# Acute mountain sickness

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**Most life-threatening altitude sickness is due to ascending with recognisable symptoms. Here is how to advise the intending high altitude traveller.**

Travellers of all ages are increasingly accessing high altitude areas. It is important that general practitioners are able to advise their patients on minimising problems associated with high altitude. One such problem is acute mountain sickness (AMS, altitude sickness), which may range in presentation from mild through to severe symptoms and is responsible for a number of deaths each year. The symptoms and especially the severe forms are completely preventable.

The risk of acute mountain sickness increases with both high altitude and rapid ascent to high altitude. It is more likely to occur in travellers who ascend rapidly to heights above 2400 m, and especially above 3400 m. Those who drive or fly in are more at risk than those who walk in, ascending slowly. Popular tourist spots that are areas of risk include the Andes in Peru and Bolivia, the Himalayas in Nepal, Mount Kenya and Mount Kilimanjaro in Africa and the Rockies in the USA and Canada.[1]

Studies report the prevalence of acute mountain sickness as 15 to 30% in skiers in the Colorado Rockies and up to 50% in trekkers through Nepal.[2] However, the use of medications is generally not needed, other than in the serious presentations.

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Prophylactic medications are generally restricted to individuals with a past history of acute mountain sickness or those who have to ascend suddenly to a high altitude.

## Symptoms

The mild form of acute mountain sickness presents as a combination of loss of appetite, dizziness, nausea and vomiting, headache, lassitude, decreased exercise tolerance and insomnia.[3]

The more serious malignant acute mountain sickness is potentially fatal and has two forms:

- high altitude pulmonary oedema (HAPE), which presents with breathlessness even at rest, increased pulse and respiration rates, dry cough or frothy white or blood-stained sputum, and blue lips
- high altitude cerebral oedema (HACE), which presents with unsteadiness of gait, erratic behaviour and impaired consciousness.

HACE can progress to coma and death, and can occur with or without HAPE.

Other problems that can occur at high altitude include peripheral oedema; it can occur alone but may progress to acute mountain sickness. Some people can develop high altitude retinopathy (retinal haemorrhages). These haemorrhages may occur with or without macular involvement and so are not always symptomatic.[4]

## Cause

Acute mountain sickness is caused by inadequate oxygen reaching the brain and muscles, although the precise mechanism is not completely understood.[5]

Increasing altitude results in a fall of inspired $P_{O_2}$, arterial $P_{O_2}$ and arterial $_{O_2}$ saturation. Relative hypoventilation and sleep disordered breathing which occur at high altitude, contribute to pulmonary vasoconstriction and pulmonary hypertension, with consequent pulmonary oedema. Fluid retention and increased intracerebral fluid volume lead to cerebral oedema. One recent study reported that HAPE-susceptible climbers had higher pulmonary artery pressures at altitude compared with their HAPE-resistant counterparts.[6] Another study reported that clearance of alveolar fluid is defective in HAPE-susceptible individuals and that salmeterol (a beta agonist which affects sodium transport) may be a helpful prophylactic in these individuals.[7] Intracapillary pressure may force the basement membranes apart, with consequent protein and fluid leakage, and a similar process may occur with HACE.[4]

However, apart from a past history of acute mountain sickness and ascent to very high altitudes (over 3000 m), there are no real predictors for who is at risk. Extreme fitness, paradoxically, is associated with increased incidence of acute mountain sickness, possibly because the climber can achieve greater heights more quickly, although other factors have been implicated.

## Prevention and treatment

It is a key point that most life-threatening altitude sickness is due to ascending with recognisable symptoms,[4] and therefore travellers should be advised not to ascend if symptoms are present, and to descend if symptoms are worsening or

not resolving. Graded ascent with time for acclimatisation is recommended.

The box on this page summarises prevention and treatment, including the medications used. Acetazolamide (Diamox) works by inhibiting carbonic anhydrase. The consequent bicarbonate excretion acts as a diuretic, thus reducing fluid retention, and also causes a metabolic acidosis, which stimulates ventilation. These processes effectively help the acclimatisation process and thus reduce symptoms in most individuals. People with a known sulfonamide sensitivity should not take acetazolamide. Dexamethasone (Dexmethsone) is used in sulfa-allergic individuals and for the treatment of more severe cases. Nifedipine can be used for HAPE.

Symptomatic treatment includes aspirin and prochlorperazine (Stemetil, Stemzine). The use of frusemide is controversial because of the risk of hypovolaemia and hypotension.

A number of other conditions may be exacerbated by high altitude – for example, ischaemic heart disease, chronic airways disease, epilepsy, sickle cell disease, polycythaemia, diabetes and probably pregnancy. These conditions may complicate recognition of symptoms of acute mountain sickness, although they can usually be differentiated.

## Key points

- The risk of acute mountain sickness increases with altitude, particularly with rapid ascent to high altitude.
- Ensure that travellers know the early symptoms.
- Recommend graded ascent, with time for acclimatisation.
- The traveller should not ascend if any symptoms are present.
- Descent is necessary if the symptoms continue to increase while the traveller is resting at a particular altitude.
- Illness at altitude is considered to be acute mountain sickness unless clearly otherwise. MT

## Prevention and treatment of acute mountain sickness

### Prevention

Advise the high altitude traveller about the following preventive measures:

- The key is gradual and slow ascent to allow the body to acclimatise.
- Spend a few days below 2400 m before ascending higher.
- The altitude at which you sleep is more important than that at which you spend the day – 'climb high and sleep low'
- Limit your ascent to 300 m per day (that is, try not to sleep at an altitude 300 m higher than that of the previous day).
- Have a rest day for each extra 1000 m.
- Drink at least 4 L of fluid daily.
- Restrict your intake of alcohol and sedatives.
- If you have possible symptoms of acute mountain sickness, tell someone and rest at the same altitude for an extra day or descend if the symptoms are severe.
- Use prophylactic medications if you have had acute mountain sickness in the past or if you are forced to make a sudden ascent.
- Try to travel with an experienced mountain climber or guide.

### Treatment

- If the symptoms are mild, rest the patient at the altitude reached or lower. Descend if the symptoms are more than mild; immediate descent is necessary if the symptoms are severe.
- Place the patient in a portable hyperbaric (Gamow-type) bag fitted with a foot pump (to increase the atmospheric pressure equivalent to a 1000 m descent).
- Give oxygen (2 to 4 L/min).
- Give medication.

### Medications

**Acetazolamide** (Diamox) tablets

- Treatment: 125 to 250 mg twice a day for moderate acute mountain sickness, with or without dexamethasone
- Prevention: 125 to 250 mg twice a day starting the day before ascent and for at least five days.

Side effects include tingling, gastrointestinal upset and increased urination.
Do not use acetazolamide if the patient is allergic to sulfa drugs.

**Dexamethasone** tablets or injection

- Treatment: 8 mg stat, followed by 4 mg every 6 hours
- Prevention: 2 to 4 mg every 6 hours from the day of ascent continued for three days and then the dose tapered off over five days.

**Nifedipine** tablets

- Treatment for HAPE (along with oxygen, descent and evacuation): 10 to 20 mg sublingually, then 20 mg orally every 6 hours.

## References

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