD). Additionally, the best climber had bigger/greater specific strength level (1,77 SD). Within anthropometrical parameters the best participant had lower body mass and lower BMI than the others.

Conclusions: Research confirmed that endurance was very important factor in the sport climbing and especially important was endurance during the climbing on "small grip". The longer duration of the climbing on the rout with "small grip" was determined higher level of such physiological factors: $\dot{V}O_2$peak, RER and the concentration La after the climbing.

THE DIFFERENCE OF FIRST AID KIT IN REGIONS WITH AN EMERGENCY RESCUE AND WITHOUT IT

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Unfortunate circumstance and wilderness condition can hinder quickly professional mountain help in case of accident or illness especially in countries without professional air emergency rescue. In such case ill and injured persons have to be attended sometimes for many hours by people who just happen to be there ("comrade rescue"). The first aid kit which anyone uses should provide physicians and alpinists or paramedics with whatever is essential to face such situations and with the instruction to the user "only use what you know how to use". The first aid kit should be divided in two compartments. 1) general compartment 2) intended to be used by the physician. In an emergency condition you can use the second compartment after telephone agreement with a physician and also in case of mountain and remote area accident there are often physicians or medical staff on the site with no equipment, there you can give them the equipment that you carry.

OXYGEN SATURATION AND AMS-SYMPTOMATOLOGY AMONG SKIERS AFTER FAST ASCENT TO HIGH ALTITUDE (3440 M)

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Introduction: Due to decreasing snowfalls in the Alps and increasing popularity of skiing, glacier ski regions are highly frequented.

Objective and methods: After a fast ascent to an altitude of 3440 m arterial oxygen saturation (SaO_2), as well as high altitude symptoms of 37 skiers (15 female, 22 male, age: 28 (19-53) were determined by pulse oximetry and by high altitude symptoms questionnaire.

Results and conclusions: No correlation between SaO_2 (Median: 89%, Min: 82, Max: 95) and questionnaire result could be found, in addition a preceding short-term stay at high altitude had no effect on the results. Despite of a notable hypoxia the skiers displayed only weak, primarily not agonizing AMS-symptoms (increasing pulse rate, reduced urine output, weakness/tiredness). Surprisingly, the highest questionnaire score as well as the lowest oxygen saturation values were found among persons older than 40 years. Because of the latency of the high altitude illness, single-day glacier skiing at middle/high altitude is possible even in an unacclimatized condition. With an increase in time spent on the glacier, a worsening of high altitude symptoms must be expected. It cannot be entirely excluded that this has beside of muscular fatigue an influence of the increasing number of accidents that can be observed in the afternoon.

PULSE OXIMETRY DURING SEVERE PHYSICAL EXERCISE AT HIGH ALTITUDE

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Introduction: During sojourns at high altitude pulse oximetry is widely used to facilitate the diagnosis of high altitude illness at an early state and to assess individual's acclimatization status. With regard to the second topic there is good evidence that measurements during physical exercise have a higher significance compared to measurements at rest. But physical exercise, especially moving hands, may influence the measurements. This raises the question whether moving artifacts compromise the use of pulse oximetry during physical exercise. The aim of this study was to investigate the amount of incorrect measurements during severe physical exercise at high altitude.

Objective and Methods: The used device (PalmSat 2500®; Nonin) records the measured values for SaO_2 and pulse every 4 seconds. To minimize interference with the ice axes we placed the flex finger sensor not on the index but on the forth finger. The hands were covered with gloves. The study was performed during an extreme ice-climb to the summit of Les Courtes (3856 m; NE-gully: 800 m; 50°). The recorded data were transferred to Excel and evaluated. The PalmSat 2500 assigns the figure "500" to each incorrect (missing or suspect) measurement. This ensures a value every 4 seconds. We calculated the ratio of these "500"-values compared to the total number for the extreme situation during the ice-climb as well as for the whole tour (cable-car, ski-ascent to the bottom of the gully, descent)

Results: During the ice-climb we recorded 2252 and in total 5728 data points for $Sa0_2$. In total we had 24.4% (1395 / 5728) of incorrect measurements and 34.6 (779 / 2252) for the ice climb. If we exclude the ice-climb the rate of incorrect measurement is 17.7 (616 / 3476) and if we further exclude the 6 min for preparation immediately before the ice-climb the rate of incorrect measurements is 16.9 (571 / 3388).

