

ALTITUDE ILLNESS

- High altitude disease can be divided into acute mountain sickness (AMS), high altitude pulmonary edema (HAPE) and high altitude cerebral edema (HACE). AMS is essentially a benign and limited disease, while HAPE and HACE can be potentially lethal. The most common form of altitude disease is acute mountain sickness.

ACUTE MOUNTAIN SICKNESS

- The incidence of AMS is about 25% at 9,000 ft and 67% at 14,000 feet.

SYMPTOMS

- Symptoms usually consist of headache, nausea, vomiting, anorexia, weakness, fatigue, light headedness, dizziness, difficulty sleeping, chilliness, irritability, difficulty in concentration, tinnitus, visual and auditory disturbances, dyspnea, palpitations, tachycardia, weight loss and Cheyne Stokes breathing.
- **HEADACHES.** Headache is usually the first manifestation and may be mild to severe, bitemporal, throbbing, worse at night and on awakening. These symptoms may occur at altitudes as low as 6500 feet (2000 m). The more common symptoms are usually attributable to cerebral edema and occur within the first 24 hours of rapid ascent, and tend to improve over 3-7 days in the majority of patients.
- **EDEMA.** Some patients may develop peripheral and visceral edema, weight gain, proteinuria and oliguria. As individuals ascend to high altitude, there is a shift of fluid from the intravascular space into the interstitial or intracellular space, and a tendency toward a decrease in diuresis.

TREATMENT

- **MILD SYMPTOMS.** Treatment of AMS is descent. However, mild symptoms can be treated with rest, acetaminophen, ibuprofen, and acetazolamide (250 mg BID).
- **MODERATE SYMPTOMS.** Moderate symptoms can be treated with rest, dexamethasone (4 mg q6h for 1-3 days, tapered over 5 days), and acetazolamide 250-500 mg BID-TID.

- **SEVERE SYMPTOMS.** Severe symptoms must be treated with oxygen, dexamethasone (8 mg followed by 4 mg q6h PO or IM), and acetazolamide up to 1.5 grams daily. Acetazolamide functions by increasing ventilation, preventing periodic breathing, improving oxygenation, increasing diuresis, and creating a metabolic acidosis by urinary loss of bicarbonate, potassium and sodium.
- **PREVENTION.** Prevention of AMS may be effected by common sense measures such as avoiding alcohol, sedatives, excessive exertion on the first day, and slow ascent. Individuals should eat frequent small meals that are high in easily digested carbohydrates such as jams, fruits, and starches. Extra salt should be avoided, but drinking more water than usual is important in preventing water loss created by over breathing the dry air at high altitudes. If ascending to 6-7000 feet (2,000 m), take 2-3 days to ascend to this level. Above 10,000 feet (3,000 m) ascend 1,000 feet per day.
- **ACETAZOLAMIDE.** Acetazolamide may be started the day before the ascent at 250-500 mg and taken every h.s. for 3-5 days.
- **NIFEDIPINE.** Nifedipine may be started 2 days before the ascent at 20 mg daily, followed by 20 mg q8h starting on the day of ascent and continued for 3 days.
- **DEXAMETHASONE.** Dexamethasone may also be started on the day of ascent at 2-4 mg q6h and continued for 3 days, and then tapered over 5 days.
- **PENTOXIFYLLINE.** Pentoxifylline has been used in some countries to improve cerebral function, and prochlorperazine at 10 mg PO q6h has also been used as a preventive measure in some countries. These latter two drugs have not been widely used in the USA.

CHRONIC MOUNTAIN SICKNESS

- This illness is also known as Monge's disease. It is uncommon and results from chronic alveolar hypoventilation in residents of high altitude settlements. It resembles alveolar hypoventilation (Pickwickian syndrome). It apparently is due to a loss of ventilatory acclimatization. The hallmarks of the disease are a low or absent ventilatory response to hypoxia, excessive hypoxemia, pulmonary hypertension, secondary polycythemia and cor pulmonale.
- It was first described in 1928 as an illness occurring in indigenous Quechua Indian residents in the Andes.

SYMPTOMS

- It is characterized by hypoxemia, cyanosis, somnolence, mental depression, clubbing of the fingers, polycythemia, and right ventricular failure.

LABORATORY

- **HEMATOCRIT.** The hematocrit commonly is greater than 75%.
- **ECG.** The ECG may show right axis deviation, right atrial and ventricular hypertrophy.
- **CHEST X-RAY.** Chest x-ray will show right heart enlargement and central pulmonary vessel prominence.
- **HEART CATHETERIZATION.** Heart catheterization may show pulmonary hypertension.
- **PULMONARY FUNCTION TESTING.** Pulmonary function testing will show alveolar hypoventilation and elevated PCO₂.

