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REVIEW ARTICLE

A Cogitation on Treatment and Prevention of High-Altitude Sickness

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Abstract

Most living beings including humans are engineered to live at sea level and plateau when humans try to scale a height of above 1000m. At 500m, the environment becomes challenging, and noticeable health problems are observed. At an altitude of 2438m or higher altitude sickness starts to occur. The most common health issues are Acute Mountain Sickness, Dehydration, High Altitude Cerebral Oedema, and High-Altitude Pulmonary Oedema. Most of the treatments are based on symptoms rather than cause due to scarcity of data as a few people only prefer mountaineering. The treatment of high altitude sicknesses can be classified into three classes namely; Allopathic medicine, Oxygenation and alternative medicines. The prevention techniques adopted are yoga, pranayama and mountain training. No engineering solutions to address these health issues related to high altitude. Here we reviewed on treatment and cure of different high-altitude sicknesses. We gathered testimonials from defence personnel, professional mountaineers and mountaineering enthusiasts on the possible prevention and cure of high-altitude sickness. Besides the traditional way of curing new technology intervention is also proposed.

Introduction:

The high altitude, low temperature, and low pressure at the mountain ranges induce various kinds of sicknesses and negative health effects. Altitude sickness is the most common, dangerous, and fatal of them. Mountain sickness or altitude sickness is an illness caused due to decrease in the amount of oxygen at a higher altitude than sea level. The high altitudes have also different ranges. Usually, about 1500m above sea level causes different ailments with varying degrees such as mild headache and tiredness to a build-up of fluid in the lungs. A few fluid build-up cases in the brain are observed as well which can be life-threatening, and cause fatality in above mentioned high altitudes. This group of symptoms can strike harm any individual even while walking or climbing or doing small workouts at a higher elevation, or altitude, very fast.

Altitude Mountain sickness and other related ailments usually occur when someone moves from lower altitudes e.g., sea level to higher altitudes (2438m or higher) in less than 24 hours. However, depending upon the person's health, age, and acclimatization; altitude sickness can even occur at a considerably lower altitude, such as 1500m. A spectrum of symptoms is associated with altitude sickness. Generally, mountain sickness covers three major syndromes caused by low air pressure such as hangover, carbon monoxide (CO) poisoning, and flu-like symptoms.

There is every possibility of occurring of minor symptoms like breathlessness at altitudes of 1,500m. Acute Mountain Sickness (AMS) commonly occurs above 2,400m. It is very unlikely to determine who may or may not be affected by altitude sickness. Only the people with a moderate to severe reduction in activities are usually diagnosed and treated. Such practice can create a possibility of occurrence of mountain sickness and complicacy even without visible symptoms. AMS can headway to High Altitude Cerebral Oedema(HACE), or High-Altitude Pulmonary Oedema (HAPO) which can endanger lives as both of these health problems are potentially fatal. This altitude sickness can only be cured by immediate descent to a lower altitude or additional oxygen supply for breathing. Chronic altitude sickness is a different condition which only occurs after exposure to high altitudes for a longer period such as soldiers,

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mountaineers, and pilgrims Gökhana *et al.* (2019).

Therefore, the present study aims at analyzing the treatment and prevention of high-altitude sickness based on the literature survey and the voices of the customers such as mountaineers, pilgrims, and defence personnel.

Objectives: the investigation aims to analyze the known facts about high altitudes on the health of climbers. Owing to the same the following objectives are formulated;

Validation and addition of less known facts on the context through one to one interviews of defense personnel, mountaineers and others.

A critical analysis of their testimonials to find a possible solution to decrease the effects of high altitude on climbers. It accommodates both prevention and cure.

A proposed technology solution to facilitate climbers.

Methods of analysis: The analysis of treatment and prevention of high-altitude sickness is carried out using two methods. First, by conducting a literature survey and secondly the feedbacks obtained from the persons involved in climbing high altitudes such as mountaineers, pilgrims, and defense personnel. The literature published in the field of high-altitude sickness is scarce. However, some related published works are reviewed and analyzed.

Review, Eligibility criteria, Data collection

There is no existent review protocol to the best of the author's knowledge. The review was conducted based on the eligibility criteria of that person who had previous mountaineering experience.

A survey was conducted through interviews and through Survey Monkey to get the customer's voices. In the survey army personnel, and mountaineers in different groups on Facebook and social media were approached. Several face-to-face meetings, and phone and video calls were also conducted with this personnel for better understanding and capturing of the data.