Conclusions: Even under these extreme conditions pulse oximetry provides meaningful results. For practical use 2/3 of usable results is sufficient. In situations

EXPERIENCES WITH A HAND-DISINFECTION GEL DURING MOUNTAINEERING AT HIGH ALTITUDE

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Introduction: As described in earlier hypoxia symposia (2009 and 2011) hand disinfection is very important to prevent enteritis during mountaineering above the snow limit, not only disinfection of melted snow for drinking-water. First tests with a commercial disinfection gel motivated the organizers of the 2nd ADEMED 2011 (Aachen Dental & Medical Expedition Solo Khumbu, Nepal, www.ademed.de), to continue the try-out of the commercial disinfection Stokosept-gel.

Methods: 10 participants (ps, medical students and physicians) were instructed how to use professionally the preventing gel (in 100 ml plastic holders), at least prior meals, after using a toilet and after using boot-laces. Each participant got 3 sheets to ascertain each use, judgement of usefulnes and in that case state of enteritis: Pre- and post questionnaire and a documentation-sheet. Timing: 4.10.2011: Arrival in Kathmandu (1400 m), 3 days in hotels, 7.10. arrival in Lukla (2610 m), begin of the 25 d mountaineering-phase (m.p., accommodation in lodges) until Everest base camp (5364 m) and back to Lukla.

Results: 5 of 10 ps. had enteritis (1 for 7 d, 4 were beginner in mountaineering) at begin of the m.p. The local leader of the study (J.R.) noted: We were inspired and the use resembled a ceremony prior eating. Additional uses were done (priority ranged): After toilet, prior eating and drinking, after using boot laces, application of contact lenses, after contact with dirty objects, disinfection of toilet seats, dirty hands, after contact with subjects, prior dental care, prior sleeping or as ultrasonic-gel. No problems until at least –7°C. Subjective: Good consistency (no drops, quickly drying – 15-30 s, thrifty – 100 ml for 24 d), good skin feeling (not wet but not drying, not cold) and neutral smelling. In general: pleasant to use.

Discussion: The enteritis at begin of the m.p. (n = 5 ~ 50%) underlines a high incidence, caused by the hygienic conditions and obviously infected during the first days after arrival, and this would be valid for many mountaineers on the way to the Everest base camp as well. Therefore it is necessary to take care not only with eating and drinking, but also to avoid infections from faces over hands to mouth. Enteritis didn't appear later after the first infections, and as we assume by strict prophylaxis concerning eating, drinking and hand disinfection. The disinfection-procedure was very practicable and we are sure effective as well, because the gel is a commercial and licensed lotion for occupational applications.

References: Ask ulmer@uni-mainz.de

References:

1. Adamek R. et al. Enteritis during mountaineering above the snow line – how to practice prophylaxis? (Hypoxia Symposium 2009)
2. Honka B., Ulmer, H.-V. Disinfection of hands at a high mountains expedition (Cho Oyu) – an experience report (Hypoxia Symposium 2011)
3. Küpper T. Prävention enteral übertragener Erkrankungen [Prevention of faecal-oral transmitted diseases]. In: Rieke B. et al. Moderne Reisemedizin [Modern Travel Medicine]. Gentner Verlag, Stuttgart, 2. Aufl. 2013, pp. 246-254

DIABETES IN MOUNTAINEERING AND SPORTS CLIMBING

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Diabetes is one of the most popular diseases in the "modern world". The number of patients suffering from diabetes has increased over the last few years and is still growing. One of the most important factors is the so-called "modern lifestyle" dealing with a huge workload, no time for healthy food or even the lack of motion. But there are also many people, who suffer from diabetes, that do not want to abandon on sports, for a certain amount of movement has a direct approach on the long-term health of the patient.

