Altitude Illness

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Key Messages

Travel to high altitude is becoming increasingly accessible and popular.
Most trips to altitude can be enjoyed safely if sensible precautions are taken.
Altitude illness describes a number of conditions that may occur in individuals ascending rapidly to high altitude, usually above 2,500m.
Severe altitude illness is a life-threatening condition and requires urgent attention.
When travelling to altitude adequate travel insurance is essential.
The key to preventing high altitude illness is gradual ascent with regular rests days.
People with pre-existing medical conditions should consult with their healthcare provider prior to travel.

Overview

In recent years travel to high altitude has become increasingly popular and accessible [1]. High altitude is defined as an elevation above 1,500m and can be subdivided into the following categories: high altitude 1,500m–3,500m, very high altitude 3,500-5,500m and extreme altitude >5,500m [2]. Altitude illness usually occurs at altitudes over 2,500m, however it is recognised that susceptible individuals can experience illness below this altitude.

Altitude illness is the term used to describe a number of conditions that may occur shortly after individuals ascend rapidly to high altitude. Altitude illnesses include acute mountain sickness (AMS), high altitude cerebral oedema (HACE) and high altitude pulmonary oedema (HAPE).

With increasing altitude, the percentage of inspired oxygen remains constant at 21 percent; however, the air pressure (barometric pressure) decreases. This results in a reduced number of oxygen molecules taken in with each breath and ultimately to reduced oxygen delivery to the body’s tissues. If an individual ascends gradually to high altitude the human body is usually able to adjust to these reduced oxygen levels. This adjustment process is known as acclimatisation. If ascent is too swift, then acclimatisation may not occur rapidly enough and altitude illness may ensue [3].

Risk areas

High altitude regions of the world include the Himalayas (Asia), Andes (South America), Rocky Mountains (North America), Alps (Europe) and the Caucasus (Europe/Asia).

Popular high altitude destinations for UK travellers include: Everest Base Camp and the Annapurna Circuit in Nepal (5,380m); Mount Kilimanjaro in Tanzania (5,895m); the Inca Trail in Peru (max ~4,200m); Aconcagua in Argentina (6,960m); Mount Kinabalu in Malaysian Borneo (4,095m) and Mount Fuji in Japan (3,776m).

Cities located at high altitude include: Lhasa, Tibet (3,658m); La Paz, Bolivia (3,630m); Cuzco, Peru (3,399m); Quito, Ecuador (2,819m); Bogotá, Colombia (2,644m); Addis Ababa, Ethiopia (2,408m) and Johannesburg, South Africa (1,750m). The Country Information pages highlight if there is a point of elevation over 2,500m in a country.

Risk for travellers

Studies of altitude illness report marked variation in prevalence, mainly as a result of the different ways these studies were performed. Approximately 9-25 percent of unacclimatised individuals ascending to 2,000-3,000m develop AMS compared to 35-50 percent of those ascending to 3,500-4,500m [4-6]. HACE and HAPE are much less common than AMS. Both are extremely rare below 2,800m and seem to occur at an incidence of around 1-2 percent at altitudes between 4-5,000m [7].

The risk of developing altitude illness is determined by both factors relating to the trip and those of the individual.

Risk factors relating to the trip include: the rate of ascent, absolute change in altitude and sleeping altitude [8]. These are important to consider when planning a trip to altitude. Ideally expeditions or treks should comply with Wilderness Medicine Society suggested maximum ascent rates [9, 10] (see preventing altitude illness). Treks with a rapid ascent rate (e.g. the ascent of Mount Kilimanjaro in less than 7 days) are of concern [9, 11].

Risk factors relating to the individual include: previous history of altitude illness, normal residence below 900m, exertion on arrival to altitude and certain pre-existing cardiovascular conditions [8]. Physical fitness does not appear to protect against altitude illness [8]. Despite knowledge of these risk factors, accurately determining an individual’s susceptibility to altitude illness is not possible. Previous performance at altitude is probably the best predictor.

The Wilderness Medicine Society has combined knowledge of individual and trip-related risk factors to categorise the risk of AMS. These risk groups refer to unacclimatised individuals. The altitudes correspond to sleeping altitude and they assume ascent will start from elevations <1,200m [9, 10].

Table 1: Wilderness Medicine Society Risk categories for Acute Mountain

Sickness

Risk Category	Description
Low	• Individuals with no prior history of altitude illness and ascending ≤2,800m • Individuals taking ≥2 days to arrive at 2,500-3,000m with subse increases in sleeping elevation less than 500m per day and an e for acclimatisation every 1,000m
Moderate	• Individuals with a history of AMS ascending to 2,500-2,800m in • Individuals with no history of AMS ascending to >2,800m in one • All individuals ascending >500 m/day (in sleeping elevation) at above 3,000m but with an extra day for acclimatisation every 1,
High	• Individuals with a history of AMS ascending to >2,800m in one • All individuals with a history of HACE or HAPE • All individuals ascending to >3,500m in one day • All individuals ascending >500 m/day (in sleeping elevation) abo 3,000m without extra days for acclimatisation • Very rapid ascents (e.g. less than 7 day ascent of Mount Kiliman

Signs and symptoms

AMS and HACE are the neurological forms of altitude illness and are likely to represent two points on a spectrum of the same disease with HACE being the more severe form. Symptoms of AMS do not start immediately on arrival at high altitude, typically they occur 6-10 hours after ascent to >2,500m (but may rarely occur at altitudes between 1,500-2,500m) [8].