The survey involved three types of population:

1. Defense personnel.
2. Professional Mountaineer.
3. General public (Pilgrims and hobbyists) with 1 or 2 mountaineering experience.

The data collection method was a questionnaire, face-to-face interaction and interviews over the phone. The data collection was conducted in two phases. In the 1st phase, qualitative data collection was conducted from 23 subjects from the above-mentioned three strata. The collected data was discussed among peers and it was felt that the survey is going in the right direction. To have a wider understanding of the problem and requirements more subjects were approached and the survey was done. The survey was based on the analysis of qualitative data only. From the limited secondary studies, the researchers could not find any research article which has taken such a survey among the mountaineers. The researchers are of the opinion that the qualitative survey work conducted is unique and cannot be expressed in a quantitative manner.

A questionnaire was prepared which was validated by medical professionals, designers, retired defence personnel who had served in high altitudes, and mountaineers before conducting the survey. A total population of 5400+ who had experienced high altitude were approached for this survey. In a period of six months, 112 responses were received from above mentioned three strata of the population. The survey method is as in Fig.-1.

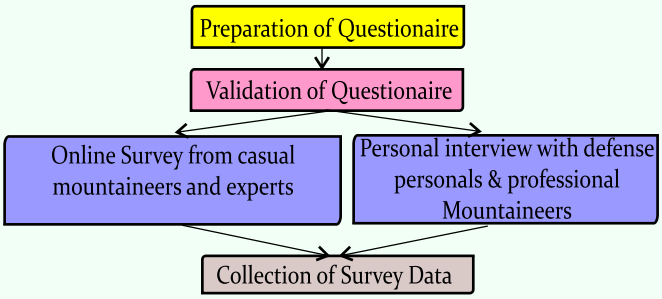

Figure-1: Survey Methodology

After receipt of the survey data, expert opinion and brainstorming sessions among peers were held to understand and interpret the data collected. After proper moderation suggestions are made for the prevention of HACE, HAPE, and AMS. The process is depicted in Fig. 2.

The time span for data collection is 24 months and in which the help of a social website www.facebook.com/ and online software www.surveymonkey.com were taken

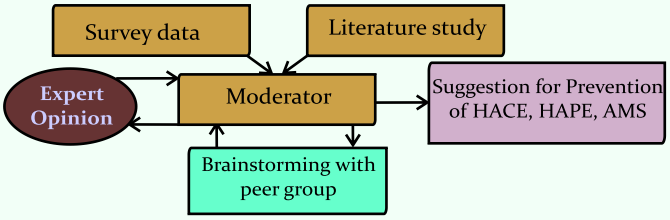

Figure-2: Moderation Process

Questionnaire on High Altitude Sickness (App-I): in High Altitude air pressure, the availability of oxygen & temperature decreases to an alarming level, creating health problems like AMS, HAPO, HACO, Dehydration, Frostbite etc. We're trying to innovate which can increase air pressure, oxygen content, temperature & moisture. To make it a success we need your help in understanding the problem better. Kindly provide non-confidential information as input for this research work.

Analysis of treatments and prevention of high-altitude sickness

The total number of studies conducted was 112 separate individuals from different walks of life in different age groups and both genders, over a span of 24 months and the biases are eliminated by repeating a few questions in a set of a new questionnaire sent. When answers deviated from the previous, another iteration was carried out. All these

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Appendix-1: Questionnaire : High Altitude related issues:

Name:_____Age: _____ Sex: M/F
Place of residence & contact:_____
Place of High Altitude travel(s): _____
Month & year of travel:_____
Prior Health complicacy:_____
Preparation for H.A.:_____Time in H.A.:_____
Acclimatization if any:_____
Your activities in H.A.:_____
Fatigue & problems in H.A. :_____
Health Problems you faced?_____
Severe Moderate Negligible
Remarks Observation:
A) Breathing B) Dehydration
C)Thermal Issue D) Decision Making Ability
E) Any Other
What kind of available health solutions for H.A. problems, you are aware of: _____

_____

We're designing breath assistance device. What kind of device you'll be interested in?
A) Features B) Weight C) Power source D)Cost
Can you please share anyone else's number or experience!

_____

Any remarks/ Additional points: _____

individuals volunteered to share their experiences with the researchers to help the study and find a new solution to prevent and treat high altitude sickness.

