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## ALTITUDE HEALTH PROBLEMS AND THEIR REMEDIES

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**ABSTRACT:** People, who have visits to high altitudes, do experience a certain type of health problems as they transit to different altitude ranges. With ascend to high altitude, various kinds of acute and chronic physiological changes occur which influence all system of the human body. These problems although have temporary manifestations, arising due to maladjustment of the body to abrupt altitudinal changes in oxygen, atmospheric pressure, and gravity but sometimes can be life-threatening. Often it has been found that these symptoms are confused with other complications of the body. Present review mention different type of altitude health problems, their symptoms, herbal and synthetic drugs that is helpful in these conditions.

**INTRODUCTION:** Millions of people travel to high altitudes every year mostly above 1500m, especially in the Himalayas in Asia, the Alps in Europe, the Rockies in the United States and Andes in South America<sup>1</sup>. Peoples such as military personnel, veterans, athletes, travellers who have frequent visits to high altitudes, they experience a certain type of health problems<sup>2</sup>. Generally, high altitude areas range from 1000 to 5500 meters or generally can be defined as areas at altitudes equal to or greater than 1500 m above mean sea level. More precisely, altitude can be classified as high altitude which lies between 1500 to 3500 meters (4921-11,483 feet), very high altitude that lies between 3500 to 5500 meters (11,484- 18,043 feet) and extreme altitude between 5500 to 8850 meters<sup>3</sup>. With an increase in the altitude to above mentioned altitudinal ranges, the physiological

Effects ranged from decreased exercise performance and increased ventilation to extreme hypoxia during sleep and high altitude illness and further extreme hypoxia and various other problems<sup>4</sup>. When one travel to elevations above 2500m a risk of developing one or more forms of acute altitude illness are common such as acute mountain sickness (AMS), high altitude pulmonary edema (HAPE), high altitude cerebral edema (HACE), frostbite and chilblains. All of this illness are together has been named as "altitude sickness." Since these problems are common for those people, who make abrupt changes high altitude very few kinds of literature mention this altitude illness, their symptoms, prevention and treatment. Present paper reviews the altitude sickness, symptoms and their remedies using by various herbal and synthetic drugs.

### High Altitude Health Problems:

**Acute Mountain Sickness (AMS):** Acute mountain sickness (AMS) is a syndrome of nonspecific symptoms defined as the presence of headache in an unacclimatized person who has recently arrived at an altitude above 2500 m<sup>5</sup>. AMS is characterized by several symptoms such as

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insomnia, gastrointestinal problems (anorexia, nausea, vomiting, *etc.*) dizziness, fatigue or lassitude, dyspnoea, poor appetite and difficulty in sleeping<sup>6</sup>. These symptoms can sometimes develop as early as 1 hour or may take 6 to 10 h after ascent. When AMS becomes more severe the symptoms of difficulty in breathing, impaired motor control, extreme fatigue, confusion, persistent cough, coughing up sputum, double vision, fluid accumulation in brain and lungs occur which depend on altitude, the rate of ascent and physical exertion in either sex<sup>7</sup>. However, some studies mention that women are more prone to AMS than men during climbing expedition<sup>8</sup>. The symptoms are more prevalent in individuals with less cerebrospinal fluid volume and those who have less ability to accommodate increased brain volume.

It has been found that the incidence of AMS increases with increase in altitude height, more severe at an altitude of 4200m or more. In the case of acute mountain sickness, the extravasation of fluid takes place from the intravascular to extravascular space, especially in the brain and lungs<sup>9</sup>. If symptoms are worsening, immediate descent or portable hyperbaric devices should be used. The only clear risk factor, apart from the rapid ascent, is a history of AMS, HAPE or HACE. Prevention of AMS will prevent progression to the more severe forms of altitude sickness. The most effective method of prevention is graded ascent<sup>10</sup>.

**High Altitude Cerebral Edema (HACE):** High altitude cerebral edema (HACE) is the severe form of acute mountain sickness resulting due to low blood circulation to the brain because of low pressure that is characterized by swelling in the brain tissues. High altitude cerebral edema is rare but potentially very serious high altitude problem<sup>11</sup>. The symptoms of HACE are severe headache, mood changes, hallucination, intracranial pressure, ataxia, vomiting, confusion, retinal hemorrhage<sup>12</sup>.

