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Altitude – Good Practice Guidelines to Venture Planning and Acclimatisation for Youth Expeditions

[Young Explorers' Trust (YET) Disclaimer: These Guidelines are produced by YET in good faith in the light of currently published generally agreed medical evidence and papers; they are in line with advice given by the BMC and UIAA; they will be updated as and when other medical evidence and papers changing the advice given by the BMC and UIAA are published.

These Guidelines are YET's interpretation of expert opinion received, and YET accepts no liability for loss or damage resulting from reliance on them. YET advises providers and leaders of youth expeditions to seek specific medical advice before undertaking expeditions to high altitude.

YET considers that it is the clear sole responsibility of the providers of ventures going to altitude to avail themselves of appropriate current information relating to the proposed venture and to provide participants with sufficient information for them to be able to give informed consent to the venture regarding the associated risks.

YET welcomes any comments on these Good Practice Guidelines from any informed source.]

Introduction

Today, expeditions and organised trips to sites and regions of recreational opportunity in high places are more and more common. Increasing numbers of tourists and adventure seeking groups are travelling and living for prolonged periods in these locations. Visitors range in age from young children to the old alike – some may be physically supremely fit, whilst others are inexperienced and are looking for a new thrill or the long dreamed of chance to visit a famous location.

Present-day travel packages enable people to fly more or less directly from effectively sea level to high altitude locations without any opportunity to acclimatise to the change in conditions. Additionally, all too often such visits are time restricted and allow no opportunity for a planned gradual ascent. The increasing volume of visitors, often unaccustomed to moving around and living at altitude, can be associated with a rising occurrence of medical and logistical problems in the provision of what should be considered appropriately safe ventures.

There are acknowledged reductions in exercise performance capability and health risks associated with altitude – but as years go by there is more and more medical knowledge and experience in prevention and handling of resulting medical conditions. It is well recognised that sensible venture planning for travelling and living at altitude can very significantly reduce the risk of occurrence of such health problems. Good planning and running of any venture can also very definitely improve the medical outcome when faced with such issues.

These guidelines introduce the reader to an awareness of and the need to respect recognised methods, as described and practiced by experts, for dealing with performance, logistics and medical issues. Such information can be largely obtained directly via the internet, but respected medical experts and organisations are available and willing to offer advice to those who ask. The reader is directed particularly to the freely available and up to date publications of the British Mountaineering Council (BMC) [http://www.thebmc.co.uk/search and then highlight 'medical advice'] and the International Mountaineering and Climbing Federation (UIAA)

[http://www.theuiaa.org/medical_advice.html] on the topics covered in this article and much more for those embarking on altitude ventures.

The mountaineering doctors' altitude medicine charity Medical Expeditions (Medex) has produced a comprehensive, readable and informative booklet on 'Travel at High Altitude'. It is recommended by BMC, UIAA and the Association of British Mountain Guides. It is freely downloadable from their web site [http://www.medex.org.uk/] and is recommended reading for all. A brief summary of travel medical advice with pointers to specialist medical advice can be found on [www.fitfortravel.nhs.uk].

A useful source of organisations and individuals able to give authoritative advice is 'How to get mountain medicine advice'; it is freely available by searching the main BMC web site.

Why is altitude important and why does it cause problems?

The answer to this question is complex, but the key point to realise is that as one ascends, the atmospheric pressure falls – by the time one has reached the top of Mount Everest it is less than one third of the sea-level pressure and the air is much 'thinner'. This has a number of inter-related consequences, but particularly significant is that, while the fraction of oxygen (~21%) remains unchanged, the progressive fall in pressure means the absolute amount of oxygen for the body to take up is reduced. As a result exercise, and even resting or sleeping, can become difficult and limiting. Also there are well recognised altitude-related medical conditions that may arise, some of which are life-threatening.

At what altitude does one have to take cautionary or preventative action?

This too is a difficult question to answer as everybody responds physiologically to even small increases in altitude – but only very slightly and un-noticeably for moderate ascents. A commonplace example of this is flying in commercial airplanes. Passengers and crew are subjected to altitude because the cabin air pressure is reduced to approximately the equivalent of sitting on a mountain at 2,500 metres. Only people with clearly recognised illnesses known to be a risk factor, *e.g.* some cardiac or respiratory diseases, or predisposing risks such as late pregnancy are advised, as a precautionary measure, against flying.