Treatments:

i) Allopathic medicine:-Drug acetazolamide helps in respiration by affecting the central nervous system; in other words, it increases ventilation and decreases the possibility of high-altitude sickness. Increased ventilation decreases the partial pressure of CO_2 and that leads to an increase in partial pressure of O_2 in blood Rahn & Otis (1949). It is also administered in HAPO. The drugs for high-altitude sickness are administered based on symptoms. In acute mountain sickness (AMS) treatment aspirin or paracetamol is used as analgesics for headache; and prochlorperazine for nausea/vomiting sensations (Olson *et al.*, 1982; Grissom *et al.*, 1992). Severe acute mountain sickness is treated with Dexamethasone and rapid descent (Hackett *et al.* 1988; Levine *et al.*, 1989; Montgomery *et al.*, 1989). The dose of Dexamethasone 4mg every six hours is administered to treat AMS. The same medicine is used in HACE. Nifedipine is administered to treat HAPO and should be avoided for patients having low blood pressure (Bartsch *et al.*, 1991). Nifedipine is used for preventing as well as treating HAPO.

ii) Oxygen and other related treatments:-AMS is treated with 0.5 to 1.0 lit/min of Oxygen (Hackett & Roach, 1987; Houston & Dickinson, 1975). The same treatment is also used for HAPO. To simulate descent and provide relief to the patient hyperbaric chambers can be of great use (Robertson & Shlim, 1991; Taber, 1990). Portable hyperbaric chambers, known as Gamow bag [Altitude Technologies, Boulder] and Certes [Sourcieux, Les Mines] as well HELP systems [Live High, Boulder]) can simulate descent by putting the individual patient in an enclosed environment with increased air pressure inside the chamber. The atmospheric pressure inside the chamber is 2psi above the ambient pressure outside. The simulation of the exact amount of descent can be understood in Table-1 (Taber, 1990; Freeman *et al.*, 2004; Himashree *et al.*, 2016; King & Greenlee, 1990).

Table-1: Equivalent descent and equivalent altitude in HAPO bag

S/N	Altitude (m) (Ambient)	Equivalent altitude in HAPO Bag (m)	Equivalent Descent (m)
1	3000	1555	1445
2	4200	2544	1656
3	6000	3975	2056

iii) Alternative medicines: Ayurveda prescribes taking Shilajit to fight High Altitude Sickness of different types. Shilajit is a herbo-mineral drug from the Himalayas. Also, it has been suggested to have supplements in high altitudes like physiologically active foods such as Aloe vera-based beverage, fruit spread, salad, etc., Seabuckthorn-based herbal tea and food items, Rhodiola based beverage, etc. can be performance enhancers in high altitude. Rhodiola Rosea root extract helps in fighting extreme climatic conditions like cold, oxygen deprivation, etc. (Khanum *et al.*, 2017).

Similarly, in Homeopathy it is advised to take Magnesia as per the prescribed dosage. Naturopathy suggests warm water is a lifesaver. Tourist guides in the Himalayas suggest inhaling a special kind of camphor intermittently to fight breathlessness at high altitudes.

Preventive measure:

i) Yoga and Pranayama: Yoga and pranayama have a significant impact on wellbeing at high altitudes which has been proven empirically. However, the experiments have been done only for perfectly fit Indian soldiers with no prior complications, who are non-smokers and non-drinkers. The yoga and pranayama practice has been for 1 hour daily for 2 months to capture significant improvement in body and mind to handle high altitude health problems (Himashree *et al.*, 2016).

ii) Mountain training: the "Mountaineer's rule" is- climb high, sleep low. On the days of the scale, those without symptoms can help adjust by climbing higher and falling back to sleep height. Due to the delay in the development of altitude sickness, even large climbings are safe. A diet rich in carbohydrates is found to be helpful. Moderate exercise and avoiding overwork also seem to help adjust to the environment. Sedative/hypnotic drugs, such as alcohol or sleeping pills, should not be used. Smoking reduces oxygen-carrying capacity and should be avoided (at any altitude), although it has not been studied as a risk factor for AMS (Meena *et al.*, 2010).

The literature study was critically analyzed and the gaps found are presented in Table-2.

