

# THE PREVENTION AND TREATMENT OF ACUTE MOUNTAIN SICKNESS

## Introduction

1. Adventure travel to the world's higher mountain ranges is becoming increasingly popular. Military personnel may take part in such activities either privately or as part of officially organised Service Adventurous Training. On occasions there may be an operational requirement to deploy personnel to high altitude at short notice, eg to mount a rescue.
2. Travel to high altitude is associated with a number of unique medical problems, the most common of which is Acute Mountain Sickness (AMS). Anyone can get AMS; there is no variation in incidence based on age, gender, fitness or previous altitude exposure. The carbonic anhydrase inhibitor drug acetazolamide, a licensed drug for the treatment of glaucoma and certain types of epilepsy, is generally accepted as being useful in both the prophylaxis and management of AMS, both of which are unlicensed indications for its use. Both Service and civilian Medical Officers (MOs) may, therefore, be asked to prescribe it and give advice on its use.
3. This policy leaflet provides guidance to Service medical personnel on the use of acetazolamide for the prevention and management of AMS. This leaflet supersedes SGPL31/01. It should be read in conjunction with [2005DIN06-010](#) "Guidelines for the Conduct of Adventurous Training Expeditions at Altitude".

## Background

4. For the purpose of this policy high altitude is defined as follows<sup>1</sup>:
  - a. High Altitude - 2500 to 3500m
  - b. Very High Altitude - 3500 to 5500m
  - c. Extreme Altitude - above 5500m
5. Most recreational high altitude travel is limited to the High and Very High category and it is these altitudes where AMS is predominantly seen. Travel to Extreme Altitude has historically only been associated with expeditions comprised of experienced mountaineers. In the Service context such expeditions have usually had dedicated and experienced medical support although this may be less frequent in future.
6. The human body adapts to the hypoxia of high altitude by a complex series of physiological changes. The rate of this physiological response varies amongst individuals but it is important that everybody is given enough time to enable acclimatisation to occur at their optimum rate. If the rate of ascent in altitude is too fast then the maladaptive condition of AMS will occur. It is estimated that 50-70% of people travelling to altitudes over 3500m will experience some mild symptoms of AMS. If unrecognised or ignored AMS may develop into the potentially life-threatening conditions of High Altitude Pulmonary Oedema (HAPE) and/or High Altitude Cerebral Oedema (HACE)<sup>2</sup>. Current thinking is that HACE and AMS form part of a spectrum of illness, with AMS being at the lower end of the spectrum. HAPE, although often preceded by AMS symptoms, has a different pathophysiology.

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<sup>1</sup> Consensus statement of the Union Internationale Des Associations D'Alpinisme, 2008.

<sup>2</sup> The E in HAPE and HACE is derived from the American spelling of oedema. These acronyms are now used almost universally when referring to these conditions.

## Symptoms Of AMS

7. AMS has been defined as the presence of headache in the setting of a recent gain in altitude together with at least one of the following symptoms<sup>3</sup>:

- a. Gastrointestinal upset (anorexia, nausea or vomiting).
- b. Fatigue or weakness.
- c. Dizziness or light-headedness.
- d. Difficulty sleeping.

## Assessment of AMS

8. The Lake Louise Symptom Score was primarily established to quantify the severity of AMS for scientific purposes; it may also be used for diagnostic purposes. The self- assessment score card has been extensively tested.

### Lake Louise Symptom Score (LLSS) self-report questionnaire

Symptoms	Severity	Points
Headache	- no headache	0
	- mild headache	1
	- moderate headache	2
	- severe headache, incapacitating	3
Gastrointestinal	- no gastrointestinal symptoms	0
	- poor appetite or nausea	1
	- moderate nausea or vomiting	2
	- severe nausea or vomiting, incapacitating	3
Fatigue and/ or weakness	- not tired or weak	0
	- mild fatigue/weakness	1
	- moderate fatigue/weakness	2
	- severe fatigue/weakness, incapacitating	3
Dizziness/light-headedness	- not dizzy	0
	- mild dizziness	1
	- moderate dizziness	2
	- severe dizziness, incapacitating	3
Difficulty of sleeping	- slept as well as usual	0
	- did not sleep as well as usual	1
	- woke up many times, poor night's sleep	2
	-unable to sleep	3

A total of > 3 points indicates AMS (if no evidence for other cause of symptoms.)

<sup>3</sup> 1991 International Hypoxia Symposium, Lake Louise, Canada.

## Prevention of AMS

9. **Controlled Ascent.** A slow, controlled rate of ascent is critical in the prevention of AMS<sup>4</sup> and it is essential that parties leave enough time in the travel itinerary to facilitate this. A widely adopted and effective rule of thumb is that, once above an altitude of 3000m, individuals should sleep no more than 300m higher each successive night. This does not preclude ascent greater than 300m during the day as long as the individual returns to the lower altitude to sleep. In addition, for every 1000m of altitude gained, it is recommended that a rest day/extra night is incorporated into the itinerary.

