

Preventing Acute Mountain Sickness

JOHN M. KITSTEINER, MD, FAWM, *Incirlik Air Force Base, Turkey*

JAMES D. WHITWORTH, PhD, *University of West Florida, Pensacola, Florida*

JOAN NASHESKY, MLS, *University of Iowa Center for Human Rights, Iowa City, Iowa*

Clinical Inquiries provides answers to questions submitted by practicing family physicians to the Family Physicians Inquiries Network (FPIN). Members of the network select questions based on their relevance to family medicine. Answers are drawn from an approved set of evidence-based resources and undergo peer review. The strength of recommendations and the level of evidence for individual studies are rated using criteria developed by the Evidence-Based Medicine Working Group (<http://www.cebm.net/?o=1025>).

The complete database of evidence-based questions and answers is copyrighted by FPIN. If interested in submitting questions or writing answers for this series, go to <http://www.fpin.org> or e-mail: questions@fpin.org.

A collection of FPIN's Clinical Inquiries published in *AFP* is available at <http://www.aafp.org/afp/fpin>.

Clinical Question

What is the most effective method for preventing acute mountain sickness?

Evidence-Based Answer

Gradual ascent is the most effective method for preventing acute mountain sickness. (Strength of Recommendation [SOR]: B, based on good-quality prospective and retrospective cohort studies.) Acetazolamide should be used to prevent acute mountain sickness in persons with a history of acute mountain sickness or when gradual ascent is not practical. (SOR: A, based on two randomized controlled trials [RCTs] and a meta-analysis of 15 RCTs.) Dexamethasone is effective in preventing acute mountain sickness, but adverse effects must be considered. (SOR: A, based on a meta-analysis of seven RCTs.) Ginkgo extract is not recommended for acute mountain sickness prophylaxis. (SOR: A, based on seven controlled trials.) Recommended prophylactic regimens for acute mountain sickness are listed in *Table 1*.¹⁻⁷

Evidence Summary

GRADUAL ASCENT

A retrospective cohort study of 278 unacclimatized climbers in the Himalayas found that the incidence of acute mountain sickness in those who walked to an altitude of 9,200 ft (2,800 m) was less than those who flew to the same point (42 and 47 percent for the two walking groups versus 60 and 85 percent for the two flying groups).¹ In a prospective cohort study of Indian soldiers, acute mountain sickness symptoms stabilized after three days in those who were transported by road to an altitude of 11,500 ft (3,500 m) compared with five days in those who flew to the same altitude.² One expert suggests a

maximal elevation gain of 2,000 ft (600 m) per day when above 8,200 ft (2,500 m).³

ACETAZOLAMIDE

A double-blind RCT involving 155 trekkers on a slow ascent in Nepal concluded that 125 mg of acetazolamide twice per day was more effective than placebo at reducing the incidence of acute mountain sickness (number needed to treat = 8).⁴ A double-blind, three-group RCT including 32 vacationers in La Paz, Bolivia, (11,900 ft [3,630 m]) found that prophylactic use of 250 mg of acetazolamide twice per day prevented acute mountain sickness, whereas 125 mg of acetazolamide or placebo twice per day did not produce a statistically significant reduction in the incidence of acute mountain sickness (number needed to treat = 6.1).⁵ A meta-analysis that included 15 RCTs (n = 805) evaluating acetazolamide concluded that it is effective in preventing acute mountain sickness, although dosing regimens were not the same across trials (effect size = -0.61; 95% confidence interval, -0.29 to -0.93).⁷

DEXAMETHASONE

The same meta-analysis included seven RCTs (n = 222) evaluating dexamethasone for acute mountain sickness.⁷ The results showed that dexamethasone is less effective than acetazolamide for preventing acute mountain sickness (effect size = -0.32; 95% confidence interval, 0.38 to -1.02).⁷ Dexamethasone has the potential to cause serious adverse effects (e.g., depression, glucose intolerance).^{3,7} Dexamethasone may be considered as first-line therapy when a rapid, unplanned ascent is required, such as in rescue operations.³ Multiple trials have confirmed that dexamethasone is superior to acetazolamide for preventing acute mountain sickness during ►

