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Altitude sickness
minimising the risk

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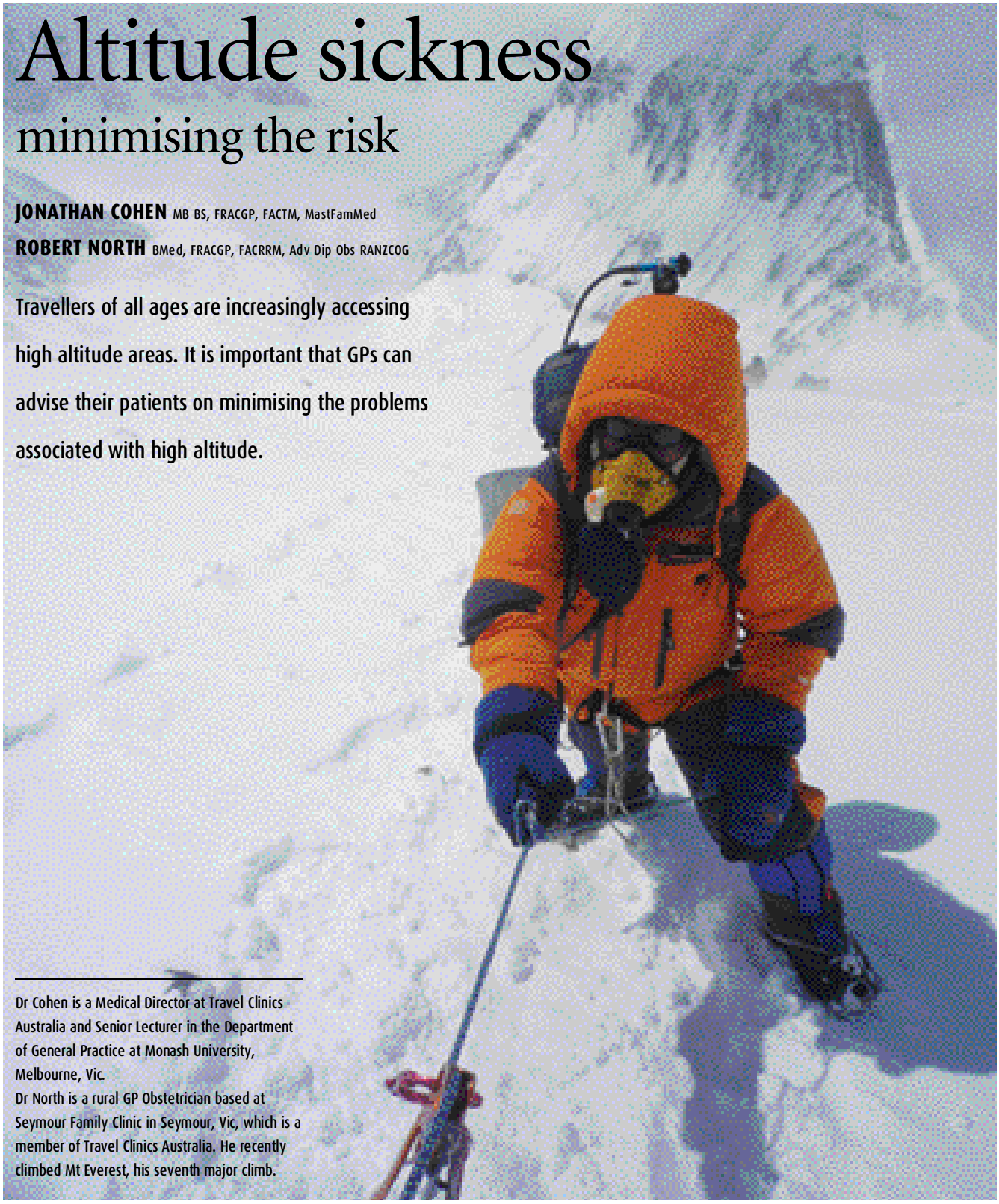
Travellers of all ages are increasingly accessing high altitude areas. It is important that GPs can advise their patients on minimising the problems associated with high altitude.