It is generally agreed amongst those expert in altitude medicine that anyone planning or leading an expedition destined to go to altitude should begin to consider potential medical and logistical implications when **intending to venture to heights above approximately 3,000m.** Going to greater heights must be undertaken with progressively increased caution in a conservative manner as medically advised. Safe travelling and living at such altitudes involves careful design of travel and activity plans.

Who is at risk of altitude-related illness?

There is some, but inconclusive and somewhat conflicting, evidence to suggest that Acute Mountain Sickness (AMS) and other more life-threatening conditions – High Altitude Pulmonary Oedema (HAPE) and High Altitude Cerebral Oedema (HACE) – are more prevalent among adolescents than among adults, perhaps more prevalent among active fit adolescents than those of a sedentary nature, and maybe among female rather than male members. There is also inconclusive evidence that adolescents may acclimatise more rapidly and better than adults, provided a rigorous acclimatisation procedure is adopted. Surprising, seasoned travellers, who have experienced no symptoms, or only very mild discomfort, on previous ventures, are not guaranteed to be unaffected on their next trip to altitude. The best predictor for future susceptibility to altitude related illness is previous poor acclimatisation.

All this means that it is effectively impossible to predict accurately if and when an individual may suffer from AMS or the life-threatening conditions of HAPE or HACE. It is, therefore, most unwise to plan a venture assuming any differentiation of probability of illness amongst groups of people.

Loss of exercise capability is also highly variable between individuals, and so it is wise to plan activities conservatively, with step-wise progression for all, and to be continually prepared to reduce expectations as circumstances dictate with a sufficient degree of flexibility to accommodate unexpected incidents. The pace of activities must be built around the slowest, least able member

of any party to prevent them over-stretching their physical and health capabilities and thus their being more likely to contract AMS or other conditions.

All venture providers and mountain leaders should make prudent travel plans that are suitable, and in accordance with good practice, for meeting most situations that may arise if AMS or other illness occurs amongst the party. Such planning must inevitably be conservative in its approach.

Acclimatisation and altitude gain

All authorities are agreed that the emphasis in planning an expedition to visit or work at altitudes over 3000m must allow the whole party to gain altitude acclimatisation in a gradual manner. The pattern of ascent described below is generally recognised as accepted expert medical advice to significantly reduce – but not necessarily eliminate – the occurrence of AMS or other altitude-related conditions within a group.

Youth expedition leaders should be extremely wary of any expedition provider that ties the expedition into a strict time-scale for high altitude ascents, particularly where financial or other constraints might act against making the time available for medically appropriate ascent profiles and altitude acclimatisation as described below.

It is regarded as an acceptable limit for an expedition to move directly to as high as 3,500m, even from sea level, but then to pause at that location for two or three days to acclimatise. However, it is preferable for any movement over 2,500m to be made more gradually, with a further day or more to reach 3,000m. Unnecessary exercise or carrying heavy loads should be avoided if at all possible until acclimatisation is achieved.

The "Zone of Tolerance" for the body to operate normally moves up with the body as it acclimatises, and a good acclimatisation programme limits upward movement daily so as to stay within that zone. Its upper level is the last altitude at which the person slept; to ascend rapidly above that point there is not enough oxygen for the body to function properly and so symptoms of AMS and other conditions are liable to occur.

The recommendations of authoritative organisations are currently that, above 3,000m, for a well-acclimatised group:

(1) The sleeping gain should not normally exceed 300m above the previous night's altitude. It is how high the party sleeps each night that is important, not the altitude gain during the day which may be considerably greater– "***climb high, sleep low***" is the maxim to adopt.

(2) Some slight flexibility may be allowed when suitable camp sites are just above that 300m limit and there are no other suitable sites on or just below the limit, or at some point of the expedition when previous altitude acclimatisation has been gained and *not been lost* by the group. At no time should 400m or more gain in sleeping altitude be exceeded in any one day.

(3) A rest day should occur every three days or every 1,000m sleeping gain.

(4) A group should be above 3,500m for at least a week before sleeping above 5,000m.

(5) Gain in altitude during a mountaineering day to heights of up to 5,500m is acceptable, provided that the sleeping height follows the advice above.

