

WILDERNESS MEDICAL SOCIETY PRACTICE GUIDELINES

Wilderness Medical Society Practice Guidelines for the Prevention and Treatment of Acute Altitude Illness: 2014 Update

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To provide guidance to clinicians about best practices, the Wilderness Medical Society convened an expert panel to develop evidence-based guidelines for prevention and treatment of acute mountain sickness, high altitude cerebral edema, and high altitude pulmonary edema. These guidelines present the main prophylactic and therapeutic modalities for each disorder and provide recommendations about their role in disease management. Recommendations are graded based on the quality of supporting evidence and balance between the benefits and risks/burdens according to criteria put forth by the American College of Chest Physicians. The guidelines also provide suggested approaches to prevention and management of each disorder that incorporate these recommendations. This is an updated version of the original WMS Consensus Guidelines for the Prevention and Treatment of Acute Altitude Illness published in *Wilderness & Environmental Medicine* 2010;21(2):146–155.

Key Words: high altitude, acute mountain sickness, high altitude pulmonary edema, high altitude cerebral edema, acetazolamide, dexamethasone

Introduction

Travel to elevations above 2500 m is associated with risk of developing one or more forms of acute altitude illness: acute mountain sickness (AMS), high altitude cerebral edema (HACE), and high altitude pulmonary edema (HAPE). Because large numbers of people travel to such elevations, many clinicians are faced with questions from patients about the best means to prevent these disorders. In addition, healthcare providers working at facilities in high altitude regions or as part of expeditions traveling to such areas can expect to see persons who are suffering from these illnesses and must be familiar with prophylactic regimens and proper treatment protocols.

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To provide guidance to clinicians and disseminate knowledge about best practices in this area, the Wilderness Medical Society (WMS) convened an expert panel to develop evidence-based guidelines for prevention and treatment of acute altitude illness. Prophylactic and therapeutic modalities are presented for each disorder and recommendations made about their role in disease management. Recommendations are graded based on the quality of supporting evidence and consideration of benefits and risks/burdens for each modality.

Methods

The expert panel was originally convened at the 2009 Annual Meeting of the WMS in Snowmass, Colorado. Members were selected by the WMS based on their clinical or research experience. Relevant articles were identified through the MEDLINE database using a key

word search using the terms acute mountain sickness, high altitude pulmonary edema, high altitude cerebral edema, treatment, prevention, acetazolamide, dexamethasone, ibuprofen, nifedipine, tadalafil, sildenafil, and salmeterol. Peer-reviewed studies related to prevention and treatment of acute altitude illnesses, including randomized controlled trials, observational studies, and case series, were reviewed, and the level of evidence supporting various prophylaxis and treatment modalities was assessed. Abstract-only studies were not included. Conclusions from review articles were not considered in the formulation of recommendations but are cited as part of efforts to provide background information on the various diseases and their management. The panel used a consensus approach to develop recommendations regarding each modality and graded each recommendation according to criteria stipulated in the American College of Chest Physicians statement on grading recommendations and strength of evidence in clinical guidelines (see [online Supplementary Table 1](#)).¹

Defining the Threshold for High Altitude and Where to Apply These Guidelines

There is a risk of high altitude illness when unacclimatized individuals ascend to more than 2500 m. Prior studies and extensive clinical experience, however, suggest that susceptible individuals can develop AMS, and potentially HAPE, at elevations as low as 2000 m.²⁻⁴ Part of the difficulty of defining a specific threshold at which altitude illness can develop is the fact that the symptoms and signs of AMS, the most common form of altitude illness, are highly nonspecific, as demonstrated in several studies in which subjects met criteria for the diagnosis of AMS despite no gain in altitude.⁵⁻⁷ As a result, studies assessing AMS incidence at modest elevations may label individuals as having altitude illness when, in fact, symptoms are related to some other process, thereby falsely elevating the incidence of the disease at that elevation.

Recognizing the difficulty in defining a clear threshold, the expert panel recommends an approach to preventing and treating acute altitude illness that does not depend strictly on the altitude to which an individual is traveling. Altitude illness is more common above 2500 m but can be seen at lower elevations. As a result, preventive measures should be considered not only based on the altitude to which the individual is traveling but should also take into account factors such as the prior history of performance at high altitude, rate of ascent, and availability of rest days for acclimatization (described in greater detail below). Similarly, the diagnoses of AMS, HAPE, or HACE should not be excluded simply based on the fact that an individual is ill below 2500 m. They

should be strongly considered in the presence of compatible clinical features with careful attempts to exclude other entities such as severe dehydration, hyponatremia, pneumonia, or hypoglycemia, which may present in a similar manner.

Acute Mountain Sickness and High Altitude Cerebral Edema

Information on the epidemiology, clinical presentation, and pathophysiology of AMS and HACE is provided in several extensive reviews.⁸⁻¹¹ From a clinical standpoint, HACE represents an extreme form of AMS and, as a result, preventive and treatment measures for the 2 disorders can be addressed simultaneously.

PREVENTION

Prophylactic measures for AMS and HACE, the evidence supporting them, and their recommendation grades are described below. Further information about how to apply these measures is then provided as part of a suggested approach to prevention.

Gradual ascent

Controlling the rate of ascent, in terms of the number of meters gained per day, is a highly effective means of preventing acute altitude illness; however, aside from 2 recent prospective studies,^{12,13} this strategy has largely been evaluated retrospectively.¹⁴ In planning the rate of ascent, the altitude at which someone sleeps is considered more important than the altitude reached during waking hours. Recommendation Grade: 1B.

Acetazolamide

Multiple trials have established a role for acetazolamide in prevention of AMS.¹⁵⁻¹⁸ The recommended adult dose for prophylaxis is 125 mg twice daily ([Table 1](#)). Although doses up to 750 mg daily are effective at preventing AMS compared with placebo, they are associated with more frequent or increased side effects, do not convey greater efficacy, and, therefore, are not recommended for prevention. Recommendation Grade: 1A. The pediatric dose of acetazolamide is 2.5 mg/kg/dose (maximum 125 mg/dose) every 12 hours.¹⁹ Recommendation Grade: 1C.

Dexamethasone

Prospective trials have established a benefit for dexamethasone in AMS prevention.^{20,21} The recommended adult doses are 2 mg every 6 hours or 4 mg every 12 hours. Very high doses (4 mg every 6 hours) may be considered in very high-risk situations such as military or search and rescue

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