Expert opinions were sought on the survey data to strengthen the formulation and authenticity of the survey-based analysis. Experts believe that high altitude can cause several illnesses to the human body such as headaches, breathing problems, asthma, dehydration, and many more. History accepts this condition and although this is the case, there are solutions to the problem

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Table 2: A gap analysis concerning method and outcomes in HA sickness

#	Author	Method of Analysis	Outcome	Gap(s)
1.	Rahn & Otis (1949)	Experimentation with a set of volunteers in different conditions.	Drug acetazolamide helps in respiration by increasing ventilation.	Drugs have side effects and it will be self-medication in HA.
2.	Olson *et al.* (1982)	Conducted drug experiments on 5 males and one 1 female.	Prochlorperazine produced a modest increase in ventilation with tidal volume and frequency.	Blockade of the receptor by the drug may have a negative impact.
3.	Grissom *et al.* (1992)	12 patients with AMS at Mt. McKinley were randomly experimented with drugs and placebo.	The use of Acetazolamide in HA improves oxygenation.	Drug's impact on preventing AMS or curing and preventing HAPE and HACE is unknown.
4.	Hackett *et al.* (1988)	15 subjects were transported from sea level to Mt. Mc Kinley. Dexamethasone dosage & placebo were tested for prevention and treatment.	It was not effective in preventing AMS. The drug helped in treatment, but with sudden stoppage AMS reoccurred.	The drug cannot be used as prevention and can give only temporary relief in treatment.
5.	Levine *et al.* (1989)	Six men were exposed to HA simulation and the effect of dexamethasone was studied	Symptoms of AMS were decreased but it didn't improve oxygenation, fluid shift, etc., and was not effective in HACE.	Without solving the physiologic abnormalities, the drug cannot prevent/cure AMS, HAPE, HACE.
6.	Montgomery *et al.* (1989)	A double-blind randomized study of dexamethasone or placebo at 2050m and 2700m. It was on health professionals.	50% decrease in AMS symptoms at 2700m, but not that effective at 2050m height.	The drug's effectiveness in HAPE HACE is unknown. It's effective at a particular range of height.
7.	Bartsch *et al.* (1991)	21 subjects were administered to nifedipine and placebo and then diagnosed by radiology.	The incidence of pulmonary edema is less when nifedipine drug was administered.	It is unclear whether the drug is effective against AMS, HACE, etc.
8.	Hackett & Roach (1987)	10 subjects were subjected to acetazolamide and 10 placeboes from a height of 1200m to 4000m.	At high altitudes, acetazolamide improved respiratory pattern and oxygenation. It has to be administered before 12 to 24hrs of ascent.	The drug is not effective in case of abrupt ascent. It has side effects even after the descent. Effectiveness in HACE & HAPE is unknown.
9.	Houston & Dickinson (1975)	12 cases of medical emergency were recorded, where 2 - persons lost their lives due to delay in evacuation.	Intravenous dexamethasone or betamet has one was administered on the patients along with hydration.	Houston suggests prevention by way of slow ascent, quick evacuation, and rest days for acclimatization.
10.	Robertson & Shlim (1991)	Out of 10 subjects were tested 4 were tested with acetazolamide alone 6 medicine with - pressurization of Gamow bag.	Subjects who were treated with Gamow bag at a 1.137 atm showed significant improvement in mild AMS.	The pressurization can help significantly in treating moderate acute mountain sickness even if the treatment span is short.
11.	Taber (1990)	Field tests at Himalayan Rescue Assn medical clinic at a height of 13920ft. Controlled test of the hyperbaric bag on AMS, HAPE, HACE patients.	2 psi effects descent to 8400ft. The time frame is 2, 4, and 6hrs for AMS, HAPE, and HACE respectively.	Carrying a 7kg weight hyperbaric bag along with all wearables and gears at high altitude must be cumbersome & difficult.
12.	Freeman *et al.* (2004)	One case of 24 years old, was reported at a height of 10,000 feet and as the evacuation was difficult, the subject stayed in Gamow bag.	Process for use of Gamow bag was – increase pressure to 1.5psi, use O2 enrichment moderately, pump 15 times a minute to clear CO2, etc.	The subject showed improvement however, when inside the Gamow bag. Subject can't descent or do other activities.
13.	Himashree *et al.* (2016)	A group of 200 soldiers acclimatized to high altitude practiced yoga to evaluate its effect on their health.	Upon consistent practice soldier group involved in yoga exhibited lower weights, BFPs, RRs, DBPs, and anxiety scores with a reduction in other malaise like triglyceride, blood urea, and others.	Yoga practice significantly improves the health indices and performance of an individual at a high altitude.