(6) Very careful consideration should be given to any plans which take young people to more than 5,500m at any point, with the emphasis on the opportunity for full altitude acclimatisation together with full flexibility in the programme to allow appropriate descent.

(7) If an expedition member feels unwell (headache, nausea, loss of appetite, vomiting, dizziness, fatigue, lethargy, undue breathlessness on exertion, difficulty sleeping, irregular breathing during sleep) at altitude, then the diagnosis is AMS until proven otherwise.

(8) Leaders must be prepared for one or more members of the party to be suffering from AMS, even if a careful altitude acclimatisation plan is followed. There must be sufficient flexibility in their plans for that person, or all the party, to remain at that altitude for a further 24 – 48hr. The natural progression for AMS is to get better within 24 – 48hr simply by resting at

the altitude at which AMS sets in. If AMS symptoms have not been alleviated within that time, then that person needs to be helped to descend to a 500 – 1,000m lower altitude.

(9) Once AMS symptoms are completely gone, and the person has acclimatised to that lower altitude, it is acceptable to continue ascending. It is imperative that no member of the party with AMS symptoms should be allowed to continue an ascent.

(10) If symptoms become worse, descent with minimal exertion is imperative. Emergency evacuation to a lower altitude must form part of the expedition's plans, and all expedition leaders must have a written copy of such plans, including details of the nearest medical assistance.

(11) At all times, even when resting in order to recover from AMS symptoms, leaders must be aware that either HAPE or HACE (see below) may occur in any of the party; this may be quite independent of, and not necessarily as a progression from AMS. The leader must monitor all the expedition members accordingly. If either HAPE or HACE are suspected, immediate assisted descent of the person, preferably by carrying them, is essential. Medical support, if available, should also be sought. The extent of the necessary descent to lower altitude is discussed below.

(12) Route planning, particularly of traverses, is extremely important and should take full account of the needs of emergency descent. Should a member require emergency evacuation to a lower altitude, this must not, under any circumstances, be by a route that requires intermediate height gain above the location at which the condition was first detected.

(13) Ascents in remote mountain locations without rapid access to medical care should be undertaken with greater caution.

Makeup of the expedition team

The expedition provider and leader should take careful account of the ratio of leadership team numbers to participants and to gender mix, particularly for groups of young people. If it is necessary for an expedition member, leader or participant, to be evacuated, **it should be ensured that an appropriate gender mix and ratio of participants to leaders is possible for both the evacuating party and the remaining group who may wish to continue the venture.** If this becomes impossible, the party should not be split in a manner that endangers their supervision and safety; the whole party should then retreat.

Care must be taken that a patient with suspected AMS, HAPE or HACE is attended to by a responsible and competent member of the party at all times. The condition of a patient with any of these conditions may deteriorate rapidly and without their full awareness of the changes. This can be extremely dangerous and rapid treatment may become necessary.

Extreme caution should be exercised especially for young children on expeditions to altitude. They may not be able to recognise symptoms of AMS, HAPE or HACE in themselves or articulate them clearly to others. It may therefore be more difficult to diagnose their condition which also may deteriorate far more rapidly than in older children or adults.

Use of a self-analysis scoring system to recognise AMS

All members of the expedition should be educated about AMS before the expedition, and be briefed to recognise the symptoms of AMS (as well as HAPE and HACE), both in themselves and in others. All expedition members must realise the absolute necessity of truthful reporting of symptoms; evidence suggests female members of the party are more willing so to do. The development of a strong "buddy system" is recommended

It is helpful to be able to monitor the health of an expedition team continually by an objective means that can be used easily by all. YET recommends the use of the self-analysis scoring system described in 'Travel at High Altitude' as an aid towards identifying the early signs of AMS, but adds the proviso that use of this system is still developing and a score below the diagnostic threshold does not exclude AMS.

The analysis system is an excellent teaching tool to advise participants of the nature of AMS and how to recognise it. Participants learn how to assess their own health and to be aware of oncoming symptoms at an early stage. It prompts their willingness to inform other team members of their condition and to discuss their level of health and acclimatisation in a collective and mutually supportive manner.

