High Altitude Illness: Current Trends

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High Altitude Illness: Current Trends

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Abstract

Nepal, the home of the highest mountain peaks, is one of the most popular trekking destinations in the world. The Himalaya begins where other mountain ranges leave off. Local farmers have cut small terrace fields on the slopes of colossal gorges which have been carved out by large glacial fed rivers. Everest Base Camp located at an altitude of 5,360 metres (17,590 ft) is 1,000 meters higher than the highest point in Europe. Human body can adjust to these altitudes, but if given enough time and rest. Being in a hurry in the mountain sojourns can give rise to high altitude illness consequences of which can even be lethal. High altitude illness collectively describes syndromes that come into play shortly after ascent to high altitude and mainly affects unacclimatized individuals. It encompasses the cerebral syndromes of acute mountain sickness (AMS), high altitude cerebral oedema (HACO) and high altitude pulmonary oedema (HAPO) [1]. Shlim et al reported dramatic increase in the number of trekkers in Nepal[2].

Methodology

During the preparation of this article, peer-reviewed studies related to prevention and treatment of acute altitude illnesses, including randomized controlled trials and observational studies were reviewed and the level of evidence supporting various prophylaxis and treatment modalities was assessed. Search was carried out using Medline, Pub Med, Google and Google Scholar using all of the keywords as subject heading terms.

Pathophysiology

Exposure to low oxygen tension leads to a series of physiologic responses that results in the adaptations to the hypoxic conditions[3]. With increase in altitude, barometric pressure decreases causing progressive decline in the partial pressure of oxygen. Process of acclimatization leads to the physiological changes that help in maintaining tissue oxygen delivery in the setting of hypobaric hypoxemia (hypoxic hypoxia). Adaptive responses include increase in alveolar ventilation, haemoglobin concentration and affinity and tissue oxygen extraction. In certain individuals, inadequate adjustment of body resulting from lack of cardiopulmonary co-ordination to meet challenge of tissue hypoxia is responsible for high altitude-specific illness[4].

Acute Mountain Sickness

Acute mountain sickness is self-limiting and benign condition characterised by mild to moderate headache, loss of appetite, nausea, dizziness and insomnia[5]. Acute mountain sickness is usually seen at moderately high altitude, above 2800 m[6]. Occurrence and severity of AMS depends on altitude, rate of ascent and physical exertion after entry into high altitude,
besides other variables. No study has demonstrated a particular altitude illness gene, but recent studies have indicated that it is a polygenic condition with a strong environmental component[7]. Hackett and Rennie documented incidence of AMS as high as 43% among trekkers reaching an altitude of 4200m[8]. Murdoch reported the incidence to be 85% among tourists who travelled by air to an altitude of 3700m[9]. In a study among western trekkers around Thorong pass (5400m) in Nepal, the prevalence of AMS was found to be 63%[10]. An incidence of 68% has been documented by Basnyat et al in their study among pilgrims at an altitude of 4300m in Nepal[11]. Basnyat et al in a different study observed incidence to be only 20% at an altitude 4243m[12]. Maggiorini et al observed that prevalence of acute mountain sickness correlated with altitude: it was 9%, 13%, 34% and 53% at altitudes of 2850 m, 3050 m, 3650 m and 4559 m respectively[6]. Hackett et al also have reported rate of ascent as risk factor for development of AMS[13]. No difference between the sexes with regard to susceptibility to AMS has been reported by Hackett et al during trekking[13]. Whereas Richalet et al, found that women are more prone to AMS than men during climbing expedition[14].

High Altitude Pulmonary Oedema (HAPO)

