

Review Article

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## Altitude Health Problems and their Remedies

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### Abstract

People, who have visits to high altitudes, do experience 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 human body. These problems although have temporary manifestations, arising due to maladjustment of 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 body. Present review mention different type of altitude health problems, their symptoms, herbal and synthetic drugs that is helpful in these conditions.

**Keywords:** Altitude Sickness, Insomnia, Herbal Remedies, Frostbite, Chilblains

### Introduction:

Millions of people travel to high altitudes every year mostly above 1500m, specially in the Himalayas in Asia, Alps in Europe, Rockies in the united states and Andes in South America 1.. Peoples such as military personnel, veterans, athletes, travelers who have frequent visits to high altitudes, they experience certain type of health problems 2.. Generally, high altitude areas ranges from 1000 to 5500 meters or generally can be defined as areas at altitudes equal to or greater than 1500m 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 3.. With increase in the altitude to above mentioned altitudinal ranges the physiological effects ranges from decreased exercise performance and increased ventilation to extreme hypoxia during sleep and high altitude illness and further extreme hypoxia and various other problems 4.. 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 chillblains. All of these 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 literatures 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 non-specific symptoms defined as the presence of headache in a unacclimatized person who has recently arrived at an altitude above 2500m 5.. AMS is characterized by several symptoms such as insomnia, gastrointestinal problems (anorexia, nausea, vomiting etc.) dizziness, fatigue or lassitude, dyspnoea, poor appetite and difficulty in sleeping 6.. These symptoms can develop sometimes as early as 1 hour or may take 6 to 10 hrs 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, rate of ascent and physical exertion in either sex 7.. However, some studies mention that women are more prone to AMS than men during climbing expedition 8.. The symptoms are more prevalent in individuals with less cerebrospinal fluid volume and those which have less ability to accommodate increased brain volume. It has been found that incidence of AMS increases with increase in altitude height, more severe at altitude of 4200m or more. In case of acute mountain sickness the extravasation of fluid takes place from the intravascular to extravascular space, especially in brain and lungs 9.. If symptoms are worsening, immediate descent or portable hyperbaric devices should be used. The only clear risk factor, apart from rapid ascent, is a past 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 10..

### 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 11.. The symptoms of HACE are severe headache, mood changes, hallucination, intracranial pressure, ataxia, vomiting, confusion, retinal haemorrhage 12.. 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 a vasogenic edema arises due to disruption of the blood brain barrier 11..

### High altitude pulmonary edema (HAPE):

HAPE is a 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 13-14.. The mechanism of cause of HAPE is often linked to pulmonary hypertension, which leads to stress failure in capillaries of over perfused areas, resulting in pulmonary edema which further depends on individual susceptibility, rate of ascent and exertion, altitude reached and coldness are known risk factor which increases pulmonary-artery pressure by means of sympathetic stimulation 15.. The first case of HAPE in unacclimatized lowlanders climbing to high altitude was reported from the rocky mountains 16.. Several recent reports of HAPE are from skiing areas having height up to 3200m and Alpine resorts located at altitudes between 1400 and 2400m 17.. 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 13.. Women may be less susceptible to HAPE than men 18.. HAPE responsible for most deaths from high altitude illness. In 2001, out of 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 19..

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 20..

### Frostnip:

It is the mildest form of cold injury and therefore does not cause any irreversible damage. Frostnip consist in a severe cold sensation which involves only the skin and may lead to numbness and even pain 21.. One of the major groups at risk of frostbite are mountaineers, who are mostly 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 in order to gather information to allow implementation of the best possible preventive measures 22..

### Chillblains:

It is an inflammatory skin condition presenting after exposure to cold as pruritic and/or painful erythematous to violaceous acral lesions. It may be idiopathic or secondary to an underlying disease 23.. Chillblains are most seen in young and middle aged women and in children, and in terms of sex ratio, women are affected more frequently than men 24.. The direct cause of chillblain 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 erythrocyanosis are prone develop chillblain 25.. The various symptoms of chillblain are inflammation, low body weight, hormonal changes, bluish red skin, pain, itchyness, Patients may experience burning sensation, ulcerating blisters 26..

### 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; ensuing and concomitant ischaemia, anoxia and acidosis contribute to the injury. 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 27.. Frostbite is of three types, first degree frostbite (epidermis), second degree frostbite (deeper) and third degree frostbite. 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 in color. 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 28.. Second-degree frostbite is a superficial frostbite and presents as white or blue skin that feels hard and frozen. Blisters usually form within 24 hours 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 29.. 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 30.. The most frequent symptoms along with headache were lightheadedness and vertigo, but sleep disturbance was most common one 31..