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One problem associated with high altitudes is acute mountain sickness (AMS), which may range in presentation from mild to severe symptoms and is responsible for a number of deaths each year. The symptoms, and severe forms especially, are completely preventable.

The risk of AMS increases with both high altitude and rapid ascent to high altitude. AMS is more likely to occur in travellers who ascend rapidly to heights of 2400 m, and especially above 3400 m. High altitude is defined as 1500 to 3500 m, very high altitude 3500 to 5500 m and extreme altitude greater than 5500 m. People who drive or fly to areas at these heights are more at risk of AMS than those who walk into these areas, ascending slowly. Areas of risk in popular tourist areas include the Andes in Peru and Bolivia, the Himalayas in Nepal and Tibet, Mount Kenya and Mount Kilimanjaro in Africa and the Rockies in the USA and Canada.[1] It is possible to drive to 5200 m and trek with no technical climbing to 6400 m in Tibet. Studies report the incidence of AMS at between 15% and 30% in skiers in the Colorado Rockies, and in up to 50% of trekkers through Nepal.[2]

The use of medications is generally not needed for AMS, other than for presentations that are more serious. Prophylactic medications are generally restricted to those people with a past history of altitude sickness, or those who have to ascend suddenly to a high altitude.

GPs should emphasise to their patients the importance of travelling with experienced and reputable operators. Travel companies offering cheaper trips have often sacrificed emergency equipment including oxygen, communications and staff-to-client ratios to achieve this. Some Everest operators will advertise a price, and then later discuss the need for oxygen and its additional cost. Consideration of this is particularly important for people travelling to high altitude areas, which are often remote, where evacuation can take days, and where helicopters may not be available or able to operate. For example, although helicopter rescue from Everest Base Camp in Nepal is possible but hazardous, there are no helicopters in Tibet. Evacuating an incapacitated trekker often requires numerous people and well prepared logistical backup. A well organised Everest expedition of 10 western climbers will have support staff of more than 25 people on the mountain, plus organised yak trains, available transport and several tonnes of equipment.

Figure. The view of Mt Everest from base camp. Travellers can drive to this base camp and hike, with no technical climbing, to 1200 m higher than the camp.

Travellers should be encouraged to maximise their fitness levels before travelling; the best activity is to trek carrying packs in hilly terrain for several hours at a time. Preparing for altitude is difficult, particularly in Australia, but any aerobic training is beneficial.

Symptoms

The mild form of AMS presents as a combination of loss of appetite, giddiness, nausea and vomiting, headache, lassitude, decreased exercise tolerance, insomnia[3] and periodic (Cheynes Stoke) breathing. The more serious malignant altitude sickness is potentially fatal and has two forms:

- **High altitude pulmonary oedema (HAPE).** Patients present with breathlessness even at rest, increased pulse and rate of breathing, dry cough, or frothy white or pink sputum and blue lips. HAPE can be rapidly fatal and can occur with or without high altitude cerebral oedema.
- **High altitude cerebral oedema (HACE).** Patients present with unsteadiness of gait, erratic behaviour and impaired consciousness. HACE can progress to coma and death, and can occur with or without HAPE.

Other symptoms that can be experienced at high altitude include peripheral oedema, which can occur alone but may progress to AMS. Retinal haemorrhages may also occur. Since these haemorrhages can occur without macular involvement, they may be asymptomatic.

