Altitude Illness

Travelers whose itineraries will take them above an altitude of 1,829-2,438 m (6,000-8,000 ft) should be aware of the risk of altitude illness (1). Travelers are exposed to higher altitudes in a number of ways: by flying into a high-altitude city, by driving or riding a bus or train to a high-altitude destination, or by hiking or climbing in high mountains. Examples of high-altitude cities with airports are Cuzco, Peru (3,000 m; 11,000 ft); La Paz, Bolivia (3,444 m; 11,300 ft); and Lhasa, Tibet (3,749 m; 12,500 ft).

Travelers vary considerably in their susceptibility to altitude illness, and no screening tests are available to predict someone's risk for altitude illness. Susceptibility to altitude illness appears to be inherent in some way and is not affected by training or physical fitness. How a traveler has responded in the past to exposure to high altitude is the most reliable guide for future trips but is not infallible.

Travelers with underlying medical conditions, such as congestive heart failure, myocardial ischemia (angina), sickle cell disease, or any form of pulmonary insufficiency, should be advised to consult a doctor familiar with high-altitude medical issues before undertaking such travel. The risk of new ischemic heart disease in previously healthy travelers does not appear to be increased at high altitudes (2). Travelers with diabetes can travel safely to high altitude, but they must exercise more caution in checking their blood glucose. Diabetic ketoacidosis may be triggered by altitude illness and may be made more difficult to treat by the use of acetazolamide (see below). Not all glucose meters may read accurately at high altitudes (3).

Most people do not have visual problems at high altitude. However, at very high altitudes some persons who have had incisional radial keratotomy (a procedure widely performed from the late 1970s to the early 1990s) may develop acute farsightedness (4). The laser surgery for vision correction that replaced radial keratotomy (e.g., Lasik and other procedures) is not associated with visual disturbances at high altitudes.

Altitude illness is the result of traveling to a higher altitude faster than the body can adapt to that new altitude. Fluid leakage from blood vessels appears to be the main cause of symptoms. Altitude illness is divided into three syndromes: acute mountain sickness (AMS), high-altitude cerebral edema (HACE), and high-altitude pulmonary edema (HAPE). AMS is the most common form of altitude illness and, while it can occur at altitudes as low as 1,219-1,829 m (4,000-6,000 ft) (5), most often it occurs in abrupt ascents to >2,743 m (>9,000 ft) (6). The symptoms resemble those of an alcohol hangover: headache, fatigue, loss of appetite, nausea, and, occasionally, vomiting. The onset of AMS is delayed, usually beginning 6-12 hours after arrival at a higher altitude, but occasionally 24 hours after ascent.

HACE is considered a severe progression of AMS. In addition to the AMS symptoms, lethargy becomes profound, confusion can manifest, and ataxia will be demonstrated during the tandem gait test. A person with symptoms of AMS who fails the tandem gait test has HACE by definition, and immediate descent is mandatory. Death from HACE can ensue within 6-24 hours of developing ataxia.

HAPE can occur by itself or in conjunction with HACE. The initial symptoms are increased breathlessness with exertion, and eventually increased breathlessness at rest.

The diagnosis can usually be made when breathlessness fails to resolve after several minutes of rest. At this point, it is critical to descend to a lower altitude. HAPE can be more rapidly fatal than HACE.

Determining an itinerary that will avoid any occurrence of altitude illness is difficult because of variations in individual susceptibility, as well as in starting points and terrain. The main point of instructing travelers about altitude illness is not to prevent any possibility of altitude illness, but to prevent death from altitude illness. The onset of symptoms and clinical course is sufficiently slow and predictable that there is no reason for someone to die from altitude illness unless trapped by weather or geography in a situation in which descent is impossible. The three rules that travelers should be made aware of to prevent death from altitude illness are:

- Know the early symptoms of altitude illness; acknowledge and verbalize when they are present.
- Never ascend to sleep at a higher altitude when experiencing any of the symptoms of altitude illness, no matter how minor they seem.
- Descend if the symptoms become worse while resting at the same altitude.