The two types of cerebral edema are cytotoxic and vasogenic caused by increased blood-brain barrier permeability due to mechanical factors such as loss of autoregulation, increased capillary pressure, ischemia, adrenergic and cholinergic neurogenic influences, activation of permeability mediators. The pathophysiology of HACE according to the

current leading theory is that it is vasogenic edema arises due to disruption of the blood-brain barrier<sup>11</sup>.

**High Altitude Pulmonary Edema (HAPE):** HAPE is life-threatening pulmonary edema that afflicts vulnerable individuals following rapid ascent to high altitude above 2500m and occurs because of deficiency of oxygen as well as low atmospheric pressure. Often reduced clearance of fluid from the alveoli may also contribute to HAPE<sup>13-14</sup>. The mechanism of the cause of HAPE is often linked to pulmonary hypertension, which leads to stress failure in capillaries of overperfused areas, resulting in pulmonary edema which further depends on individual susceptibility, the rate of ascent and exertion, altitude reached, and coldness are known risk factor which increases pulmonary-artery pressure using sympathetic stimulation<sup>15</sup>.

The first case of HAPE in unacclimatized lowlanders climbing to high altitude was reported from the Rocky Mountains<sup>16</sup>. Several recent reports of HAPE are from skiing areas having a height up to 3200m and Alpine resorts located at altitudes between 1400 and 2400m<sup>17</sup>. With usual ascent rates, the incidence is about 1% to 2%, but as many as 10% of people ascending rapidly to 4500m may develop the conditions<sup>13</sup>. Women may be less susceptible to HAPE than men<sup>18</sup>.

HAPE is responsible for most deaths from high altitude illness. In 2001, out of the total number of armed forces personnel deployed in high altitude areas, 225 were admitted with HAPE while in 2003 this figure was down to 90. Abnormalities of cardiopulmonary circulation increase the risk of high-altitude pulmonary edema. Pulmonary hypertension and polycythemia are common at high altitude in case of permanent residents which lead to cardiac failure<sup>19</sup>. The various symptoms of HAPE are external dyspnoea, cough, reduced exercise performance, breathlessness at rest, gurgling in the rest, chest pain, fluid excess in the lungs. HAPE presents within 2 to 5 days of arrival at high altitude.

It is rarely observed below altitudes of 2500-3000m, and after one week of acclimatization at a particular altitude, the various symptoms of HAPE are external dyspnoea, cough, reduced exercise

performance, breathlessness at rest, gurgling in the rest, chest pain, fluid excess in the lungs<sup>20</sup>.

**Frostnip:** It is the mildest form of cold injury and therefore does not cause any irreversible damage. Frostnip consists of a severe cold sensation which involves only the skin and may lead to numbness and even pain<sup>21</sup>. One of the major groups at risk of frostbite is mountaineers, who are most affected in cold seasons and at high altitudes. Little work has been carried out, thus far, to study the scope of the problem in this group, and the medical literature is lacking in studies on the epidemiology and predisposing factors of frostbite among mountaineers. We are active members of the Mountaineering Club of Tehran University of Medical Sciences. Having encountered many cases of frostbite among our fellow mountaineers, we planned this study, describing the settings of the injury to gather information to allow implementation of the best possible preventive measures<sup>22</sup>.

**Chilblains:** It is an inflammatory skin condition presenting after exposure to cold as pruritic and painful erythematous to violaceous acral lesions. It may be idiopathic or secondary to an underlying disease<sup>23</sup>. Chilblains are most seen in young and middle-aged women and children, and in terms of sex ratio, women are affected more frequently than men<sup>24</sup>. The direct cause of chilblains is cold exposure, but exposure to both mild non-freezing cold and humidity seem to be required. People who exercise or work outdoors in wet and cold rooms, women and people who have acrocyanosis or erythrocytosis are prone to develop chilblain<sup>25</sup>. The various symptoms of chilblains are inflammation, low body weight, hormonal changes, bluish-red skin, pain, itchiness, Patients may experience a burning sensation, ulcerating blisters<sup>26</sup>.

**Frostbite:** Frostbite is a condition caused by the action of cold on the body. The central pathogenic mechanism of frostbite is ice crystal formation in tissues, resulting in cellular injury; ensuring and concomitant ischemia, anoxia and acidosis contribute to the injury. The appearance of frostbite not only depends on temperature but also on the duration of exposure to cold, humidity, airflow, pre-existing disorders such as arterial circulatory

disorders, chronic alcoholism<sup>27</sup>. Frostbite is of three types, first-degree frostbite (epidermis), second-degree frostbite (deeper) and third-degree frostbite. The first-degree frostbite occurs in people who live in very cold climates or do a lot of outdoor activity in winter. It involves the top layer of skin (epidermis) and presents as numbed skin that has turned white.