Treatment of the mild form of Acute Mountain Sickness

Leaders planning to climb higher than 2,500m must be prepared to treat mild AMS with rest, fluids, and mild analgesics (such as Aspirin, Paracetamol or Ibuprofen) to help with headaches, and with travel sickness drugs (such as Stemetil and Stugeron) to help with nausea and dizziness.

Other conditions such as dehydration and sunburn can cause symptoms that may be confused with AMS. However, if there is any doubt as to the cause of symptoms, they should always be presumed to be caused by AMS and treated as such.

Any members of the party suffering from AMS must rest and become fully acclimatised at the sleeping location; if recovery does not take place within two days, then descent is the only remedy, lest AMS develop into one of its two severe forms – HAPE or HACE.

It is most important to note however that either HAPE or HACE may strike without the forewarning symptoms of AMS, and responsible leadership teams must be vigilant at all times.

Treatment of the severe forms of Acute Mountain Sickness

High Altitude Pulmonary Oedema (HAPE)

This occurs when fluid accumulates in the lungs and causes severe illness. It may come on in minutes, and is recognised by:

- extreme fatigue
- breathlessness (especially when at rest)
- fast shallow breathing
- cough, possibly producing frothy or pink sputum
- gurgling or rattling breaths
- chest tightness, fullness, or congestion
- blue or grey lips or fingernails
- drowsiness
- sometimes a bubbling sound in the chest.

HAPE usually occurs on the second night after an ascent and is more frequent, it would seem, in young fit climbers and trekkers. It is not necessary that previous symptoms of AMS have occurred for HAPE to strike.

Such patients must be considered as dangerously ill and **rapid descent with minimal exertion to the last altitude at which the person felt well on awakening is mandatory**. This should be a 500 – 1,000m altitude descent.

Oxygen by mask or taking Nifedipine, Diamox and steroid drugs (such as Dexamethasone) can be helpful, but **note** the latter may be hazardous to use without appropriate medical supervision and advice. Medical support should be sought if possible.

HAPE usually resolves rapidly with descent, and one or two days of rest at a lower elevation where the patient is comfortable may be adequate for complete recovery. Once the symptoms have fully resolved, cautious re-ascent is acceptable.

High Altitude Cerebral Oedema (HACE)

This condition is brought about by fluid collecting within the brain and causes severe illness, potentially fatal within hours. It is recognised by:

- inability to think coherently
- confusion and changes in behaviour
- lethargy
- ataxia – loss of co-ordination (especially a staggering walk as if intoxicated – try the "finger-to-nose or toe-to-heel test" – or inability to stand up without assistance).

It is not necessary that previous symptoms of AMS have occurred for HACE to strike, often over a period of just a few hours.

Such patients must be considered as dangerously ill and **rapid descent with minimal exertion to the last altitude at which the person felt well on awakening is mandatory**. This should be a 500 – 1,000m altitude descent and preferably further.

Oxygen by mask or steroid drugs (such as Dexamethasone) are helpful, but the latter may be hazardous to use without appropriate medical supervision or advice. Seeking medical support is strongly recommended if at all possible whenever HACE is suspected.

Sometimes, the symptoms of HACE may be confused with those of hypothermia. If the above symptoms are observed, the patient should be presumed to be experiencing HACE and treated accordingly. Possible hypothermia can be treated concurrently without delaying the treatment of HACE.

The use of Acetazolamide (Diamox or similar)

Acetazolamide (Diamox or similar) is a drug that can be used both to help prevent AMS and to treat it.

YET encourages careful consideration of the alternatives (especially carefully planned altitude acclimatisation) to the pre-emptive use of acetazolamide as a prophylactic medication for any venture involving young people.

Most expedition members who have been through a good altitude acclimatisation programme will not need to use acetazolamide. In addition to some common minor but unpleasant side effects (numbness, tingling, vibrating sensations in extremities, ringing in the ears, taste alterations, perhaps visual blurring) acetazolamide carries the risk of the severe side effects that may occur with all such sulfonamides. Expedition members planning to use Diamox should take a test dose before departure in case an allergic reaction is encountered.

Expedition Leaders must be aware that the use of acetazolamide only relieves the symptoms of AMS by encouraging more rapid acclimatisation. It will not prevent the condition worsening in anyone who continues to ascend whilst suffering from AMS. Therefore acetazolamide should not be used in a routine manner to allow continued or rapid ascent at high altitude, but only for the relief of AMS symptoms in a controlled fashion to allow rest and possible descent to recover. Acetazolamide does not mask AMS symptoms, it only eases them – if the patient feels well then the patient is well.

