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REVIEW ARTICLE

Wilderness Medical Society Consensus Guidelines for the Prevention and Treatment of Acute Altitude Illness

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To provide guidance to clinicians about best practices, the Wilderness Medical Society (WMS) convened an expert panel to develop evidence-based guidelines for the prevention and treatment of acute mountain sickness (AMS), high altitude cerebral edema (HACE), and high altitude pulmonary edema (HAPE). These guidelines present the main prophylactic and therapeutic modalities for each disorder and provide recommendations for their roles 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 the prevention and management of each disorder that incorporate these recommendations.

Key words: high altitude, acute mountain sickness, high altitude pulmonary edema, high altitude cerebral edema, acetazolamide, dexamethasone, nifedipine, salmeterol, tadalafil, sildenafil

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), or 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.

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.

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Methods

The expert panel was convened at the 2009 Annual Meeting of the WMS in Snowmass, CO. Members were selected by the WMS based on their clinical and/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, nifedipine, tadalafil, sildenafil, and salmeterol. Peer-reviewed studies related to prevention and treatment of acute alti-

Table 1. ACCP classification scheme for grading evidence and recommendations in clinical guidelines

Grade	*Description*	*Benefits vs risks and burdens*	*Methodological quality of supporting evidence*
1A	Strong recommendation, high-quality evidence	Benefits clearly outweigh risks and burdens or vice versa	RCTs without important limitations or overwhelming evidence from observational studies
1B	Strong recommendation, moderate-quality evidence	Benefits clearly outweigh risks and burdens or vice versa	RCTs with important limitations or exceptionally strong evidence from observational studies
1C	Strong recommendation, low-quality or very low quality evidence	Benefits clearly outweigh risks and burdens or vice versa	Observational studies or case series
2A	Weak recommendation, high-quality evidence	Benefits closely balanced with risks and burdens	RCTs without important limitations or overwhelming evidence from observational studies
2B	Weak recommendation, moderate-quality evidence	Benefits closely balanced with risks and burdens	RCTs with important limitations or exceptionally strong evidence from observational studies
2C	Weak recommendation, low-quality or very low quality evidence	Uncertainty in the estimates of benefits, risks and burden; benefits, risk and burden may be closely balanced	Observational studies or case series

ACCP = American College of Chest Physicians; RCT = randomized controlled trial.

Source: Guyatt G, Gutterman D, Baumann MH, et al. Grading strength of recommendations and quality of evidence in clinical guidelines: report from an American College of Chest Physicians task force. *Chest.* 2006;129:174-181.

tude 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 below 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 (Table 1).[1]

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.[2-4] From a clinical standpoint, HACE represents the end stage of AMS and, as a result, preventive and treatment measures for the two 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 two recent prospective studies,[5,6] this strategy has largely been evaluated retrospectively.[7] 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 the prevention of AMS.[8-10] The recommended adult dose for prophylaxis is 125 mg twice daily (Table 2).

Table 2. Recommended dosages for medications used in the prevention and treatment of altitude illness

Medication	*Indication*	*Route*	*Dosage*
Acetazolamide	AMS, HACE prevention	Oral	125 mg twice per day Pediatrics: 2.5 mg/kg every 12 h
	AMS treatment[a]	Oral	250 mg twice per day Pediatrics: 2.5 mg/kg every 12 h
Dexamethasone	AMS, HACE prevention	Oral	2 mg every 6 h or 4 mg every 12 h Pediatrics: 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 Pediatrics: 0.15 mg/kg/dose every 6 h
Nifedipine	HAPE prevention	Oral	30 mg SR version, every 12 hours or 20 mg of SR version every 8 h
	HAPE treatment	Oral	30 mg SR version, every 12 hours or 20 mg of 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[b]

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

[a] 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.

[b] Should not be used as monotherapy and should only be used in conjunction with oral medications.

While higher doses up to 500 mg daily are effective at preventing AMS, they are associated with more frequent and/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 per dose (maximum 125 mg per dose) every 12 hours.[11] Recommendation grade: 1C.

Dexamethasone

Prospective trials have established a benefit for dexamethasone in AMS prevention.[12,13] 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 personnel being airlifted to altitudes greater than 3500 m with immediate performance of physical activity but should not be used outside these limited circumstances. The duration of use should not exceed 10 days to prevent glucocorticoid toxicity or adrenal suppression. Recommendation grade: 1A. Dexamethasone should not be used for prophylaxis in the pediatric population due to the potential for side effects unique to this population and the availability of other safe alternatives—specifically, graded ascent and acetazolamide.

