

What's New in Environmental Illnesses of Travel: Appraisal and Summary of the Updated Guidelines from the Wilderness Medical Society

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Introduction

- Global rates of travel have skyrocketed in recent years and with this, travelers have also become increasingly adventurous.
- With this rising trend, travelers are at an increased risk of environmental illness and exposures and travel specialists must develop expertise in evidence-based therapeutics and risk-mitigation of environmental illness.
- The Wilderness Medicine Society (WMS) has recently published updated treatment and prevention guidelines on acute altitude sickness¹, frostbite², and avalanche and non-avalanche snow burial³.
- With the fast expansion of wilderness medicine research, a summary of the practice guidelines as well as a review of the emerging evidence is provided here.

Objective

- To highlight emerging evidence of clinical significance in wilderness medicine, for the purpose of updating and guiding travel medicine specialists caring for patients at risk of environmental exposures.

Methods

- Environmental illness management procedures were organized and reviewed
- Updated guidelines were compared with previous versions, and the evidence prompting new guidelines were reviewed and highlighted
- A concise literature search was conducted to assess the future direction of environmental-illness research and foresee the projection of future updated guidelines

Results

Table 1: Summary of 2024 WMS guideline updates and Appraisal of evidence

Guideline	Grade	Study Type (Sample Size)	Relevant Findings/Limitations
Inhaled budesonide should not be used for altitude illness prophylaxis.	SRHE	RCT (n=50); RCT (n=103);	Relevant finding: Inhalation of budesonide does not have a significant effect on pulmonary gas exchange. Relevant finding: Budesonide was ineffective for the prevention of acute mountain sickness.
Acetaminophen should not be used for AMS prevention.	SRLE	Prospective Randomized Trial (n=225*);	Limitations: There was a lack of placebo-control group comparison. The participants were recruited at a high altitude site, rendering any AMS incidence results potentially confounded by the preventive effect of preacclimatization.
Hypoxic tents are not recommended for facilitating acclimatization and preventing AMS.	SRME	RCT (n=76);	Relevant finding: Sleeping in a normobaric hypoxic tent for 14 consecutive nights reduced symptoms and incidence of AMS at higher altitudes later on. Limitations: Technical difficulties lead to inconsistencies in hypoxic dose received by a number of participants
Acetaminophen can be used to treat headache at high altitude, but not to treat AMS or HACE.	SRLE	Prospective RCT (n=74);	Relevant finding: Acetaminophen was as effective as ibuprofen in treating high altitude headache, a common symptom of altitude illness.
Ibuprofen can be used to treat headache at high altitude, but not to treat AMS or HACE.	SRLE	Prospective RCT (n=74)	Relevant finding: Ibuprofen, which was chosen as the comparator in this study, is deemed effective in treating high altitude headache, a common symptom of altitude illness.
No recommendation can be made regarding use of continuous positive airway pressure (CPAP) for AMS treatment.	N/A	2-Part Crossover study (n=5; n=14) Case report (n=1)	Relevant finding: CPAP is useful for raising oxyhemoglobin saturation as part of treating AMS in high altitudes. Relevant finding: The use of a portable CPAP device, in adjunct to pharmaceutical treatments for AMS, HAPE and HACE, showed a marked improvement in oxygen saturation.
Salmeterol is not recommended for HAPE prevention.	WRME	RCT (n=37)	Relevant finding: Inhalation of salmeterol both decreased the incidence of pulmonary edema and alleviated hypoxemia-related symptoms of AMS. Three participants (2 from intervention group) reported tremor and/or nocturnal palpitations.