HAPO is a life-threatening non-cardiogenic form of pulmonary oedema that afflicts vulnerable individuals following rapid ascent to high altitude above 2500 m[15]. Risk factors of HAPO are similar to those of other high altitude illnesses. Rate of ascent has been indicated as a risk factor by Singh et al when Indian soldiers rapidly air lifted to 11,500 ft from sea level developed HAPO with an incidence that varied from 2.3% to 15%[16]. A major determinant for the incidence of HAPO is vulnerability of an individual[17]. Symptoms associated with high altitude pulmonary oedema are incapacitating fatigue, chest tightness and dyspnoea at the minimal effort that advances to dyspnoea at rest and orthopnoea, and a dry non-productive cough progressing to cough with pink frothy sputum due to hemoptysis[5]. The symptoms of HAPO are known to develop within the first four days at high altitude[18]. The hallmark of HAPO is an excessively elevated pulmonary artery pressure in response to hypoxic pulmonary vasoconstriction leading to an elevated pulmonary capillary pressure and protein content as well as oedema fluid rich in red blood cells. HAPO is a form of hydrostatic pulmonary oedema with altered alveolar-capillary permeability[19]. Reduced clearance of fluid from the alveoli may also contribute to this non-cardiogenic pulmonary oedema[17]. Incidence of HAPO has been found to be quite variable. Menon reported an incidence of 5.7 per 1000 in a study on Indian soldiers in North Western Himalayas[20]. Hackett and Rennie reported an incidence of 2.5% among trekkers[13]. Among pilgrims at altitude of 7300m, Basnyat et al observed incidence to be 5%[11]. They also observed that women had higher incidence of HAPO at an altitude of 4300m[11]. Hanoka et al reported genetic associations between HAPO and certain major HLA histocompatibility complexes namely HLA-DR6 and HLA-DQ4[21]. The association of AMS and HAPO has been explored but conclusive evidence remains elusive. It has been documented that abnormalities on chest x-rays are seldom common in patients with AMS and HAPO and also HAPO is not necessarily preceded by AMS[1][22-24]. Reports of AMS being present in up to 80% of HAPO patients have also been published[13].

High Altitude Cerebral Oedema (HACO)

HACO is one of the most severe forms of high altitude illness. Common symptoms and signs of HACO in order of frequency are disturbed consciousness, ataxia, headache, anorexia, nausea and papilloedema[25]. HACO represents the end stage of AMS[26]. Risk factors of HACO are similar to that of other high altitude illnesses. High altitude cerebral oedema seems to result from an increase in intracranial pressure directly dependent on an increase of cerebral volume. Role of nitric oxide by regulation of cerebral blood flow has also been implicated[27]. Hackett and Rennie found incidence to be 1.8% among trekkers at an altitude of 4243m[13]. Basnyat et al observed incidence to be 31% among pilgrims at an altitude of 4300m in Nepal[11].

Discussion

In order to prevent the adverse effects of high altitude, preventive measures need to be taken. High altitude sickness can be prevented by slow ascent. Consumption of depressants like tobacco, alcohol, barbiturates and tranquilizers should be avoided as these further reduce the respiratory drive during sleep leading to aggravation of symptoms. Sufficient amount of fluids should be consumed in order to maintain hydration levels, as lot of fluid gets lost during the process of acclimatization. Drugs like acetazolamide...
can be used for treatment as well as prevention of high altitude sickness. It acts by increasing the respiratory rate leading to increased oxygen metabolism and thus minimizing the symptoms caused by poor oxygenation. Incidence and severity of AMS was found to be effectively reduced following administration of low dose acetazolamide prior to ascent and on the first day at an altitude of 4300 m [28]. As per a recent randomised controlled trial, effect of Ibuprofen was found similar to acetazolamide in preventing symptoms of AMS[29]. Levine et al reported dexamethasone to be effective in reducing the symptoms of acute mountain sickness[30-32]. Both dexamethasone and tadalafil can be effective in the prevention and treatment of HAPO. It acts by inhibiting hypoxic pulmonary vasoconstriction, thereby preventing the rise in pulmonary artery pressures which is responsible for the development of pulmonary oedema[33]. Nifedipine, a calcium-channel antagonist, plays an important role in the prevention and treatment of HAPO. It acts by inhibiting hypoxic pulmonary vasoconstriction, thereby preventing the rise in pulmonary artery pressures which is responsible for the development of pulmonary oedema[33]. Nifedipine administered before and during exposure to high altitude in subjects with a history of pulmonary oedema reduced the incidence of the condition significantly and also had a beneficial effect in reducing the symptoms of acute mountain sickness[34]. On the contrary, Hohenhaus et al recommended the use of nifedipine only in the treatment of HAPO as lowering of pulmonary arterial pressure has no beneficial effect on the symptoms of AMS in subjects not susceptible to HAPO[35]. Adverse effects of high altitude illness, especially HACO and HAPO needs to be tackled as medical emergencies. Prompt first aid and evacuation from the high altitude can be life saving in case of HACO and HAPO. Portable hyperbaric chamber is recommended for the treatment of severe cases of acute mountain sickness, as well as for risky descent to lower altitudes[36].

**Conclusion**

Better knowledge of the high altitude sickness among members of trekking groups will be essential for the prevention and preparedness towards this health problem. Indoctrination sessions about the do’s and don’ts at high altitude for trekkers, pilgrims and other associated high risk groups prior to starting the ascent must be done. Health professionals at all levels should be trained in medical management of high altitude sickness. Provision of air evacuation and hyperbaric chamber facilities at various strategic locations will be highly beneficial to decrease morbidity and mortality burden due to high altitude illness.

**References**

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