Table 1. Prophylactic Treatment of Acute Mountain Sickness

Treatment	Regimen	Number needed to treat	References
Gradual ascent	Above 8,200 ft (2,500 m), sleeping altitude should not be increased by more than 2,000 ft (600 m) in 24 hours	5.5	1
		2.6*	2
	One day should be added for acclimatization for every increase in 2,000 to 4,000 ft (600 to 1,200 m)	—	3
Acetazolamide	125 mg twice per day, 24 hours before ascent and for the first two days	8	4
	250 mg twice per day, 24 hours before ascent and for the first two days	6.1	5
	500 mg sustained-release once per day, 24 hours before ascent and for the first two days	—	6
Dexamethasone	2 mg every six hours, 24 hours before ascent	3.7	7
	4 mg every 12 hours, 24 hours before ascent	3.1	7

*—Prospective and retrospective cohort trials only. Information from references 1 through 7.

rapid ascent.⁷ Multiple dosing regimens have been proposed, but 2 mg every six hours or 4 mg every 12 hours beginning 24 hours before ascent is recommended.³ The literature does not support a specific duration of dexamethasone therapy.

GINKGO

A systematic review of seven placebo-controlled trials (n = 715) identified four trials showing that use of ginkgo extract prevents acute mountain sickness and three trials showing no preventive effect.⁸ The variability of commercially available ginkgo extract may cause mixed results.⁸ In two trials, researchers found evidence that the source and composition of the extract may determine the effectiveness of treatment.⁸ Ginkgo extract may be effective at preventing acute mountain sickness, but because of its complex nature and variability, it is unlikely to be consistently effective. Therefore, it is not recommended as a prophylactic agent.

Recommendations from Others

The Wilderness Medical Society and the Canadian Committee to Advise on Tropical Medicine and Travel recommend gradual ascent as the most effective method of preventing acute mountain sickness.^{6,9} The Wilderness Medical Society endorses acetazolamide (125 mg twice per day), whereas the Canadian Committee recommends acetazolamide (125 to 250 mg twice per day or 500 mg sustained-release once per day, starting 24 hours before ascent and for the first two days) to prevent acute mountain sickness.^{6,9} Dexamethasone (2 mg every six hours or 4 mg every 12 hours, starting 24 hours before ascent) is recommended by the Canadian Committee only for the treatment of acute mountain sickness or for prophylaxis in persons who cannot tolerate or who are allergic to

acetazolamide. The Wilderness Medical Society endorses dexamethasone (2 mg every six hours or 4 mg every 12 hours) for acute mountain sickness prophylaxis.⁹

The opinions and assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the U.S. Air Force Medical Department or the U.S. Air Force at large.

Copyright Family Physicians Inquiries Network. Used with permission.

Address correspondence to John M. Kitsteiner, MD, FAWM, at john.kitsteiner@incirlik.af.mil. Reprints are not available from the authors.

Author disclosure: No relevant financial affiliations to disclose.

REFERENCES

- Hackett PH, Rennie D, Levine HD. The incidence, importance, and prophylaxis of acute mountain sickness. *Lancet*. 1976;2(7996):1149-1155.
- Purkayastha SS, Ray US, Arora BS, et al. Acclimatization at high altitude in gradual and acute induction. *J Appl Physiol*. 1995;79(2):487-492.
- Hackett PH, Roach RC. High-altitude illness. *N Engl J Med*. 2001;345(2):107-114.
- Basnyat B, Gertsch JH, Johnson EW, Castro-Marin F, Inoue Y, Yeh C. Efficacy of low-dose acetazolamide (125 mg BID) for the prophylaxis of acute mountain sickness: a prospective, double-blind, randomized, placebo-controlled trial. *High Alt Med Biol*. 2003;4(1):45-52.
- Carlsten C, Swenson ER, Ruoss S. A dose-response study of acetazolamide for acute mountain sickness prophylaxis in vacationing tourists at 12,000 feet (3630 m). *High Alt Med Biol*. 2004;5(1):33-39.
- Committee to Advise on Tropical Medicine and Travel (CATMAT). Statement on high-altitude illnesses. An Advisory Committee Statement (ACS). *Can Commun Dis Rep*. 2007;33(ACS-5):1-20.
- Ried LD, Carter KA, Ellsworth A. Acetazolamide or dexamethasone for prevention of acute mountain sickness: a meta-analysis. *J Wilderness Med*. 1994;5(1):34-48.
- van Patot MC, Keyes LE, Leadbetter G III, Hackett PH. Ginkgo biloba for prevention of acute mountain sickness: does it work? *High Alt Med Biol*. 2009;10(1):33-43.
- Luks AM, McIntosh SE, Grissom CK, et al. Wilderness Medical Society consensus guidelines for the prevention and treatment of acute altitude illness [published correction appears in *Wilderness Environ Med*. 2010; 21(4):386]. *Wilderness Environ Med*. 2010;21(2):146-155. ■