Ginkgo biloba

Although several trials have demonstrated a benefit of *Ginkgo* in AMS prevention,[14,15] several negative trials have also been published.[16,17] This discrepancy may result from differences in the source and composition of the *Ginkgo* products.[18] Acetazolamide is considered far superior prophylaxis for AMS prevention. Recommendation grade: 2C

Other options

Chewed coca leaves, coca tea, and other coca-derived products are commonly recommended for travelers in the Andes for prophylaxis, and anecdotal reports suggest they are now being used by trekkers in Asia and Africa for similar purposes. However, their utility in prevention of altitude illness has never been systematically studied, and they should not be substituted for other established preventive measures described in these guidelines. “Forced” or “over”-hydration has also never been shown to prevent altitude illness and may even increase the risk of hyponatremia; however, maintenance of adequate hydration is important because symptoms of dehydration can mimic those of AMS.

Table 3. Risk categories for acute mountain sickness

Risk category	*Description*
Low	• Individuals with no prior history of altitude illness and ascending to ≤2800 m; • Individuals taking ≥2 days to arrive at 2500-3000 m with subsequent increases in sleeping elevation <500 m/d
Moderate	• Individuals with prior history of AMS and ascending to 2500-2800 m in 1 day • No history of AMS and ascending to >2800 m in 1 day • All individuals ascending >500 m/d (increase in sleeping elevation) at altitudes above 3000 m
High	• History of AMS and ascending to ≥2800 m in 1 day • All individuals with a prior history of HAPE or HACE • All individuals ascending to >3500 m in 1 day • All individuals ascending >500 m/d increase in sleeping elevation) above >3500 m • Very rapid ascents (eg, Mt. Kilimanjaro)

Altitudes listed in the table refer to the altitude at which the person sleeps. Ascent is assumed to start from elevations <1200 m. The risk categories described above pertain to unacclimatized individuals. AMS = acute mountain sickness; HACE = high altitude cerebral edema; HAPE = high altitude pulmonary edema.

SUGGESTED APPROACH TO AMS/HACE PREVENTION

Because the physiologic responses to high altitude and rates of acclimatization vary considerably between individuals, clinicians must recognize that the recommendations that follow, while generally effective, will not guarantee successful prevention in all high altitude travelers. The approach to prevention of AMS and HACE should be a function of the risk profile of the individual traveling to high altitude (Table 3). In low-risk situations, prophylactic medications are not necessary and individuals should rely on a gradual ascent profile. Above an altitude of 3000 m, individuals should not increase the sleeping elevation by more than 500 m per day and should include a rest day (ie, no ascent to higher sleeping elevation) every 3 to 4 days. Prophylactic medications should be considered in addition to gradual ascent for use in moderate-to high-risk situations. Acetazolamide is the preferred agent, but dexamethasone may be used as an alternative in individuals with a prior history of intolerance of or allergic reaction to acetazolamide. In rare circumstances (eg, military or rescue teams who must ascend rapidly to and perform physical work at altitudes >3500 m), consideration can be given to the concurrent use of acetazolamide and dexamethasone. This strategy should be avoided except in these particular or other emergency circumstances that mandate a very rapid ascent.

Acetazolamide carries a low risk of cross-reactivity in persons with sulfonamide allergy, but those with a known allergy to sulfonamide medications should consider a supervised trial of acetazolamide prior to their trip, particularly if planning travel into an area that is remote from medical resources.[19] A history of anaphylaxis to sulfonamide medications should be considered a contraindication to acetazolamide. Acetazolamide should be started the day before ascent (but will still have beneficial effects if started on the day of ascent); dexamethasone may be started the day of ascent. For individuals ascending to and staying at the same elevation for more than several days, prophylaxis may be stopped after 2 to 3 days at the target altitude. For an itinerary that involves ascending to a high point and then descending to a lower elevation, prophylactic medications should be stopped once descent is initiated.

TREATMENT

Potential therapeutic options for AMS and HACE include the following.

Descent

When feasible, descent remains the single best treatment for AMS and HACE. However, it is not necessary in all circumstances (discussed further below). Individuals should descend until symptoms resolve, unless impossible due to terrain. Symptoms typically resolve following descent of 300 to 1000 m, but the required descent will vary between persons. Individuals should not descend alone, particularly in cases of HACE. Recommendation grade: 1A.