10. In reality few journeys will mirror this optimum ascent profile. The availability of shelter, food and water may dictate stopping places and many mountain journeys start by flying directly into airstrips above 3500m. These factors, together with wide variation in individual rates of acclimatisation, necessitate a flexible and adaptable schedule, free from unrealistic time constraints. Controlling the rate of ascent is, therefore, the main way of avoiding or minimising the symptoms of AMS.

11. **Acetazolamide.** In an attempt to accelerate the process of acclimatisation and to minimise symptoms of AMS, a number of drugs have been utilised. The most effective and widely used of these is the carbonic anhydrase inhibitor acetazolamide. Its primary mode of action is thought to be due to increased urinary excretion of bicarbonate resulting in a metabolic acidosis, which in turn stimulates respiration.

12. Trials have established a role for acetazolamide in the prevention of AMS<sup>5,6,7</sup>. Acetazolamide does not 'mask' symptoms: if a patient feels well while taking acetazolamide then they are well. Most importantly it does not protect against developing worsening illness if continuing to ascend with symptoms.

13. The drug is a mild diuretic and this can be a nuisance particularly at night. Other common side effects, which may limit patient tolerance, are tingling of the fingers, face and feet, and altered taste when drinking carbonated beverages. These symptoms are temporary and usually resolve quickly once acetazolamide is stopped. Dizziness, vomiting, drowsiness, confusion and rashes have all been reported but are unusual.

14. A dose of 125mg twice a day is recommended for prophylaxis and individuals electing to use the drug should normally be advised to begin 1-2 days prior to ascent above 3000m and to continue for 3-4 days thereafter. Individuals who are allergic to sulphonamide antibiotics should not be prescribed acetazolamide and the drug is not advised for use in the first trimester of pregnancy.

15. Despite its usefulness acetazolamide should not need to be routinely prescribed for low risk high altitude travellers; most people who have a reasonable ascent schedule will not need it. It is, however, useful for prophylaxis against AMS in moderate and high risk groups as defined by the Wilderness Medicine Society<sup>8</sup>. Team Leaders and MO can use the table below to help decide whether or not to use acetazolamide as prophylaxis for AMS.

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<sup>4</sup> Bloch KE, Turk AJ, Maggiorini M, et al. Effect of ascent protocol on acute mountain sickness and success at Muztagh Ata, 7546 m. *High Alt Med Biol.* 2009;10:25–32.

<sup>5</sup> Van Patot MC, Leadbetter G, Keyes LE, Maakestad KM, Olson S, Hackett PH. Prophylactic low-dose acetazolamide reduces the incidence and severity of acute mountain sickness. *High Alt Med Biol.* 2008;9:289–293.

<sup>6</sup> Basnyat B, Gertsch JH, Holck PS, et al. Acetazolamide 125 mg BD is not significantly different from 375 mg BD in the prevention of acute mountain sickness: the Prophylactic Acetazolamide Dosage Comparison for Efficacy (PACE) trial. *High Alt Med Biol.* 2006;7:17–27.

<sup>7</sup> Gertsch JH, Basnyat B, Johnson EW, Onopa J, Holck PS. Randomised, double blind, placebo controlled comparison of ginkgo biloba and acetazolamide for prevention of acute mountain sickness among Himalayan trekkers: the Prevention of High Altitude Illness Trial (PHAIT). *BMJ.* 2004; 328:797.

<sup>8</sup> Luks AM, McIntosh SE, Grissom CK et al. Wilderness Medical Society Consensus Guidelines for the Prevention and Treatment of Acute Altitude Illness. *Wilderness and Environmental Medicine.* 2010;21:2:146-155.

Risk Category	Description
Low	<ul style="list-style-type: none"> <li>• Individuals with no prior history of altitude illness and ascending to ≤2800 m;</li> <li>• Individuals taking ≥2 days to arrive at 2500-3000 m with</li> </ul>
Moderate	<ul style="list-style-type: none"> <li>• Individuals with prior history of AMS and ascending to 2500-2800 m in 1 day</li> <li>• No history of AMS and ascending to &gt;2800 m in 1 day</li> <li>• All individuals ascending &gt;500 m/d (increase in sleeping</li> </ul>
High	<ul style="list-style-type: none"> <li>• History of AMS and ascending to ≥2800 m in 1 day</li> <li>• All individuals with a prior history of HAPE or HACE</li> <li>• All individuals ascending to &gt;3500 m in 1 day</li> <li>• All individuals ascending &gt;500 m/d increase in sleeping elevation) above &gt;3500 m</li> </ul>

### Treatment of AMS

16. The golden rules of preventing death at high altitude are<sup>9</sup>:

- a. If the person feels unwell, they have AMS until proven otherwise.
- b. Do not ascend further if the person has symptoms of AMS.
- c. If the person is getting worse then descend immediately to an altitude lower than that at which the symptoms started.
- d. Do not leave the person unattended.