### **Insomnia:**

Insomnia is also a very common 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 32..

### **Prevention of altitude health problems:**

Prevention of HAPE involves the following methods, 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 33.. It is found that nifedipine helps to avoid HAPE but is not effective for prevention of AMS 34.. When HACE is feasible, descent remains the single best treatment for HACE. The symptoms typically resolves following descent of 300 to 4000m, but the required descent will vary between persons. Supplemental oxygen delivered by nasal canula 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 35.. 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 36.. Sufficient amount of fluids should be consumed in order to maintain hydration level as lots of fluid gets lost during the process of acclimatization. Consumption of depressants like tobacco, alcohol, barbiturates and tranquillizers should be avoided 37.. To prevent secondary damage by hypoxia, 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 in all circumstances. Individuals should try to descend at least 1000m or until symptoms resolve 38.. Supplemental oxygen is involved in the treatment of HAPE, delivery of oxygen by 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 39.. Multiple trials have established a role for acetazolamide in the prevention of AMS 40.. The recommended adult dose for prophylaxis is 250mg 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 41.. Two doses of dexamethasone of 4mg, 6 hrs 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 compare 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 42.. The recommended adult dose for prophylaxis is 250mg twice a day, for children 2.5mg/kg in every 12 hrs through oral route 26.. Prospective trials have established a benefit for dexamethasone in HACE treatment 43.. The recommended adult doses are 2mg every 6 hrs or 4mg every 12 hrs.

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 44.. When oxygen or descent is not available, use of nifedipine is demonstrated, it's dose is 20mg slow release formulation every 6hrs. 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 45-46..

Synthetic drugs used for insomnia are benzodiazepines such as donormyl, temazepam and midazolam etc 47.. A meta-analysis by concluded that BDZs reduced sleep latency by 4.2 minutes and increased sleep duration by 61.8 minutes 48.. 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 49.. Pentoxifylline is used for treatment of frostbite by increasing red blood cells flexibility 50..

### **Herbal remedies:**

The most commonly used herb is Gingko biloba, It is play an important role in AMS prevention, it has tonic effect on the brain, stimulate blood circulation and reduce oxygen requirement of the body, although several negative trials have also been published but still better than the synthetic drugs 51-52.. This discrepancy may result from 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 become unbalanced making us feel tired, edgy and depressed 53.. *Rhodiola rosea* helps in re-establishment of nervous system by acting as an adaptogen- an agent that strengthens the body's response to physical, mental and emotional stress 10.. *Zinziber officinalis* has thermogenic and digestive properties which help us to get relief from AMS symptoms. If symptoms do not go away, descend 300m 54.. 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 in Tibet, but no scientific studies have examined its effectiveness in humans 55..

*Gingko biloba* play an important role in HACE treatment, although several negative trials have also been published 56.. *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 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 57..

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 58.. The mechanism of action of *shilajit* is described as fulvic acid which stimulates blood formation, energy production, and prevents cold exposure and hypoxia 59.. *Shilajit* amplifies the benefits of other herbs by enhancing their bioavailability in the body 60.. The dose of *shilajit* in the form of powder is taken with milk twice a day will ensure optimal blood levels and therapeutic efficacy 61.. *Shilajit* is also used in the treatment of AMS and HACE. Treatment of chillblain include 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 62.. Following Chinese prescriptions were used alone or in combination with western drugs, *Gingko leaf tablets*, *rhodiola pills*, the root of *Rhodiola rosea*, *Danhong injection* 63.. 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 obstruction in the collaterals. *Gingko leaf tablets* contain extract of *Gingko biloba* and mechanism of action is 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 *aloe* when applied externally can actually help speed healing and restore skin tissues. Smoking is absolutely 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 with 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 64.. Some of herbs and there use are mentioned in the Table 1 65

### 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 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 are 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 are the low atmospheric pressure, impaired mental performance and disordered sleep. The deleterious effects of high altitude are greatly reduced by acclimatization and use of herbal remedies.

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<b>Herbs</b>	<b>Biological name</b>	<b>Formulations</b>	<b>Dose</b>
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
Passion flower	<i>Passiflora incarnate</i>	Tea and tincture	Tea, 1 cup 3x daily and tincture, 30-60 drops 3-4x daily
Valeran	<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

**Table 1:** Herbs used for insomnia

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