Supplemental oxygen

Oxygen delivered by nasal cannula at flow rates sufficient to raise arterial oxygen saturation (Spo_2) to greater than 90% provides a suitable alternative to descent. Use

Table 4. Acute mountain sickness classification

Category	*Mild AMS*	*Moderate–Severe AMS*	*HACE*
Symptoms	Headache plus 1 or more other symptom (nausea/vomiting; fatigue, lassitude, dizziness; difficulty sleeping). All symptoms of mild intensity	Headache plus 1or more other symptom (nausea/vomiting; fatigue, lassitude, dizziness; difficulty sleeping). All symptoms of moderate–severe intensity	Worsening of symptoms seen in moderate to severe AMS
Signs	None	None	Ataxia, severe lassitude, altered mental status encephalopathy
Lake Louise AMS Score[a]	2-4	5-15	Not applicable

AMS = acute mountain sickness; HACE = high altitude cerebral edema.
[a] Self-report AMS score.[43]

is not required in all circumstances and is generally reserved for severe cases when descent is not feasible. Unlike at hospitals or large clinics, the supply of oxygen may be limited at remote high altitude clinics or on expeditions, necessitating careful use of this therapy. Recommendation grade: 1C.

Portable hyperbaric chambers

These devices are effective for treating severe altitude illness[20,21] but require constant tending by care providers and are difficult to use with claustrophobic or vomiting patients. Symptoms may recur when individuals are removed from the chamber.[22] Use of a portable hyperbaric chamber should not delay descent in situations where descent is feasible. Recommendation grade: 1B.

Acetazolamide

Only one study has examined acetazolamide for treatment of AMS. The dose studied was 250 mg twice daily and whether a lower dose might suffice is unknown.[23] Recommendation grade: 1B. No studies have assessed treatment of AMS in pediatric patients, but anecdotal reports suggest it has utility in this regard. The pediatric treatment dose is 2.5 mg/kg per dose twice daily up to a maximum of 250 mg per dose. Recommendation grade: 1C.

Dexamethasone

Dexamethasone is very effective in the treatment of AMS.[24-26] The medication does not facilitate acclimatization and further ascent should be delayed until the patient is asymptomatic while off the medication. Recommendation grade 1B. Extensive clinical experience supports the use of dexamethasone in patients with HACE. It is administered as an 8-mg dose (intramuscularly, intravenously, or orally) followed by 4 mg every 6 hours until symptoms resolve. The pediatric dose is 0.15 mg/kg per dose every 6 hours.[11] Recommendation grade: 1C.

SUGGESTED APPROACH TO AMS/HACE TREATMENT

Care should be taken to exclude disorders whose symptoms and signs may resemble those seen in AMS and HACE, such as dehydration, exhaustion, hypoglycemia, hypothermia, and hyponatremia.[2] Persons with altitude illness of any severity should stop ascending and may need to consider descent depending on the clinical circumstances and severity of illness (Table 4).[2] Patients with AMS can remain at their current altitude and use non-opiate analgesics for headache and anti-emetics for gastrointestinal symptom relief, which may be all that is required. Acetazolamide, by speeding acclimatization, will help treat AMS, but it works better for prevention than for treatment. While acetazolamide is good for treating mild illness, dexamethasone is a more reliably effective treatment agent for any degree of AMS, especially moderate to severe disease, which often requires descent as well. Individuals with AMS may resume their ascent once symptoms resolve, but further ascent or re-ascent to a previously attained altitude should never be undertaken in the face of ongoing symptoms. After resolution of AMS, reascent with acetazolamide is prudent.

HACE is differentiated from severe AMS by neurological findings such as ataxia, confusion, or altered

mental status in the setting of acute ascent to high altitude and may follow AMS or occur concurrently with HAPE. Individuals developing HACE in populated areas with access to hospitals or specialized clinics should be started on supplemental oxygen and dexamethasone. In remote areas away from medical resources, descent should be initiated in any suspected HACE victim or if symptoms of AMS are not responding to conservative measures or treatment with acetazolamide or dexamethasone. If descent is not feasible due to logistical issues, supplemental oxygen or a portable hyperbaric chamber should be considered. Persons with HACE should also be started on dexamethasone and consideration can be given to adding acetazolamide. No further ascent should be attempted until the victim is asymptomatic and no longer taking dexamethasone.

High Altitude Pulmonary Edema

Information on the epidemiology, clinical presentation and pathophysiology of HAPE, the majority of which comes from studies in adults, is provided in several extensive reviews.[4,27,28] While some of the prophylactic and therapeutic modalities are the same for HAPE as for AMS and HACE, important differences in the underlying pathophysiology of the disorder dictate different management and treatment approaches.