Results - continued

Guideline	Grade	Study Type (Sample Size)	Relevant Findings/Limitations
Nifedipine should be used for HAPE treatment when descent is impossible or delayed and reliable access to supplemental oxygen or portable hyperbaric therapy is unavailable.	SRLE	Nonrandomized, unblinded study (n=6)	Relevant finding: Nifedipine (10 mg sublingually, 20 mg slow-release) was an effective treatment for all 6 participants with moderate to severe HAPE, resulting in better oxygenation, reduced alveolar arterial oxygen gradient and pulmonary artery pressure, as well as clearing of alveolar edema. No co-interventions were administered. As such, it may serve as an emergency intervention when descent is not possible.
CPAP may be considered for treatment of HAPE when supplemental oxygen or pulmonary vasodilators are not available or as adjunctive therapy in patients not responding to supplemental oxygen alone.	WRLE	Experimental study (n=17)	Relevant finding: CPAP administered to HAPE subjects, at rest at high altitudes, resulted in improved gas exchange. In the control group, non-HAPE subjects participating in rigorous activity at high altitudes, CPAP results in greater arterial oxygen saturation at the expense of greater minute ventilation and heart rate. CPAP is recommended when descent is not a viable option.
Acetazolamide should not be used for treatment of HAPE.	SRLE	Prospective RCT (n=74)	Relevant finding: Multiple treatments were used on all patients, with some patients receiving additional pharmacological therapeutics. Methodology doesn't permit sound comparison of effectiveness.
Although further studies are needed to determine the absolute efficacy of tPA for frostbite injury and to compare IV and intra-arterial tPA to IV prostacyclin, monitored administration of IV or intra-arterial tPA within 24 h of injury is recommended for the treatment of severe frostbite (Cauchy Grade 3 and 4), especially if iloprost is not available.	SRLE	Retrospective case series (n=56) Randomized open-label trial (n=47)	Limitations: Methodology doesn't permit sound comparison of effectiveness. No comparison of inter-physician variability. Relevant finding: Risk of amputation following treatment of severe frostbite was significantly lower in the 2 intervention groups (0% and 19% respectively) compared to the control group (60%). Study could not rule out additive effect posed by tPA in the second intervention outlined. The second intervention regimen should be considered on a case-by-case basis.
If available, appropriate imaging, including single photon emission computed tomography (CT)/CT, should be used to assess tissue viability and guide timing and extent of amputation.	WRLE	Retrospective Case Series (n=7, n=19 frostbite injuries)	Relevant finding: In six patients, the intervention led to more distal amputation.
Consider iloprost for deep frostbite (Cauchy Grades 2-4) to or proximal to the distal interphalangeal joint; within 72 h after rewarming but ideally as soon as possible.	SRLE	Randomized open-label trial (n=47); one retrospective observational study (n=90) and 4 case series	Relevant finding: Risk of amputation following treatment of severe frostbite was significantly lower in the 2 intervention groups (0% and 19% respectively) compared to the control group (60%). Limitations include wide confidence intervals, as well as lack of ischemia documentation with appropriate diagnostic modalities prior to therapy initiation.
An airbag that deflates after burial may help prevent asphyxia by creating an air pocket.	SRLE	Prospective Cohort Study (n=12)	Relevant finding: 92% of participants were able to complete a 60 minute snow burial, with the use of air bags, while maintaining oxygenation levels. Results reflect the potential of air bags to delay asphyxiation under proper condition only; if there is an oral or nasal obstruction, air bag deployment may not provide the same benefits.
Mountain rescue organizations should be prepared to manage multiple burial accidents.	EO	Experimental Observational Simulation Field Study (n=1070 full burials)	Relevant finding: Use of Monte Carlo simulations of the Avalife algorithm, derived from retrospective analysis of 1070 full burials and large prospective field tests, limiting CPR duration to 6 min may provide the "Greatest good for the greatest number" with the limited number of available rescuers. The main limitation is that this is an experimental study without human participants; the reported number of uses for this algorithm in real-life avalanche burials are low.
Core temperature (where measurable) or the Revised Swiss System can be used to estimate the risk of hypothermic cardiac arrest.	SRME	Evidence-based clinical guidelines on clinical staging of accidental hypothermia (Revised Swiss System)	Limitations noted are: 1)Overestimation of risk of cardiac arrest may occur with presence of conditions that may impair consciousness such as trauma, asphyxia, HACE 2)Use of level of consciousness as a single triaging factor poses a limitation when considering a single core temperature could manifest in different levels of consciousness
EtCO ₂ <10 mm Hg should not be used to predict a fatal outcome.	SRHE	Case-control Study of cardiac arrest patients (n=131)	Relevant Finding: Hypothermic cardiac arrest is associated with decreased levels of EtCO ₂ and pH-stat PaCO ₂ than non-hypothermic cardiac arrests. Limitations include: 1)No adjustment for potential confounders such as quality of chest compressions and ventilation rate 2)Possible systematic bias introduced by the potential time lag between the measurements of EtCO ₂ and PaCO ₂ 3)Only the first measurement of the parameters of interest were included in analysis 4)Statistical limitations with a study of 131 patients
Provision of psychological assistance to avalanche victims and rescuers is recommended.	SRLE	Qualitative Study (n=13 avalanche first-responders included)	Relevant findings: 1)Among the 13 first responders interviewed, symptoms of substance use disorder, depression, anxiety, panic, acute stress disorder, posttraumatic stress disorder and adverse effects on personal relationships were noted. 2)There is a lack of formal psychological support for avalanche first-responders Limitations include: 1)The study sample displays underrepresentation of female and layperson responders, and has geographical limitations 2)Possibility of reporting bias as interviews were conducted over the phone, on sensitive topics that are difficult to communicate 3)The variability in avalanche rescue experience confounds the participants' experience of rescues and thus the psychological impact
Avalanche accident registries should be used to improve the management of victims.	SRME	Consensus study	Limitations include: 1)Lack of reproducibility in consensus studies 2)Bias of selection of experts (n=16 ICAR Medcom members versus n=6 non-members)

SRHE – Strong recommendation, high quality of evidence; SRME – Strong recommendation, Moderate quality of evidence; SRLE – Strong recommendation, low quality of evidence; WRHE – Weak recommendation, high quality of evidence; WRLE – Weak recommendation, low quality of evidence; EO – Expert opinion

Discussion

- Since 2010, WMS has developed guidelines for managing wilderness injuries, from prevention to treatment.
- Recent updates address altitude sickness, frostbite, and snow burials, with key details in an overview table.
- Research gaps include adjunct therapies for altitude sickness, frostbite prevention, and post-thaw care.
- Ethical limits on avalanche trials suggest using advanced simulations for prevention and treatment strategies.
- WMS emphasizes preparedness through protective gear, life support, and search-and-rescue methods.
- Expanding guidelines may address broader health impacts of climate events, water disasters, air pollution, and severe wilderness injuries like frostbite afterdrop.

Conclusion

- In 2024, WMS updated guidelines for preventing, treating, and managing acute altitude illness, frostbite, and avalanche injuries.
- Guidelines are graded by evidentiary support and risk-to-benefit ratio to provide structured medical recommendations.
- Expanding research could enhance evidence-based practices in travel medicine and standardize guideline implementation.

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