Cause

The cause of AMS is a result of inadequate oxygen reaching the brain and muscles, although the precise mechanism is not completely understood.[4] Increasing altitude results in a fall of the inspired partial pressure of oxygen (PO_2), arterial

Prevention and treatment of altitude sickness

Prevention

- The key to preventing altitude sickness is gradual and slow ascent to allow the body to acclimatise.
- Spend a few days below 2400 m before ascending higher.
- Remember that the altitude at which you sleep is more important than that at which you spend the day.
- Limit ascent to 300 m per day – that is, try not to sleep at an altitude 300 m higher than the previous day – 'climb high and sleep low'.
- Have a rest day for each extra 1000 m you ascend.
- Drink at least 4 litres of fluid daily.
- Go slowly; when trekking make it a race to be last; walk as slow as it takes to be able to speak when you stop.
- Consider trying pre-exercise hyperventilation and pursed lip breathing.
- Restrict alcohol consumption and use of sedatives.
- If possible symptoms occur, tell someone and rest at the same altitude for an extra day, or descend if more severe symptoms develop.
- If you have a past history of altitude sickness, or if ascent will be sudden, use prophylactic medications.
- Try to travel with an experienced mountain climber or guide.

Treatment

- If a patient has mild symptoms, advise rest at that altitude or at a lower altitude; if symptoms are more severe, advise descent.
- Place the patient in a portable hyperbaric, Gamow-type bag with a foot pump (to increase atmospheric pressure equivalent to a 1000 m descent).
- Administer oxygen (2 to 4 litres per minute).
- Give medication (see the Table).

Table. Wilderness Medical Society's guidelines on medications for altitude sickness*

Medication	Indication	Route	Dosage
Acetazolamide	AMS, HACE prevention	Oral	125 mg twice per day Paediatrics: 2.5 mg/kg every 12 h
	AMS treatment†	Oral	250 mg twice per day Paediatrics: 2.5 mg/kg every 12 h
Dexamethasone	AMS, HACE prevention	Oral	2 mg every 6 h or 4 mg every 12 h Paediatrics: should not be used for prophylaxis
	AMS, HACE treatment	Oral, IV, IM	AMS: 4 mg every 6 h HACE: 8 mg once then 4 mg every 6 h Paediatrics: 0.15 mg/kg/dose every 6 h
Nifedipine	HAPE prevention	Oral	30 mg SR version every 12 h, or 20 mg SR version every 8 h
	HAPE treatment	Oral	30 mg SR version every 12 h, or 20 mg SR version every 8 h
Tadalafil	HAPE prevention	Oral	10 mg twice per day
Sildenafil	HAPE prevention	Oral	50 mg every 8 h
Salmeterol	HAPE prevention	Inhaled	125 µg twice per day‡

* Reprinted from: Wilderness Environ Med, Vol 21, Luks A, McIntosh SE, Grisson CK, et al. Wilderness Medical Society consensus guidelines for the prevention and treatment of acute altitude illness. p. 148. Copyright 2010, with permission from Elsevier.[8]

† Acetazolamide can also be used at this dose as an adjunct to dexamethasone in HACE treatment, but dexamethasone remains the primary treatment for that disorder.

‡ Should not be used as monotherapy and should only be used in conjunction with oral medications.

ABBREVIATIONS: AMS = acute mountain sickness; HACE = high altitude cerebral oedema; HAPE = high altitude pulmonary oedema; IM = intramuscular; IV = intravenous; SR = sustained release.

PO_2 and arterial O_2 saturation.

Relative hypoventilation and sleep disordered breathing occurring at high altitude contributes to pulmonary vasoconstriction and pulmonary hypertension with consequent pulmonary oedema. Fluid retention and increased intracerebral fluid volume leads to cerebral oedema.

One study reported that HAPE-susceptible climbers had higher pulmonary artery pressures at altitude compared with their HAPE-resistant counterparts.[5] Another study reported that clearance of alveolar fluid is defective in HAPE-susceptible individuals and that salmeterol (a beta-agonist affecting sodium transport) may be a helpful prophylactic in these individuals.[6]

In patients with HAPE, intracapillary pressure may force the basement membranes apart, with consequent protein and fluid leakage, and a similar process may occur with HACE.[7]

Who is at risk?

Apart from a past history of altitude 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 AMS, possibly because the climber can achieve greater heights more quickly, although other factors have been implicated. Older age tends to be a protective factor, perhaps because of the converse of why fitness is a risk factor. Overexertion is a risk factor.