PREVENTION

Potential preventive measures for HAPE include the following:

Gradual Ascent

No studies have prospectively assessed whether limiting the rate of increase in sleeping elevation prevents HAPE; however, there is a clear relationship between rate of ascent and disease incidence.[7,29,30] Recommendation grade: 1C.

Nifedipine

A single randomized, placebo-controlled study[31] and extensive clinical experience have established a role for nifedipine in the prevention of HAPE in susceptible individuals. The recommended dose is 60 mg of the sustained release preparation administered daily in divided doses. Recommendation grade: 1A.

Salmeterol

In a single randomized, placebo-controlled study, the long-acting inhaled beta-agonist salmeterol decreased the incidence of HAPE by 50% in susceptible individuals.[32] Very high doses (125 μg twice daily) that are often associated with side effects were used in the study. Clinical experience with the medication at high altitude is limited. As a result, salmeterol is not recommended as monotherapy but may be considered as a supplement to nifedipine. Recommendation grade: 2B.

Tadalafil

In a single, randomized, placebo-controlled trial, 10 mg twice daily of tadalafil was effective in preventing HAPE in susceptible individuals.[33] The number of individuals in the study was small and clinical experience with the medication is lacking compared to nifedipine. As a result, further data are necessary to validate these results. Recommendation grade: 1C.

Dexamethasone

In the same study that assessed the role of tadalafil in HAPE prevention, dexamethasone (16 mg/d in divided doses) was also shown to prevent HAPE in susceptible individuals. The mechanism for this effect is not clear and there is very little, if any, clinical experience using dexamethasone for this purpose. Further data are necessary to validate this result. Recommendation grade: 1C.

Acetazolamide

Because acetazolamide hastens acclimatization, it should be effective at preventing all forms of acute altitude illness. It has been shown to blunt hypoxic pulmonary vasoconstriction in animal models[34,35] and in a single study in humans,[36] but there are no data specifically supporting a role in HAPE prevention.[37] Clinical observations suggest acetazolamide may prevent re-entry HAPE, a disorder seen in children who reside at high altitude, travel to lower elevation, and then develop HAPE upon rapid return to their residence. Recommendation grade: 2C.

SUGGESTED APPROACH TO HAPE PREVENTION

As noted earlier, because the physiologic responses to high altitude and rates of acclimatization vary considerably between individuals, the recommendations that follow, while generally effective, will not guarantee successful prevention in all high altitude travelers. A gradual ascent profile is the primary recommended method for preventing HAPE; the recommended ascent rate noted above for AMS and HACE prevention also applies with HAPE prevention. Drug prophylaxis should only be con-

sidered for individuals with a prior history of HAPE and nifedipine is the preferred option in such situations. It should be started on the day prior to ascent and continued either until descent is initiated or the individual has spent 5 days at the target elevation. Further research is needed before tadalafil or dexamethasone can be recommended for this purpose. Acetazolamide is a rational choice for HAPE prevention and clinical experience supports this, but data are lacking. Salmeterol should only be considered as a supplement to nifedipine in high-risk individuals with a clear history of recurrent HAPE.

TREATMENT

Potential therapeutic options for HAPE include the following:

Descent

As with AMS and HACE, descent remains the single best treatment for HAPE but is not necessary in all circumstances. Individuals should try to descend at least 1000 m or until symptoms resolve. They should exert themselves as little as possible on descent (eg, travel without a pack or via animal transportation) because exertion can further increase pulmonary artery pressure and exacerbate edema formation. Recommendation grade: 1A.

Supplemental Oxygen

Oxygen delivered by nasal cannula or face mask at flow rates sufficient to achieve goal S_pO_2 >90% provides a suitable alternative to descent, particularly when patients can access healthcare facilities and be monitored closely.[38,39] Recommendation grade: 1B.

Portable Hyperbaric Chambers

As with AMS and HACE, portable hyperbaric chambers can be used for HAPE treatment. They have not been systematically studied in this role, but their use in HAPE has been reported in the literature.[40] Use of a portable hyperbaric chamber should not delay descent in situations where descent is feasible. Recommendation grade: 1B.

Nifedipine

A single, nonrandomized, unblinded study demonstrated utility of nifedipine in HAPE treatment when oxygen or descent is not available.[41] No other treatment studies have been conducted, but there is extensive clinical experience with its use as an adjunct to oxygen or descent. Sixty milligrams of the sustained release version is administered daily in divided doses without a loading dose. It should not be relied on as the sole therapy unless descent is impossible and access to supplemental oxygen or portable hyperbaric therapy cannot be arranged. Recommendation grade: 1C (for use as adjunctive therapy).