TREATMENT

- The treatment of CMS is simple. Descent to lower altitudes causes a rapid improvement in the symptoms and reversal of the abnormal physical findings and laboratory abnormalities. Patients that are unable to move to lower altitudes may be treated with medroxyprogesterone and other respiratory stimulants. Phlebotomy may be used, but is not the treatment of choice.

HIGH ALTITUDE PULMONARY EDEMA (HAPE)

- HAPE usually occurs after a rapid ascent to above 9000 feet (2700 m).

CONTRIBUTING FACTORS

- Contributing factors include strenuous exercise and exposure to cold. Long term residents at high altitude may develop reentry pulmonary edema when they return to high altitude after a short visit at lower altitudes. Patients that have a congenital absence of one pulmonary artery are particularly at risk for HAPE, and tend to

develop the syndrome at altitudes as low as 5000 feet (1500 m). There is also an increased incidence of HAPE in individuals that have a previous history of HAPE.

SYMPTOMS

- The symptoms begin after about 6-96 hours after arriving at the high altitude level. The symptoms consist of a dry irritating cough that may become bloody and frothy, dyspnea, substernal pain, wheezing, orthopnea, cyanosis, tachycardia, weakness, ataxia, and coma. The incidence of HAPE varies from .01-2%. It is uncommon, but potentially much more serious than acute mountain sickness. Most of the complicated cases occur at altitudes beyond 10,000 ft. It is not unusual to see 1-2 deaths from HAPE at Colorado ski resorts annually.

LABORATORY

- **CHEST X-RAY.** Chest x-rays will show unilateral or bilateral alveolar infiltrates with enlargement of the pulmonary arteries. The pulmonary edema is a noncardiogenic form of pulmonary edema, and cardiomegaly and Kerley B lines are not seen in HAPE. Recurrent episodes of pulmonary edema usually do not show the same radiographic distribution of infiltrates. The atrial pressure is normal, but there is elevation of the pulmonary artery pressure. The pulmonary wedge pressure is normal, while the pulmonary vascular resistance is elevated.
- **BLOOD TESTS.** The white count is occasionally elevated, but the sedimentation rate is usually normal. Patients with HAPE have a relative thrombocytopenia and prolonged prothrombin time.
- **ECG.** ECG findings may reveal right ventricular strain. The mortality of HAPE ranges from between 0-50% depending on several factors.

TREATMENT

- Treatment of HAPE consists of oxygen, descent to a lower altitude, and rest.
- **OXYGEN.** By administering 100% oxygen, the pulmonary artery pressure will drop, arterial oxygen saturation will increase, and respiratory rates will decrease. High flow rates should be given by

mask to maintain arterial oxygen saturation greater than 90% in patients with severe HAPE.

- **DESCENT.** Descent of about 1500-3000 feet is usually effective.
- **REST.** Exertion should be kept to a minimum.
- **EPAP.** Expiratory positive airway pressure (EPAP) up to 10 cm H₂O will improve the hypoxia, increase tidal volume and decrease the respiratory rate without a change in the minute ventilation.
- **DEXAMETHASONE.** Dexamethasone at 8 mg initially, followed by 4 mg q6h PO may be useful, but its effectiveness has not been established.
- **ACETAZOLAMIDE.** Likewise acetazolamide may be helpful by increasing diuresis and stimulating ventilation, but its efficacy has not been established.
- **FUROSEMIDE.** Furosemide should not be given, as it has no benefit, and may lead to pulmonary embolism.
- **NIFEDIPINE.** Nifedipine has been shown to lower pulmonary hypertension and improve oxygenation. It is initially given as 10 mg sublingually plus 20 mg PO, followed by 20 mg PO q6h. Nifedipine may be used as a prophylactic agent for HAPE.

HIGH ALTITUDE CEREBRAL EDEMA

- High altitude cerebral edema (HACE) is the least common of all of the syndromes, but can be potentially severe. HACE usually occurs with HAPE, but can occur by itself.

SYMPTOMS

- After about 1-3 days at altitudes greater than 8250 feet (2500 m), the patient will develop severe headaches, confusion, staggering gait, truncal ataxia, seizures, hallucinations, mental confusion, slurred speech, nausea and vomiting, which can progress to coma. The development of cerebellar ataxia is a sensitive symptom, prompting immediate treatment. Retinal hemorrhages may be seen in about 50% of patients. They are very common at altitudes greater than 16,000 feet (5000 m). They usually are of no concern unless they appear in the macular area. Nosebleeds are rare, but subungual splinter hemorrhages are occasionally seen at altitudes greater than 16,000 feet (5000 m).