Studies have shown that travelers who are on organized group treks to high-altitude locations are more likely to die of altitude illness than travelers who are by themselves (7). This is most likely the result of group pressure (whether perceived or real) and a fixed itinerary. The most important aspect of preventing severe altitude illness is to refrain from further ascent until all symptoms of altitude illness have disappeared.

Children are as susceptible to altitude illness as adults, and young children who cannot talk can show very nonspecific symptoms, such as loss of appetite and irritability. There are no studies or case reports of harm to a fetus if the mother travels briefly to high altitude during pregnancy. However, it may be prudent to recommend that pregnant women stay below 3,658 m (12,000 ft) if possible. The dangers of having a complication of pregnancy in remote, mountainous terrain should also be discussed.

Three medications have been shown to be useful in the prevention and treatment of altitude illness. Acetazolamide (Diamox) can prevent AMS when taken before ascent and can speed recovery if taken after symptoms have developed. The drug appears to work by acidifying the blood, which causes an increase in respiration and thus aids in acclimatization. An effective dose that minimizes the common side effects of increased urination and paresthesias of the fingers and toes is 125 mg every 12 hours, beginning the day of ascent. However, most clinical trials have been done with higher doses of 250 mg two or three times a day (8). Allergic reactions to acetazolamide are extremely rare, but the drug is related to sulfonamides and should not be used by sulfa-allergic persons, unless a trial dose is taken in a safe environment before travel. People with a history of severe penicillin allergy have occasionally had an allergic reaction to acetazolamide (9).

Dexamethasone has been shown to be effective in the prevention and treatment of AMS and HACE (10,11). The drug prevents or improves symptoms, but there is no evidence that it aids acclimatization. Thus, there is a risk of a sudden onset or worsening of symptoms if the traveler stops taking the drug while ascending. It is preferable for the traveler to use acetazolamide to prevent AMS while ascending and to reserve the use of dexamethasone to treat symptoms while trying to descend. The adult dosage is 4 mg every 6 hours.

HAPE is always associated with increased pulmonary artery pressure. Drugs that can selectively lower pulmonary artery pressure have been shown to be of benefit in preventing and treating HAPE. Nifedipine has been shown to prevent and ameliorate HAPE in persons who are particularly susceptible to HAPE (12). The adult dosage is 10-20 mg every 8 hours. Sildenafil citrate (Viagra) and related compounds can also selectively lower pulmonary artery pressure, with less effect on systemic blood pressure. Preliminary studies suggest that this class of drug may prove useful in prevention and treatment of HAPE (13).

Newer medications have recently been tried to help prevent AMS and HAPE. When taken before ascent, gingko biloba, an herbal remedy, was shown to reduce the symptoms of AMS in adults in two small trials, but a third trial failed to confirm the findings of the first two. Gingko biloba has not yet been compared directly to acetazolamide. Inhaled salmeterol (a beta-adrenergic agonist) was dem-onstrated to help prevent HAPE in a small group of climbers who had previously shown susceptibility to HAPE (14). Whether salmeterol will prove beneficial in a more general population remains to be seen. The mechanism of action of salmeterol suggests that it could be of benefit in treating already established HAPE, but there are no studies yet to confirm this. Salmeterol was chosen for prophylactic studies because of a longer duration of action. The less expensive albuterol may also be effective, but no studies utilizing this drug at altitude have been done.

For trekking groups and expeditions going into remote high-altitude areas, where descent to a lower altitude could be problematic, a pressurization bag (such as the Gamow bag) can prove extremely beneficial (15). Persons with altitude illness can be zipped into the bag, and a foot pump can increase the pressure inside the bag by 2 lbs. per in^2, mimicking a descent of 1,500-1,800m (5,000-6,000 ft), depending on the starting altitude. The total packed weight of the bag and pump is approximately 6.5 kg.

For most travelers, the best way to avoid altitude illness is to plan a gradual ascent, with extra rest days at intermediate altitudes. If ascent must be rapid, acetazolamide may be used prophylactically, and dexamethasone and pulmonary artery pressure-lowering drugs, such as nifedipine or sildenafil, may be carried for emergencies (16,17).

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