In this work an overview concerning the different forms of diabetes and the therapeutically options will be given. We will also take a closer look on the advantages of sports for diabetes-patients and especially what those patients have to pay attention to when going to the mountains or sports climbing. These two disciplines are special, because, the one is an endurance discipline and the other deals with short, but high loads.

HUMAN PERFORMANCE DURING HIGH ALTITUDE HIGH OPENING PARACHUTE JUMP - BODY CORE TEMPERATURE AND OXYGEN SATURATION

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Background: Data as ascertained in the lab are only very severe in the real environment to transfer. Often other results were found in the real environment and thereby the efficiency of the human performance was estimated wrong. In particular the influence of the environment is to be incorporated in the physiological whole consideration. However, measurements are very difficult in the field because the present measuring possibilities are either too invasive the hardware is too heavy, or the measured parameters are wrong interpreted without having a look into environmental conditions. Now moreover a method was found to examine this closer.

Methods: Parachutists became instrumented with a new system which included also the environmental parameters. New developed and off the shelf available sensors, all non-invasive, where used. Getting a "whole understanding" of the complexity between environment and physiological reactions a full setup and combination of parameters were measured. Foresightful, regarding further investigations under different environmental conditions the setup of the used system was chosen that carefully to have the possibility to compare all recorded data and have the sensitivity of all given surroundings.

Results: In a preliminary investigation 39 participants became the corresponding equipment and were measured during real parachute jumps in Eloy, AZ, USA. It was observed that the oxygen saturation decrease under 90%, but already during the flight. That indicated clearly the desaturation right before the action. During the whole time flight, exit and landing the body core (BCT) and skin temperature (ST) were measured. BCT increases during the whole time with a peak in contrast to ST which decreases significant. In the complexity these data with the physiological circumstances and environmental condition have to go be interpreted carefully.

Conclusions: Obviously measurements of physiological data obtained in the lab seem to be different compared to those in real environments. Particularly, the selection of the sensors to be used for physiological data recordings and the inclusion of environmental parameters point the complex process. But there is a need to combine all these conditions to get the whole understanding of the efficiency of human performance. In the present preliminary investigation it was feasible to show by survey in the real environment that it is possible to measure physiological data without disturbing the human being. With this acceptable setup it is possible to validate human performance in different environments with the same approach and will help also to find the physiological response of the unchanging human body in the changing climates.

ALTITUDE/HYPOXIC TRAINING BY OLYMPIC ATHLETES FOR THE ENHANCEMENT OF SEA LEVEL PERFORMANCE

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At the Olympic level, differences in measurable performance are typically less than 0.5 percent. This helps explain why many contemporary elite endurance athletes in summer and winter sport incorporate some form of altitude/hypoxic training within their year-round training plan, believing that it will provide the "competitive edge" to succeed at the Olympic level. This presentation is made with the following objectives in mind:

1. To review research-based evidence supporting the effect of altitude/hypoxic acclimatization on both hematological and non-hematological markers, including erythrocyte volume, skeletal muscle buffering capacity, hypoxic ventilatory response, and physiological efficiency/economy.

2. To describe the practical application of altitude/hypoxic training as utilized by elite athletes.

3. To discuss the concept of "effective hypoxic dose": how high, how many days, how many hours per day?

To examine legal and ethical issues associated with the use of altitude/hypoxic training.

Within the context of these objectives, both scientific and anecdotal evidence will be presented relative to the efficacy of several contemporary altitude/hypoxic training models currently used by Olympic-level athletes for the purpose of enhancing performance. These include the three primary altitude/hypoxic training models: 1. live high + train high (LH + TH), 2. live high + train low (LH + TL), and 3. live low + train high (LL + TH). The LH + TL model will be examined in detail and will include its various modifications: natural/terrestrial altitude, simulated altitude via nitrogen dilution or oxygen filtration, and hypobaric normoxia via supplemental oxygen. A somewhat opposite approach to LH + TL is the altitude/hypoxic training strategy of LL + TH (intermittent hypoxic training), and data regarding its efficacy will also be presented.