High Altitude Hypoxia
(Dealing With Altitude)

WHAT CAUSES ALTITUDE ILLNESSES

Altitude is defined as:

- High: 8,000 - 12,000 feet (2,438 - 3,658 meters)
- Very High: 12,000 - 18,000 feet (3,658 - 5,487 meters)
- Extremely High: 18,000+ feet (5,500+ meters)

People are seldom experienced in very high altitudes, so it is difficult to know who may be affected, and there are no tests to determine if you will develop high altitude illness. If you haven't been to high altitude before, it's important to be cautious. If you have been at that altitude before with no problem, you can probably return to that altitude without problems as long as you are properly acclimatized. The major cause of altitude illnesses is going too high too fast.

At an altitude of 12,000 feet you are getting about 40% fewer oxygen molecules with each breath. Because of this you must breathe faster to get the same amount of oxygen you get at sea level. The oxygen required for activity is the same, so the body must adjust to having less oxygen. Also at high altitude, lower air pressure causes fluid to leak from the capillaries, which can cause fluid build-up in both the lungs (pulmonary (lung) edema) and the brain (cerebral edema). Continuing to higher altitudes without adjusting (acclimatizing) slowly can lead to potentially serious, even life-threatening illness and death.

WHAT HAPPENS TO YOUR BODY AT HIGHER ALTITUDES?

- The depth of respiration increases.
- Pressure in pulmonary arteries is increased, “forcing” blood into portions of the lung that are normally not used during sea level breathing.
- The body produces more red blood cells to carry oxygen.
- The body produces more of a particular enzyme that helps oxygen be released from *hemoglobin* (carried in your red blood cells) to the body tissues.

PREVENTION

Prevention of altitude illnesses falls into two categories: proper acclimatization and preventive medications.

Below are a few basic guidelines for proper *acclimatization*:

- If possible, don't fly or drive to high altitude. Start below 10,000 feet (3,048 meters) and walk up.
- If you do fly or drive, do not over-exert yourself or move higher for the first 24 hours.
- If you go above 10,000 feet (3,048 meters), only increase your altitude by 1,000 feet (305 meters) per day and for every 3,000 feet (915 meters) of elevation gained, take a rest day.
- “Climb high and sleep low.” This is the saying used by climbers. You can climb more than 1,000 feet (305 meters) in a day as long as you come back down and sleep at a lower altitude.
- If you begin to show symptoms (problems) of moderate altitude illness, don't go higher until symptoms decrease. Don't go up until symptoms go down.
- If symptoms increase, go down, down, down!
- Keep in mind that different people will acclimatize at different rates. Make sure all of your party is properly acclimatized before going higher.
- Stay properly hydrated. Acclimatization is often accompanied by fluid loss, so you need to drink lots of fluids to remain properly hydrated (at least 3-4 quarts per day). Urine output should be plentiful and clear.
- Take it easy; don't over-exert yourself when you first get up to altitude. Light activity during the day is better than sleeping because respiration decreases during sleep, making the symptoms worse.

- Avoid tobacco, alcohol, and other depressant drugs including, barbiturates, tranquilizers, and sleeping pills. These depressants further decrease the respiratory drive during sleep resulting in a worsening of the symptoms.
- Eat a high carbohydrate diet (more than 70% of your calories from carbohydrates) while at altitude.
- Remember that the acclimatization process is inhibited by dehydration (uncoordinated or unsteady movements), over-exertion, and alcohol and other depressant drugs.

There are a number of medications which can be prescribed to prevent high altitude illnesses. Discussion with your caregiver can help determine what should be the best course of treatment for you. Diamox is the only medication which prevents high altitude illness, but a number of symptoms may be treated with other medications. This includes using ibuprofen for headaches, and nifedipine which helps with the shortness of breath which comes from fluid accumulation in the lungs.