Prevention and treatment

Most cases of life-threatening altitude sickness are due to ascending with recognisable symptoms, and, therefore, travellers should be advised not to ascend if symptoms are present, and to descend if symptoms are not resolving or worsening. Graded ascent with time for acclimatisation is recommended.

Information on the treatment and prevention of altitude sickness are given in the Box on page 72, and specific dosage recommendations from the Wilderness Medical Society's consensus guidelines are summarised in the Table.[8] The medications for AMS, HACE and HAPE are prescribed off-label in Australia.

Acetazolamide, a sulfonamide, works by inhibiting carbonic anhydrase and increasing bicarbonate concentration. The consequent bicarbonate diuresis 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 people.

Dexamethasone is used in sulfa-allergic individuals and for the treatment of more severe cases of altitude sickness and HACE. It is generally considered that dexamethasone should only be used in conjunction with descent. Despite the recommendations of the Wilderness Medical Society, shown in the Table, in our experience, few doctors in the field recommend the use of dexamethasone as a prophylactic agent, as AMS will respond less well to it if an emergency arises.

Sildenafil has been shown at altitude to reduce pulmonary artery pressure and thus the pulmonary hypertension of altitude, and it improves gas exchange and exercise performance.[9] It is being used to prevent HAPE. Tadalafil is also used as a prophylactic for HAPE.

Symptomatic treatment includes aspirin and prochlorperazine. Use of frusemide is controversial because of the risk of hypovolaemia and hypotension.

Conditions affected by high altitude

A number of other conditions may be exacerbated by high altitude. These include ischaemic heart disease, chronic airways disease, epilepsy, sickle cell disease, polycythaemia, diabetes and, probably, pregnancy. These conditions may also complicate recognition of symptoms of AMS, although the latter can usually be differentiated.

Key points

- Risk increases with altitude.
- Risk increases with rapid ascent to high altitude.
- Ensure travellers can recognise the early symptoms.
- Recommend graded ascent with time for acclimatisation.
- Travellers should not ascend if any symptoms of AMS are present.
- Travellers should descend if symptoms are increasing while resting at the same altitude.
- Illness at altitude is considered to be AMS unless clearly otherwise. MT

References

1. Cohen J. The traveller's pocket medical guide and international certificate of vaccination. 8th ed. Melbourne, Australia: The Travel Clinic; 2009.
2. Yung AP, Ruff TA. Altitude sickness. In: Manual of travel medicine. 2nd ed. Melbourne: Victorian Infectious Diseases Service, Royal Melbourne Hospital; 2004. pp. 236-237.
3. Basnyat B. High altitude. In: Dawood R, ed. Travellers' health: how to stay healthy abroad. 4th ed. Oxford: Oxford University Press; 2002. p. 314.
4. Hackett P. Medical problems of high altitude. In: Dupont HL, Steffen R, eds. Textbook of travel medicine and health. Hamilton, Ontario: BC Decker Inc; 1997. pp. 51-62.
5. Swenson ER, Maggiorini M, Mongovin S, et al. Pathogenesis of high-altitude pulmonary edema: inflammation is not an etiological factor. JAMA 2002; 287: 2228-2235.
6. Sartori C, Allemann Y, Duplain H, et al. Salmeterol for the prevention of high-altitude pulmonary edema. N Engl J Med 2002; 346: 1631-1636.
7. Hacket PH, Roach RC. High-altitude illness. N Engl J Med 2001; 345: 107-114.
8. Luks A, McIntosh SE, Grisson CK, et al. Wilderness Medical Society consensus guidelines for the prevention and treatment of acute altitude illness. Wilderness Environ Med 2010; 21: 146-155.
9. Richalet JP, Gratadour P, Robach P, et al. Sildenafil inhibits altitude-induced hypoxemia and pulmonary hypertension. Am J Respir Crit Care Med 2005; 171: 275-281.

COMPETING INTERESTS: None.