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14. King & Greenlee (1990)	Six cases of altitude sickness were reported. Such mountaineers were treated with Gamow bag as immediate descent to low altitude is neither possible nor recommended.	Altitude sickness was quickly treated with a Gamow bag. It was successful in treating cases of HAPE, HACE, and others. However the descent of the patients to low altitude was recommended to use the bag.	In some extreme cases besides treating patients in bags other drugs were administered in combination. However, in most cases treatment with Gamow bag served good results. But, it can't be used for prevention.
15. Khanum *et al.* (2017)	Exoneration of different problems faced by the Indian army at high altitude and providing supplementary dietary aids to cope & perform.	Review on different dietary recommendations to alleviate different high-altitude sickness to exalt performance.	Dietary recommendations in the form of health food are prepared by DHFL but clear policies are required for functional foods.
16. Burtscher & Koch (2016)	Expounds herbal drug Shilajit to treat high altitude problem like hypoxia, acute mountain sickness and other.	Shilajit drug at metered dose proves to treat HAPE, HACE, AMS, and others.	The assertion from the author about the multifarious application and great efficacy of the drug tracing its historical perspective in Indian Ayurvedic medicinal science.

as well. Some of the solutions proposed by experts are the use of a body warmer, oxygen cylinder, pain relievers, oxygen mask, and taking certain fruits, vegetables, and herbs at high altitudes.

The present study shows that even though limited, there is a cure for high-altitude health problems. At the same time, it is almost impossible to intervene diligently in high-altitude due to the lack of medical facilities, and trained doctors accompanying mountaineers all the time is very less likely.

Though there are preventive pieces of training, yoga, and *pranayama*; however, there is no preventive medicines, equipment, or system to help mountaineers at high altitude. Moreover, there is no system that can enhance performance even in adverse environmental conditions of high altitudes. A preventive system is an utmost requirement as there is hardly any possibility of proper diagnosis at a high altitude. As carrying weight at a high altitude will not be feasible, therefore the preventive system can be preferably a low weight wearable system.

Discussion

Allopathic medicines like acetazolamide, aspirin, paracetamol, and dexamethasone decrease the partial pressure of CO_2 and increase the partial pressure of O2 in the blood. As a result, the rate of ventilation is increased and the possibility of high-altitude sickness is decreased. The oxygen-related treatment like the use of a Gamow bag also decreases the probability of high-altitude sickness. Alternative medicines like Ayurveda and homoeopathy are used to fight against high altitude sickness. Also, it is suggested to take physiologically functional foods like fruit, salad, herbal tea, and food product to decrease the rate of high-altitude sickness. In addition, 1-2hrs of yoga and pranayama on daily basis has a significant impact on the reduction of high-altitude sickness. It is observed that the drug acetazolamide has a side effect, Prochlorperazine may have a negative impact, and Dexamethasone dosage and placebo can give only temporary relief in treatment. The depletion of the negative effect of Allopathic drugs is one of the main challenges. Herbal drugs may use to reduce any side effects inside the human body. Clinical studies show that vitamin C supplementation can reduce serum uric acid levels and that may also improve acute mountain sickness. Thus, herbal medicines of vitamin C may replace the use of Allopathic drugs to cure high altitude sickness. It is suggested to be careful while ascending high altitudes. Proper precautionary measures need to be taken to safeguard one's health. Options like an oxygen mask and other methods can be used. Another suggestion is using fruits and vegetables to keep the body hydrated and energetic. Always take appropriate safety measures when ascending to high altitudes.

Meaningful inferences from the analysis are:

a. The weight of the system should be 2 to 4 kgs for defence personnel and professional mountaineer (78% of the respondents had asked for this weight).
b. The weight of the system should be 1 to 2.5 kgs for the general public with mountaineering experience (65% of respondents asked for the same).
c. Features of the system required are:
   - Compressed air (63% of respondents)
   - Oxygen support (97% of respondents)
   - A battery power source (62% of respondents)
   - Human effort as a power source (24% of respondents)

Conclusively, The present work analyses the treatment and cure of high-altitude sickness based on a survey of literature and customers. The high-altitude sickness includes headache, dizziness, loss of appetite, shortness of breath, etc. High altitude pulmonary oedema (HAPE) can be very dangerous and even life-threatening. Complete elimination of the sickness is not conceivable. However, it can be reduced. The reduction of high-altitude sickness is achieved by treating through drugs like acetazolamide,

prochlorperazine, acetazolamide, nifedipine, etc. The used allopathic drugs cannot be used profusely owing to their negative effects on the human body.