ACUTE MOUNTAIN SICKNESS (AMS)

AMS is common at high altitudes. At elevations over 10,000 feet (3,048 meters), 75% of people will have mild symptoms. The occurrence of AMS is dependent upon the elevation, the rate of ascent, and individual susceptibility. Many people will experience mild AMS during the acclimatization process. Symptoms usually start 12-24 hours after arrival at altitude and begin to decrease in severity about the third day. The symptoms of mild AMS are headache, dizziness, fatigue, shortness of breath, loss of appetite, nausea (feeling sick to your stomach), disturbed sleep, and a general feeling of malaise. Symptoms tend to be worse at night and when respiratory drive is decreased. Mild AMS does *not* interfere with normal activity and symptoms generally subside within 2-4 days as the body acclimatizes. As long as symptoms are mild, and only a nuisance, ascent can continue at a moderate rate. When hiking, it is essential that you communicate any symptoms of illness immediately to others on your trip. AMS is considered to be a neurological problem caused by changes in the central nervous system. It is basically a mild form of High Altitude Cerebral Edema.

BASIC TREATMENT OF AMS

The only **cure** is either acclimatization or descent. Symptoms of Mild AMS can be treated with pain medications for headache and Diamox. Both help to reduce the severity of the symptoms, but remember, reducing the symptoms is not curing the problem. Diamox allows you to breathe faster so that you metabolize more oxygen, thereby minimizing the symptoms caused by poor oxygenation. This is especially helpful at night when respiratory drive is decreased. Since it takes a while for Diamox to have an effect, it is advisable to start taking it 24 hours before you go to altitude and continue for at least five days at higher altitude. The recommendation of the Himalayan Rescue Association Medical Clinic is 125 mg. twice a day (morning and night). (The standard dose was 250 mg., but their research showed no difference for *most* people with the lower dose, although some individuals may need 250 mg.) Possible side effects include tingling of the lips and fingertips, blurring of vision, and alteration of taste. These side effects may be reduced with the 125 mg. dose. Side effects subside when the drug is stopped. Contact your physician for a prescription. Since Diamox is a sulfonamide drug, people who are allergic to sulfa drugs should ***not*** take Diamox. **Diamox has also been known to cause severe allergic reactions to people with no previous history of Diamox or sulfa allergies.** Frank Hubbell of SOLO in New Hampshire recommends a trial course of the drug **before** going to a remote location where a severe allergic reaction could prove difficult to treat.

MODERATE AMS

Moderate AMS includes severe headache that is ***not*** relieved by medication, nausea and vomiting, increasing weakness and fatigue, shortness of breath, and decreased coordination *(ataxia)*. Normal activity is difficult, although the person may still be able to walk on their own. At this stage, only advanced medications or descent can reverse the problem. Descending even a few hundred feet (70-100 meters) may help and definite improvement will be seen in descents of 1,000-2,000 feet (305-610 meters). Twenty-four hours at the lower altitude will result in significant improvements. The person should remain at lower altitude until symptoms have subsided (up to 3 days). At this point, the person has become acclimatized to that altitude and can begin ascending again. The best test for moderate AMS is to have the person “walk a straight line” heel to toe. Just like a sobriety test, a person with ataxia (uncoordinated or unsteady movements) will be unable to walk a

straight line. This is a clear indication that ***immediate*** descent is required. It is important to get the person to descend ***before*** the ataxia reaches the point where they cannot walk on their own (which would necessitate a litter evacuation).

SEVERE AMS

Severe AMS presents as an increase in the severity of the aforementioned symptoms, including shortness of breath ***at rest***, inability to walk, decreasing mental status, and fluid buildup in the lungs. Severe AMS requires ***immediate*** descent to lower altitudes (2,000 - 4,000 feet [610-1,220 meters]).

There are two other severe forms of altitude illness: High Altitude Cerebral Edema (HACE) and High Altitude Pulmonary Edema (HAPE). Both of these happen less frequently, especially to those who are properly acclimatized. When they do occur, it is usually with people going too high too fast, or going very high and staying there. The lack of oxygen results in leakage of fluid through the capillary walls into either the lungs or the brain.

HIGH ALTITUDE PULMONARY EDEMA (HAPE)

HAPE results from fluid buildup in the lungs. The fluid in the lungs prevents effective oxygen exchange. As the condition becomes more severe, the level of oxygen in the bloodstream decreases, and this can lead to cyanosis, impaired cerebral function, and death. Symptoms include shortness of breath even at rest, “tightness in the chest,” marked fatigue, a feeling of impending suffocation at night, weakness, and a persistent productive cough bringing up white, watery, or frothy fluid. Confusion and irrational behavior are signs that insufficient oxygen is reaching the brain. One of the methods for testing yourself for HAPE is to check your recovery time after exertion. If your heart and breathing rates normally slow down in “X” seconds after exercise, but at altitude your recovery time is much greater, it may mean fluid is building up in the lungs. In cases of HAPE, ***immediate*** descent is a necessary, life-saving measure (2,000 - 4,000 feet [610-1,220 meters]). Anyone suffering from HAPE ***must*** be evacuated to a medical facility for proper follow-up treatment.