The skin may feel stiff to touch, but the tissue underneath is still warm and soft. Blistering, infection or scarring seldom occurs if it is treated promptly<sup>28</sup>. Second-degree frostbite is superficial frostbite and presents as white or blue skin that feels hard and frozen. Blisters usually form within 24 h of injury and are filled with clear or milky fluid. The tissue underneath is still intact, but medical treatment is required to prevent further damage<sup>29</sup>. Third-degree frostbite, also known as deep frostbite, appears as blue skin alternating with white zones. The underlying skin tissue is damaged and feels hard and cold to touch. The vast majority of frostbite injuries in the military are either first or second degree, according to a recent review of army experience in Alaska<sup>30</sup>. The most frequent symptoms along with headache were light headedness and vertigo, but sleep disturbance was the most common one<sup>31</sup>.

**Insomnia:** Insomnia is also a widespread problem at high altitudes. Sleep is one of the most deeply healing and revitalizing experiences known. When we can get enough restful sleep each night, the entire world looks brighter. Sleep pattern at high altitude has been studied by Robert *et al.*, mainly with the use of polysomnography, and it is proved that at high altitude sleep decreases. Sleep problems affected general sleep quality and sleep induction<sup>32</sup>.

**Prevention of Altitude Health Problems:** Prevention of HAPE involves the following methods, the slow ascent is the most effective method of prevention and one that is effective even in susceptible individuals. Prophylaxis with nifedipine (an inhibitor of hypoxic pulmonary vasoconstriction) can be recommended for individuals with a history of HAPE if slow ascent is not possible, improper acclimatization remains the foremost risk factor for HAPE. In addition to descent and supplemental oxygen, nifedipine

appears to provide no additional benefit in the resolution of HAPE; its dose is 60mg daily of a severe release formulation<sup>33</sup>. It is found that nifedipine helps to avoid HAPE but is not effective for prevention of AMS<sup>34</sup>. When HACE is feasible, descent remains the single best treatment for HACE. The symptoms typically resolve following descent of 300 to 4000 m, but the required descent will vary between persons. Supplemental oxygen delivered by nasal cannula at flow rates sufficient to raise arterial oxygen saturation to greater than 90% provides a suitable alternative to descent. Portable hyperbaric chambers are effective for treating HACE and other severe altitude illness<sup>35</sup>.

But required constant tending by care providers and are difficult to use with vomiting patients. Symptoms may recur when individuals are removed from the chamber<sup>36</sup>. Sufficient amount of fluids should be consumed to maintain hydration level as lots of fluid gets lost during the process of acclimatization. Consumption of depressants like tobacco, alcohol, barbiturates, and tranquilizers should be avoided<sup>37</sup>. To prevent secondary damage by hypoxia, the patient at high altitude should be treated with supplemental oxygen. Other methods are oxygen administration, use of dexamethasone, hyperbaric bags.

Various methods are involved in the treatment of HAPE, as with AMS and HACE, descent remains the single best treatment for HAPE but is not necessary for all circumstances. Individuals should try to descend at least 1000m or until symptoms resolve<sup>38</sup>. Supplemental oxygen is involved in the treatment of HAPE, delivery of oxygen by a nasal route at flow rates sufficient to achieve oxygen partial pressure more than 90% provides a suitable alternative to descent.

**Drug Treatment:** Various methods and drugs are used in the treatment of AMS such as controlling the rate of ascent in terms of the number of meters gained per day, is a highly effective means of preventing acute altitude illness<sup>39</sup>. Multiple trials have established a role for acetazolamide in the prevention of AMS<sup>40</sup>. The recommended adult dose for prophylaxis is 250 mg twice a day. It is a carbonic anhydrase inhibitor, and its mechanism of action is thought to be to acidify the blood, causing an increase in respiration centrally and an increase

in oxygenation. Acetaminophen and Ibuprofen are used for headache<sup>41</sup>. Two doses of dexamethasone of 4 mg, 6 h apart for adults. Chemical medicines show various types of side effects such as polyurea, paraesthesia, taste disturbances, depression, hyperglycemia, etc. Therefore we prefer herbal drugs as compared to synthetic medicines.