The most important treatment, therefore, is to cease further ascent when symptoms develop. Individuals experiencing mild to moderate symptoms should stop at their current altitude for an extra night to allow the acclimatisation process to catch up. Individuals with more severe symptoms, or those who have not responded to a halt in ascent, should descend until symptoms subside. Re-ascent can be attempted cautiously after a few days, with prophylactic acetazolamide a consideration if not already started.

17. However, it is important to emphasise that AMS, though unpleasant and potentially life threatening, is usually a self-limiting condition without serious sequelae. Treatment may include the following:

- a. Simple analgesics (aspirin, paracetamol or ibuprofen) which have all been shown to be effective in the treatment of AMS headache.
- b. Anti-emetics may be useful for nausea and vomiting. In extreme cases dexamethasone 4-8mg PO may improve symptoms to allow descent.

<sup>9</sup> [http://www.altitude.org/altitude\\_sickness.php](http://www.altitude.org/altitude_sickness.php)

- c. For more severe cases acetazolamide may be used acutely at a dose of 250mg twice daily (if not already on it). This reduced symptoms and improved oxygenation in a randomised controlled trial of 12 cases of AMS.
- d. Oxygen, to raise arterial oxygen saturation above 90%, is of benefit but supply is often limited.
- e. Dexamethasone is effective but may mask worsening symptoms, has potential serious side effects and should only be used under medical supervision.
- f. Descent may not always be possible, e.g. due to inclement weather or darkness, and when available a portable hyperbaric chamber, such as the Gamow Bag®, is a valuable treatment option for more severe cases.
- g. The only 'cure' is to become acclimatised to the hypoxia.

### Treatment of insomnia at altitude

18. Sleep disturbance is very common on ascent to altitude, particularly in non - acclimatised individuals. Periodic breathing can cause frequent waking with a sensation of suffocation. Cerebral hypoxia is the main factor in its pathogenesis. Hypnotics such as benzodiazepines can further depress the respiratory centre and should probably be avoided, although there is no evidence that they provoke AMS. Acetazolamide, by its stimulant action on the respiratory centre, reduces periodic breathing and is effective at promoting sleep at altitude. The recommended dose is 125-250mg as a single dose.

### Prescribing and supply of acetazolamide

19. Under current legislation there are only two mechanisms by which acetazolamide can be supplied to personnel who may require it for either the treatment of or prophylaxis against AMS:

- a. **Expeditions Including a Medical Officer (MO).** Acetazolamide can be prescribed and issued by the medical officer in the usual way.
- b. **Expeditions Not Including a MO.** Acetazolamide can be prescribed and issued, both for prophylaxis and for treatment, by a MO before departure. In these circumstances, each expedition member must receive a comprehensive briefing and an individual supply of medication; communal supplies are not appropriate. Each individual should receive a patient information sheet, including instructions for use, with their medication.

**MOs must be aware and understand their responsibilities when prescribing that this is an unlicensed but well recognised use of acetazolamide. MOs with no travel medicine experience should seek further advice from experienced travel medicine clinicians.**

20. Aircrew should avoid flying duties for 3-days following the cessation of administration of acetazolamide.

### Further Information

21. The following text is a comprehensive guide to all aspects of high altitude medicine and physiology: High Altitude Medicine and Physiology 4th Edition by Michael P Ward, James S Milledge, and John B West published by Arnold, London (2007). The High Altitude Medicine Handbook by Andrew J Pollard and David R Murdoch, 2nd Edition, published by Radcliffe Medical Press (2003) is a useful quick reference, easily digested by non-medical personnel.

22. There are many useful online resources including:

a. One of the best online resources for expeditions is the Medex book: Travel at High Altitude [http://medex.org.uk//medex\\_book/about\\_book.php](http://medex.org.uk//medex_book/about_book.php).

b. The 2010 Wilderness Medicine Consensus Guidelines for the prevention and treatment of acute mountain sickness can be found at [http://www.wemjournal.org/article/S1080-6032\(10\)00114-6/fulltext](http://www.wemjournal.org/article/S1080-6032(10)00114-6/fulltext)

c. The International Union of Alpine Associations (UIAA) produce a useful set of fact sheets on a number of high altitude medical issues including AMS. This can be accessed through the British Mountaineering Council website at <http://www.thebmc.co.uk/Category.aspx?category=19>.

d. Other websites to note are: [www.high-altitude-medicine.com](http://www.high-altitude-medicine.com), [www.ismmed.org](http://www.ismmed.org) and <http://www.altitude.org/home.php>

23. If required, further guidance can also be sought from sS Medical Directorates or the Committee for High Altitude and Remote Area Medicine (via Defence Consultant Advisor in Emergency Medicine).

### **Summary**

24. AMS can be life-threatening. Although an unlicensed indication, acetazolamide is effective in the prevention of AMS and has been widely used for over twenty years, with serious side effects from the drug being uncommon. However, it should not be considered as a substitute for a carefully controlled ascent and is not routinely needed by all personnel travelling to high altitude. Its use should be confined to those individuals at increased risk of developing AMS.