Beta-agonists

Although there are reports of beta-agonist use in HAPE treatment,[42] no data support a benefit from salmeterol or albuterol in patients suffering from HAPE. Recommendation grade: 2C.

Phosphodiesterase Inhibitors

By virtue of their ability to cause pulmonary vasodilation and decrease pulmonary artery pressure, there is a strong physiologic rationale for using phosphodiesterase inhibitors in HAPE treatment. While reports document their use for this purpose,[42] no systematic studies have examined the role of either tadalafil or sildenafil in HAPE treatment. Recommendation grade: 2C

Continuous Positive Airway Pressure

A small study demonstrated that expiratory positive airway pressure (EPAP), in which a mask system is used to increase airway pressure during exhalation only, improved gas exchange in HAPE patients.[43] However, no studies have established that this modality or the more commonly used continuous positive airway pressure (CPAP), in which a continuous level of pressure is applied to the airways through the entire respiratory cycle, improves patient outcomes. Given the low risks associated with the therapy, it can be considered an adjunct to oxygen administration in the hospital setting, provided the patient has intact mental status and can tolerate the mask. It is generally not feasible in the field setting and the required level of pressure has not been established. Recommendation grade: 2B.

Diuretics

Although their use has been documented in the literature,[29] diuretics have no role in HAPE treatment, particularly because many HAPE patients have concurrent intravascular volume depletion. Recommendation grade: 2C.

SUGGESTED APPROACH TO HAPE TREATMENT

Prior to initiating treatment, care should be taken to rule out other causes of respiratory symptoms at high altitude, such as pneumonia, viral upper respiratory tract infection, bronchospasm, or myocardial infarction.[2] Descent is the first treatment priority in persons with HAPE. If descent cannot be initiated due to logistical factors, supplemental oxygen or a portable hyperbaric chamber should be used. Patients who have access to oxygen (eg, a hospital or high altitude medical clinic) may not need to descend to lower elevation and can be treated with oxygen at the current elevation. In the field setting, where resources are limited and there is a lower margin for error, nifedipine can be used as an adjunct to descent, oxygen administration, or portable hyperbaric therapy. It should only be used as primary therapy if none of these other measures is available. A phosphodiesterase inhibitor may be used if nifedipine is not available, but concurrent use of multiple pulmonary vasodilators is not recommended. In the hospital setting, CPAP can be considered as an adjunct to supplemental oxygen and nifedipine can be added if patients fail to respond to oxygen therapy alone. In well-selected patients (adequate support from family or friends, adequate housing or lodging arrangements), it is feasible to discharge them from care with supplemental oxygen rather than admitting them to a healthcare facility. There is no established role for acetazolamide, beta-agonists, or diuretics in the treatment of HAPE.

Individuals who develop HAPE may consider further ascent to higher altitudes or re-ascent to join their party only when symptoms of their disease have resolved and they maintain stable oxygenation at rest and with mild exercise while off supplemental oxygen and/or vasodilator therapy. Consideration may be given to using nifedipine or another pulmonary vasodilator upon resuming ascent.

SUGGESTED APPROACH FOR PATIENTS WITH CONCURRENT HAPE AND HACE

Dexamethasone should be added to the treatment regiment of patients with concurrent HAPE and HACE at the doses described above for those with HACE. Some patients with HAPE may have neurologic dysfunction due to hypoxic encephalopathy rather than true HACE, but making the distinction between hypoxic encephalopathy and HACE in the field can be difficult and, as a result, dexamethasone should be added to the treatment regimen for HAPE patients with neurologic dysfunction that does not resolve rapidly with administration of supplemental oxygen and improvement in the patient's oxygen saturation. Nifedipine or other pulmonary vasodilators may be used in patients with concurrent HAPE and HACE, but care should be exercised to avoid overly large decreases in mean arterial pressure, as this may decrease cerebral perfusion pressure and, as a result, increase the risk for cerebral ischemia.

Conclusions

To assist practitioners caring for people planning travel to or already at high altitude, we have provided evidence-based guidelines for prevention and treatment of acute altitude illnesses, including the main prophylactic and therapeutic modalities for AMS, HACE, and HAPE, and recommendations regarding their role in disease management. While these guidelines cover many of the important issues related to prevention and treatment of altitude illness, several important questions remain to be addressed and should serve as a focus for future research. Such research includes the optimum rate of ascent to prevent altitude illness, the role of acetazolamide in HAPE prevention and treatment, proper dosing regimens for prevention and treatment of altitude illness in the pediatric population, and the role of intermittent hypoxic exposure in altitude illness prevention.

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