YET clearly and explicitly states that acetazolamide (Diamox or similar) should only be used by children pre-emptively with written informed consent of parents / guardians. Other expedition members should only use it after consultation with the individual's medical practitioner (GP, school doctor) who knows the person's medical history.

Dehydration and sunburn

Dehydration, and the associated increased risk of AMS, should be avoided at altitude. The inevitable water losses due to sweating and breathing on exertion at altitude will cause dehydration unless adequate amounts of water are drunk – this could be as much as 4-5 litres a day on strenuous ventures. Alcoholic drinks and smoking should be avoided at all times as these

encourage the onset of AMS. It is advisable to avoid consuming diuretics such as coffee or strong tea.

Travel, drinking and eating in many of the regions of the world, including those at altitude, is always associated with the risk of gastro-intestinal upset and potentially severe diarrhoea. Apart from the obvious wish to recover quickly, it is important to recognise that the condition is associated with heavy loss of body water which needs to be stopped as quickly as possible to avoid undue dehydration. Strict adherence to personal hygiene and proper handling and cooking of food, coupled with reliance on safe water supplies are the key ways to prevent such upsets. However, a gastro-intestinal drug, such as Immodium, should be used immediately if the condition does arise.

The best way to monitor successful avoidance of dehydration is to observe the colour of the urine – it should be pale or clear.

Protection from the sun is also very important at altitude. The strong, unfiltered solar radiation can affect and possibly damage both eyes and skin more rapidly and is worse than exposure on the beach. The higher the altitude, the greater the amount of UV light to which one is exposed; climbing on snow or ice at altitude adds to this exposure significantly due to light reflection. Furthermore, UV radiation can penetrate clouds and thus cause damage in both sunny and cloudy conditions.

The eyes, unless suitably protected with goggles or powerful sunglasses, are liable to suffer snow blindness in the immediate time frame and potentially cataracts in the longer term. Snow blindness is an obvious potential source of danger to life and limb of both the casualty and those who have to help the sufferer. It is not uncommon for expedition members to lose their goggles or sunglasses or drop them irretrievably. They may also be trodden on and broken. Thus it is highly advisable always to carry spare pairs and to use a retaining cord around the neck.

Immediate treatment is indicated and medical advice on this should have been sought before the expedition sets off.

The sun can cause burning of the skin very quickly at altitude and expedition members can easily be caught out unless considerable preventative care is taken. Sunburn of unprotected body parts is very common. Bare legs, arms and hands as well as the face, neck and ears are obvious targets for the direct radiation from the sun above. On snow and ice surfaces, the reflected radiation also hits the body, but in additional places, such as the underside of the chin and nostrils, which generally are less accustomed to exposure.

The best way to avoid sunburn is continual vigilance and to cover up all possibly exposed places with clothing. However, most people also use sunscreens, which must be of a very high protection level for both UVA and UVB radiation. Screens without protection to both forms of UV radiation are not appropriate. Screen should be applied liberally and relatively frequently to all potentially exposed parts because of the removal effects of sweating and the resulting wiping of skin surfaces.

There is a third type of UV radiation – UVC – that also burns the skin and will cause snow blindness. This is effectively filtered out by the ozone layer above the Earth's surface so it is not normally of concern. However, expeditions to Antarctic regions should begin to consider the implications of this additional radiation and, if in the future the ozone layer is depleted over other areas of the globe, protection against it should be given further consideration.

Sunburn should be prevented for well publicised reasons of long term protection against cancers. More immediately, it should be determinedly avoided because severe cases can be totally incapacitating, causing prolonged disruption of the expedition's planned activities.

People taking doxycycline (doxycycline hyclate) as malaria prophylaxis should be aware that it can, in a few cases, make the skin particularly sensitive to sunburn.

It is well known that sunscreens may cause unacceptable side effects for some people. It is always sensible to thoroughly test products before use on an expedition to be satisfied they will not cause reactions on the venture. Those with known skin sensitivities or allergies should seek medical advice to identify suitable products before departure.