HIGH ALTITUDE CEREBRAL EDEMA (HACE)

HACE is the result of swelling of brain tissue from fluid leakage. Symptoms can include headache, loss of coordination *(ataxia)*, weakness, and decreasing levels of consciousness including, disorientation, loss of memory, hallucinations, psychotic behavior, and coma. It generally occurs after a week or more at high altitude. Severe instances can lead to death if not treated quickly. ***Immediate*** descent is a necessary life-saving measure (2,000 - 4,000 feet [610-1,220 meters]). There are some medications that may be prescribed for treatment in the field, but these require that you have proper training in their use. Anyone suffering from HACE ***must*** be evacuated to a medical facility for proper follow-up treatment.

OTHER MEDICATIONS FOR ALTITUDE ILLNESSES

- **Nifedipine** rapidly decreases pulmonary artery pressure and relieves HAPE.
- **Oxygen** reduces the effects of altitude illnesses.
- The Gamow Bag (pronounced ga´ mäf) has revolutionized field treatment of high altitude illnesses. The bag is basically a sealed chamber with a pump. The person is placed inside the bag and it is inflated. Pumping the bag full of air effectively increases the concentration of oxygen molecules and therefore simulates a descent to lower altitude. In as little as 10 minutes the bag can create an “atmosphere” that corresponds to that at 3,000 - 5,000 feet (915 - 1,525 meters) lower. After 1-2 hours in the bag, the person's body chemistry will have “reset” to the lower altitude. This lasts for up to 12 hours outside of the bag, which should be enough time to walk them down to a lower altitude and allow for further acclimatization. The bag and pump weigh about 14 pounds (6.3 kilos) and are now carried on most major high altitude expeditions. Bags can be rented for short-term trips such as treks or expeditions.
- Cheyne-Stokes Respirations: Above 10,000 feet (3,000 meters) most people experience a periodic breathing during sleep known as Cheyne-Stokes Respirations. The pattern begins with a few shallow breaths and increases to deep sighing respirations, then falls off rapidly. Respirations may cease entirely for a few seconds, and then the shallow breaths begin again. During the period when breathing stops the person often

becomes restless and may wake with a sudden feeling of suffocation. This can disturb sleeping patterns, exhausting the climber. *Acetazolamide* is helpful in relieving the periodic breathing. This type of breathing is **not** considered abnormal at high altitudes. However, if it occurs first during an illness (other than altitude illnesses) or after an injury (particularly a head injury) it may be a sign of a serious disorder.

HOME CARE INSTRUCTIONS FOLLOWING ALTITUDE EXPOSURE AND ILLNESS:

- For the first 24 to 36 hours exercise lightly.
- Drink plenty of fluids and eat small, light meals.
- Avoid smoking, sedatives and alcoholic beverages.
- To prevent high altitude sickness during future trips, give your body a few days to adjust to the changes in altitude before starting activities. Go to higher elevations slowly, giving your body time to adjust. Visit higher elevations during the daytime and return to lower elevations at night. Medications are available which can prevent this illness. If you have previously been diagnosed with high altitude sickness, it is best to be *prophylactically* (preventively) placed on one of these medications.

SEEK MEDICAL CARE IF:

- You do not feel better in one hour or as directed by your caregiver.
- You have mountain sickness (headache, nausea, vomiting, tiredness, shortness of breath, dizziness, and difficulty sleeping) and returning to a lower elevation does not relieve the symptoms.

SEEK IMMEDIATE MEDICAL CARE IF:

You develop symptoms such as:

- Severe shortness of breath
- Chest pain
- Rapid heart beat
- Increasingly severe headache
- A dry cough that produces bloody sputum
- Difficulty walking
- Difficulty concentrating
- Confusion

MAKE SURE YOU:

- Understand these instructions.
- Will watch your condition.
- Will get help right away if you are not doing well or get worse.

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