The Lake Louise Consensus Group defined AMS as the onset of headache in an unacclimatised individual who has recently arrived at altitude accompanied by one or more of the following: gastrointestinal symptoms (anorexia, nausea, vomiting), dizziness, fatigue or weakness [12]. The Lake Louise criteria are a useful guide but are mainly used as a research tool and in general any new symptoms occurring after ascending to altitude should be regarded as altitude illness until proven otherwise. AMS is usually self-limiting and if further ascent is delayed it tends to resolve in 1-3 days [1].

HACE is caused by swelling of the brain (cerebral oedema) and is characterized by the onset of confusion, altered consciousness and or incoordination (ataxia). HACE is commonly preceded by AMS [13].

HAPE is the respiratory form of altitude illness. Initial symptoms include breathlessness on exertion, and a dry cough. These may progress to breathlessness at rest, breathlessness when lying flat, a wet cough, blood stained sputum, wheeze and chest tightness [14]. HAPE may occur in the absence

of AMS. HAPE and HACE tend to occur at least 2 days after ascent to altitude greater than 3-4,000m and rarely occur at altitudes lower than 2,800m [14]. They are uncommon but severe forms of altitude illness and frequently occur together. Without intervention they may rapidly progress to death [14].

Headache at high altitude is very common [15]. Despite forming part of the diagnostic criteria for AMS it can occur independently and could easily be associated with other issues such as exhaustion, dehydration or hangover.

Periodic breathing at altitude describes the cycle of rapid breathing (hyperventilation) alternating with episodes of decreased breathing (hypoventilation) and pauses in breathing (apnoea) [2]. Individuals often wake during apnoeic episodes and although alarming for those affected or their companions it is usually harmless.

Diagnosis and treatment

AMS, HACE and HAPE are all diagnosed based on clinical findings [12]. The severity of AMS is determined subjectively by the intensity of the symptoms reported by the individual [12]. The symptoms of AMS can easily be confused with other conditions. Because AMS can in some cases develop in to more severe life threatening illness, a traveller with relevant symptoms who has recently ascended to a new altitude is assumed to have AMS until proven otherwise, and should follow management advice for this. It is important to remember that many high altitude settings are based in remote locations away from medical care.

Travellers with AMS should stop further ascent (symptoms often resolve in 1-3 days), rest, take basic analgesia (painkillers) such as ibuprofen or paracetamol and anti-sickness medication if needed and descend if symptoms deteriorate or do not improve over one to two days [10].

Travellers with symptoms of HACE and HAPE require urgent medical attention and should descend to a lower altitude [9, 10]. Oxygen, portable hyperbaric chamber and medicines such as nifedipine / dexamethasone are often used when available and, these should be used to aid descent.

Treatment information is available from the Wilderness Medicine Society 2014 guidelines [9] and the update document 2019 [10]. However it has been suggested that the evidence for some of the treatments for altitude related illness is limited, of low quality and that more trials are needed [16].

Preventing altitude illness

Serious altitude illness or dying as a result of altitude related illness is avoidable in most cases [17]. The following prevention guidelines are based largely on the Wilderness Medicine Society guidelines [9, 10].

General advice

- Awareness of the symptoms of altitude illness is crucial. Remember altitude illness can and does kill people each year. Symptoms at altitude are caused by altitude illness until proven otherwise.
- Never ascend to sleep at a higher altitude in the presence of symptoms of altitude illness.
- Always attempt to descend if symptoms of altitude illness worsen at a given altitude or if symptoms are severe.
- Never leave an individual with altitude illness alone.
- Always trek with an experienced guide.
- Travel insurance should adequately cover the itinerary and activities. The planned maximum altitude should be disclosed and emergency evacuation by helicopter included within the policy.
- Where possible avoid travel from altitudes less than 1,200m to altitudes greater than 3,500m in a single day.
- Above 3,000m avoid increasing sleeping elevation by more than 500m a day and ensure a rest day (at the same altitude) every three or four days.
- It is recognised that travellers flying or driving directly to high altitude locations may be unable to ascend gradually. In such cases, rest days should be strongly considered before or after such large gains in elevation and elsewhere in the itinerary to ensure that the overall ascent rate averaged over the entire trip (e.g, total elevation gain divided by the number of days of ascent during the trip) falls below the 500m/day threshold.