HACE which clinically represents the end stage of AMS and as a result, treatment measures for both the disorders can be addressed almost similar. Acetazolamide is commonly used; various trials have established a role for acetazolamide in the prevention and treatment of HACE<sup>42</sup>. The recommended adult dose for prophylaxis is 250 mg twice a day, for children 2.5 mg/kg every 12 h through oral route<sup>26</sup>. Prospective trials have established a benefit for dexamethasone in HACE treatment<sup>43</sup>. The recommended adult doses are 2mg every 6 h or 4mg every 12 h.

As with AMS and HACE, portable hyperbaric chambers can be used for HAPE treatment. They have not been systematically studied in this role, but their use in HAPE has been reported<sup>44</sup>. When oxygen or descent is not available, use of nifedipine is demonstrated, its dose is 20 mg slow release formulation every 6 h. Inhalation of beta-2-receptor agonists might be used in addition to nifedipine is commonly used. It is likely that sildenafil which attenuates hypoxic pulmonary vasoconstriction is effective for the treatment of HAPE, but no clinical trials have yet been reported<sup>45-46</sup>.

Synthetic drugs used for insomnia are benzodiazepines such as donormyl, temazepam and midazolam, etc.<sup>47</sup> A meta-analysis concluded that BDZs reduced sleep latency by 4.2 min and increased sleep duration by 61.8 min<sup>48</sup>. Hypnotic medications are often used to treat insomnia. On discontinuation of hypnotic medication after more than a few days use, rebound insomnia, physical as well as psychological withdrawal effects and recurrence of insomnia may occur<sup>49</sup>. Pentoxifylline is used for the treatment of frostbite by increasing red blood cells flexibility<sup>50</sup>.

**Herbal Remedies:** The most commonly used herb is *Gingko biloba*. It plays an important role in AMS prevention, it has a tonic effect on the brain,

stimulate blood circulation and reduce oxygen requirement of the body, although several negative trials have also been published still better than the synthetic drugs<sup>51-52</sup>. This discrepancy may result from a difference in the sources and composition of ginkgo products. Other herbal remedies are *Zinziber officinalis*, *Cocculum vulgare*, *Pulsatilla vulgaris*, *Rhodiola rosea*, etc. The *Rhodiola rosea* relieves stress and symptoms of AMS by balancing the body's stress-response system. It consists of the sympathetic and parasympathetic nervous system. With constant stress, the system becomes unbalanced making us feel tired, edgy and depressed<sup>53</sup>. *R. rosea* helps in re-establishment of the nervous system by acting as an adaptogen- an agent that strengthens the body's response to physical, mental and emotional stress<sup>10</sup>.

*Zinziber officinalis* has thermogenic and digestive properties which help us to get relief from AMS symptoms. If symptoms do not go away, descend 300 m<sup>54</sup>. These remedies in combination may help in improvement in shortness of breath, disorientation and speed recovery. *Rhodiola crenulata* is widely used to prevent AMS in the Himalayan areas and Tibet, but no scientific studies have examined its effectiveness in humans<sup>55</sup>.

*Gingko biloba* play an essential role in HACE treatment, although several negative trials have also been published<sup>56</sup>. *Gingko biloba* is a useful drug in all types of altitude sicknesses. A multi-vitamin herbal beverage known as "Leh Berry" rich in natural vitamins like A, B1, B2, C, E, and K has been formulated using a high altitude plant called "seabuckthorn" for the treatment of high altitude cerebral edema. Those herbal medicines which are used in the treatment of AMS are used for HACE as well. Caffeine is successful in the treatment of headaches at low altitudes owing to its cerebral vasoconstriction properties; it is likely that caffeine will help prevent or treat altitude headaches and hence useful in HACE<sup>57</sup>.

Herbal medicines such as *Gingko biloba*, *Rhodiola rosea*, *Zinziber officinalis*, etc. are used for the treatment of HAPE which are also used in the treatment of acute mountain sickness. Shilajit a herbomineral drug which contains ample amounts of fulvic acid and mineral constituents<sup>58</sup>. The mechanism of action of shilajit is described as

fulvic acid which stimulates blood formation, energy production, and prevents cold exposure and hypoxia<sup>59</sup>. Shilajit amplifies the benefits of other herbs by enhancing their bioavailability in the body<sup>60</sup>. The dose of shilajit in the form of powder is taken with milk twice a day will ensure optimal blood levels and therapeutic efficacy<sup>61</sup>. Shilajit is also used in the treatment of AMS and HACE. Treatment of chilblain includes the use of following herbal drugs: Ginger, rosemary (leaves, flowers), *Clandula officinalis*, *Juglans regia*, *Citrus limonum*, *Allium cepa*, nettle juice, tincture of myrrh, horsetail and oak tree bark, etc.