Treating with herbal drugs and practice of yoga and pranayama regularly can be the best possible method to reduce high altitude problems within the available solutions. It is evident from the survey that high altitudes cause problems to mountaineers and defence personnel alike. Taking proper safety measures is the best way to keep oneself safe. Existing medical solutions; both treatments with drugs and the use of engineering products like Gamow bag are not sufficient to treat individuals at high altitudes. Thus, in this study, the voice of the customers is deciphered proactively to innovate, develop and design a portable device to prevent the onset of altitude sickness.

The paper deals with the analysis of qualitative data collected from various sources and statistical prudent of the data are difficult to analyze and kept for future scope of the work. However, all the set of the questionnaire is enclosed in appendix-I.

A lightweight system which can be easily carried and actuated by hand or battery with the capability to either compress air or enrich oxygen or both needs to be investigated to meet the prevention requirement.

References:

Bartsch, P., Maggiorini, M., Ritter, M., Noti, C., Vock, P. & Oelz, O. (1991): Prevention of high-altitude pulmonary edema by nifedipine. *N. Eng. J. Med*., 325(18):1284-1289.

Burtscher, M. & Koch, R. (2016): Effects of pre-acclimatization applying the "Climb High and Sleep Low" maxim: an example of rapid but safe ascent to extreme altitude. *J. Human Perform. Extreme Environ*., 12(2) Article 2.

Freeman, K., Shalit, M. & Stroh, G. (2004): Use of the Gamow Bag by EMT-basic park rangers for treatment of high altitude pulmonary edema and high altitude cerebral edema. *Wildern. Environ. Med*., 15(3):198-201.

Gökhana, A., Keremb, Ç.S. & Özen, C. (2019): High-altitude illness: management approach. *Turk. J. Emerg. Med*., 19:121-126.

Grissom, C.K., Roach, R.C., Sarnquist, F.H. & Hackett, P. (1992): Acetazolamide in the treatment of acute mountain sickness: Clinical efficacy and effect on gas exchange. *Ann. Intern. Med*., 116(6):461-465.

Hackett, P.H. & Roach, R.C.M (1987): Medical therapy of altitude illness. *Ann. Emerg. Med*., 16(9):980- 986.

Hackett, P.H., Roach, R.C., Wood, R.A., Foutch, R.G., Meehan, R.T., Rennie, D. & Mills Jr, W.J. (1988): Dexamethasone for prevention and treatment of acute mountain sickness. *Aviat. Space Environ. Med*., 59(10):950-954.

Himashree, G., Mohan, L. & Singh, Y. (2016): Yoga practice improves physiological and biochemical status at high altitudes: A prospective case-control study. *Altern. Therap. Health Med*., 22(5):53-59.

Houston, C.S. & Dickinson, J.G. (1975): Cerebral form of high altitude illness. *Lancet*, 2:758-761.

Khanum, F., Anand, T., Ilaiyaraja, N., Patil, M.M., Singsit, D., Shiromani, S. & Sharma, R.K. (2017): Health food for soldiers. *Def. Life Sci. J*., 2(2):111-119.

King, S.J. & Greenlee, R.R. (1990): Successful use of the Gamow Hyperbaric Bag in the treatment of altitude illness at Mount Everest. *J. Wildern. Med*., 1(3):193-202.

Levine, B.D., Yoshimura, K., Kobayashi, T, Fukushima, M., Shibamoto, T. & Ueda, G., (1989): Dexamethasone in the treatment of acute mountain sickness. *N. Eng. J. Med*., 321(25):1707-1713.

Meena, H., Pandey, H.K., Arya, M.C., Ahmed, Z. (2010): Shilajit: A panacea for high-altitude problems. *Int. J. Ayur. Res*., 1(1):37-40.

Montgomery, A.B., Luce, J.M., Michael, P. & Mills, J. (1989): Effects of dexamethasone on the incidence of acute mountain sickness at two intermediate altitudes. *JAMA*, 261(5):734-736.

Olson, L.G., Hensley, M.J. & Saunders N.A. (1982). Augmentation of ventilatory response to asphyxia by prochlorperazine in humans. *J. Appl. Physiol*., 53(3):637-643.

Rahn, H. & Otis, A.B. (1949): Man's respiratory response during and after acclimatization to high altitude. *Am. J. Physiol*., 157(3):445-462.

Robertson, J.A. & Shlim, D.R. (1991): Treatment of moderate acute mountain sickness with pressurization in a portable hyperbaric (GamowTM) bag. *J. Wildern. Med*., 2(4):268-273.

Taber, R.L. (1990): Protocols for the use of a portable hyperbaric chamber for the treatment of high altitude disorders. *J. Wildern. Med*., 1(3):181-192.