Medication

- Preventative medications are not necessary for low risk situations (see Table 1) and individuals should rely on gradual ascent.
- Preventative medications may be considered in addition to gradual ascent in moderate or high-risk situations (see Table 1).
- Preventative medications are not a substitute for gradual ascent.
- Acetezolamide (Diamox®) is the preferred drug (unlicensed). The recommended dose is 125mg twice daily to be commenced one day prior to ascent to high altitude and then continued for at least two days after reaching the highest altitude (see also below for children).
- For individuals ascending to a high point and then descending toward the base (eg, descending from the summit of Mount Kilimanjaro), in the absence of symptoms, preventive medications should be stopped when descent is initiated.
- A trial dose of Diamox® for one or two days should be taken prior to travel to check for side effects which include: increased urine production (diuresis), pins and needles (paraesthesia), nausea, vomiting, headache and taste disturbance.
- Diamox® is contraindicated in pregnant women particularly in the first trimester and those with severe allergy to sulfa-based drugs (such as history of anaphylaxis or Stevens-Johnson syndrome) [18]. However, those with less severe allergy to sulfonamide medications can consider a supervised trial of acetazolamide before the trip, particularly if planning travel to a location remote from medical resources [19].
- Evidence for the benefit of gingko biloba and coca is either inconclusive or lacking [9] and is

not recommended for the prevention of AMS [10]. A 2017 Cochrane review found that the benefits and harms of other drugs such as dexamethasone are unclear, due to the small number of studies [20].

Extremes of temperature can significantly affect medications. Information and guidance about this is available from UIAA.

Pre-existing health problems

These must be carefully considered in consultation with a health professional prior to ascent for the following reasons: access to health care and medications is often limited in remote high altitude locations; certain medical problems (e.g. some forms of congenital heart disease) may increase the risk of altitude illness; certain medical problems may limit individual-performance or worsen at high altitude for example chronic obstructive pulmonary disease (COPD) or angina.

Further information is available from the US CDC and the UIAA websites (see resources below).

Pregnancy

There is a lack of data regarding the safety of travel to altitude whilst pregnant. It is prudent to avoid high altitude in the first trimester and advisable that at least one scan has been performed to confirm a healthy intrauterine pregnancy [21].

After 20 weeks gestation short stays (hours to days) at altitudes up to 2,500m without heavy exercise in women with uncomplicated pregnancies are thought to pose minimal risk [22]. The World Health Organization (WHO) state that travel to sleeping altitudes over 3,000m or to remote areas is not advisable during pregnancy [23].

Women with complicated pregnancies of any gestation should also avoid travel to high altitude for example those with unexplained bleeding, preeclampsia or risk factors for preeclampsia.

The Summary of Product Characteristics for acetazolamide states that this drug should not be used during pregnancy, particularly during the first trimester [18].

Children

Making specific recommendations for children ascending to altitude is difficult due to limited evidence. Children are not thought to be at higher risk of developing altitude illness compared to adults and travel to altitudes up to 2,500m is considered to be low risk in healthy children [24, 25]. Younger, particularly pre-verbal, children may have difficulty communicating symptoms of altitude illness making diagnosis challenging. Healthy children older than 8 years are likely to be capable of communicating their symptoms effectively and will usually present in a similar way to adults [24]. The Wilderness Medical Society guidelines 2019 suggest acetazolamide can be used for children for the prevention of AMS when indicated (see Table 1) at 2.5mg/kg dose 12 hourly up to a maximum

of 125mgs) [10].

The consensus statement of the UIAA medical commission on children at altitude is available online.

Other risks to consider at high altitude

Travellers should carry a first aid kit and equipment to cope with common problems, blisters, sore throat, sun exposure. Contaminated food and water can be an issue in some areas, travellers should food and water hygiene advice and be prepared to manage the symptoms of travellers' diarrhoea.

Exposure to low temperatures can lead to hypothermia or and cold injury at altitude. Prevention is key using appropriate non restrictive clothing, maintaining hydration, nutrition and being aware of signs and symptoms. Wilderness Medicine Society has detailed guidelines for the prevention and treatment of frostbite and treatment of hypothermia.

Resources

- Cochrane Review: Drugs commonly used for preventing high altitude illness, 2017
- Cochrane Review: Treatments for high altitude illness, 2018
- US CDC: Travelers' Health, Altitude illness
- Wilderness Medical Society Guidelines, 2019
- The International Climbing and Mountaineering Federation (UIAA): Mountain medicine advice and recommendations
- UIAA consensus statement of the medical commission: Women going to altitude
- Medex: Travel at high altitude
- Mountain medical kits: epidemiology-based recommendations and analysis of medical supplies carried by mountain climbers in Colorado, J. Trav. Med. 2017

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Published Date: 13 Sep 2019

Updated Date: 13 Sep 2019