**Treatment of Frostbite:** Recent research has been shown that the efficacy of Traditional Chinese Medicine for treating altitude problems been suggested by a large number of published case series and randomized trials, although some trials have demonstrated negative results<sup>62</sup>. Following Chinese prescriptions were used alone or in combination with western drugs, *Gingko* leaf tablets, *Rhodiola* pills, the root of *Rhodiola rosea*, Danhong injection<sup>63</sup>. The components of *Rhodiola* pills are *Codonopsis pilosula*, *Salvia miltiorrhiza*, and *Radix tinosporae*.

The mechanism of action of *Rhodiola* pills is promoting blood circulation to remove blood stasis and tranquilizing the mind. Danhong injection has following components extract of *Salvia miltiorrhiza* and safflower, and its mechanism of action is promoting blood circulation and removing an obstruction in the collaterals. *Gingko* leaf tablets contain extract of *Gingko biloba* and mechanism of action is the same as that of danhong injection. *Aloe vera* is also used in the treatment of frostbite; it has good healing properties which helps in frostbite recovery. It is proved that alone when applied externally can help speed healing and restore skin tissues. Smoking is prohibited during recovery from frostbite.

Insomnia can be based on or aggravated by a neurotransmitter imbalance. Neurotransmitters are chemicals that allow nerve impulses to travel from one nerve cell to another and include serotonin, acetylcholine, GABA, and the sex hormones testosterone and estrogen. Sleep disorders and such symptoms as depression are directly related to an imbalance in the neurotransmitter serotonin.

Serotonin is manufactured by the body from the amino acid tryptophan. Herbs and food high in tryptophan that help restore proper serotonin levels in the brain are St. John's wort, hops, lavender,

quinoa, spirulina, and soy products. *Ziziphus spinosa* seed is used to treat insomnia and anxiety<sup>64</sup>. Some of the herbs and their use are mentioned in **Table 1**<sup>65</sup>.

**TABLE 1: HERBS USED FOR INSOMNIA**

Herbs	Biological name	Formulations	Dose
Chamomile	<i>Anthemis nobilis</i>	Tea and tincture	Tea, 1 cup 2-3x daily and tincture, 30 drops 3x daily
Hops	<i>Humulus lupulus</i>	Tea and tincture	Tea, 1 cup 2-3x daily and tincture, 30-40 drops 2-3x daily
Lavender	<i>Lavendula officinalis</i>	Massage oil and tea	3-10 drops of oil for massage and tea, 1 cup 2-3x daily
Passionflower	<i>Passiflora incarnate</i>	Tea and tincture	Tea, 1 cup 3x daily and tincture, 30-60 drops 3-4x daily
Valerian	<i>Valeriana officinalis</i>	Tea and tincture	1 cup as needed and tincture, 2-5 droppers full 2-3x daily
Wild lettuce	<i>Lactula virosa</i>	Tincture	2-3 droppers full 3-4x daily
Californica poppy	<i>Eschscholzia californica</i>	Tincture and tea	Tincture, 30-40 drops 2-3x daily and tea, 1 cup 2-3x daily
Kava- kava	<i>Piper methysticum</i>	Tincture	Tincture, 3-4 droppers full 2-3x daily
St. John's wort	<i>Hypericum perforatum</i>	Tablets, capsules and tincture	1-2 tablets and capsules 2-3x daily Tincture, ½ to 1 teaspoon 2-3x daily

**Herbal Formulas for Insomnia:** A calming tea blend is the composition of following herbs such as linden flowers (1 part), hawthorn flowers & leaves (1 part), chamomile (2 parts), Catnip (1 part), lemon balm (1 part), wintergreen (1 part), stevia herb (1/8 part) and bedtime tea. It contains valerian (30%), linden (20%), kava (20%), chamomile (20%), catnip (10%).

**CONCLUSION:** To aware people about high altitude health problems such as acute mountain sickness(AMS), high altitude pulmonary edema (HACE), high altitude cerebral edema (HACE), frostbite and chilblains. The synthetic and herbal remedies involve in their treatment and prevention is also discussed.

Any signs and symptoms of distress at high altitude that are notable for atypical onset appear in unusual combination should alert health care providers to other possible emergencies in addition to high altitude illness. The basic physiologic mechanism of high altitude problems is the low atmospheric pressure, impaired mental performance, and disordered sleep. The deleterious effects of high altitude are greatly reduced by acclimatization and the use of herbal remedies.

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