



## A Study of Medical Care Challenges in High Altitude Regions

**Dr (Brig) DC Joshi, MD**

Consultant Hospital & Health Admin

**\*Corresponding Author:**

**Dr (Brig) DC Joshi, MD**

Consultant Hospital & Health Admin

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### Abstract

**Background and objectives:** High altitude terrain poses many challenges as regards the health care delivery is concerned in these regions. Extreme cold climate clubbed with inaccessibility to proper roads, widely scattered habitations and wide frontages pose healthcare and logistic challenges. The objective of this study was to identify these challenges so that suitable remedial action can be taken at appropriate level.

**Method:** An observational study was undertaken by visiting the medical centres located in these difficult areas. Personal interaction was carried out with the medical/technical staff to gain firsthand information about the problems and challenges faced by them.

**Result:** The challenges faced in high altitude regions in efficient delivery of health care have been categorized as medical challenges, Logistic challenges, Human resource challenges and Environmental challenges.

**Conclusion:** The study has revealed that the challenges faced by health care workers in high altitude regions are multifarious and need to be resolved on priority for efficient and effective health care delivery in remote and inaccessible high-altitude regions.

**Keywords:** High altitude, challenges, acclimatization, adverse effects

### Introduction

Climate has a profound influence on health, incidence of diseases, their epidemiology and endemicity. People gets acclimatized to the high-altitude environment through complex physiological and psychological processes. The environment comprises of physical, biological and social factors. Physical environment constitutes range of natural factors like the atmosphere, climate, soil, topographical features and so on. It also includes the artificial innovations, as aids to adaptation to natural environment e.g., housing, clothing, air conditioning, artificial heating, cooling and so on. The biological factors like pathogenic organisms, the disease producing ectoparasites, the arthropod vectors and animal reservoirs of infections are very much influenced by climatic factors and therefore climate exerts its influence on health in multiple ways

### Peculiarities of High-Altitude Terrain

As we ascend to greater heights in high altitude areas, the air becomes rarer and rarer, and the air pressure progressively decreases. At 5500 mtr above mean sea level (18000 ft), the pressure is half of that obtained at sea level. Life ceases instantaneously above 10,000 mtr above sea level. In high altitude terrain, the atmosphere contains air, water vapour, radiation and terrestrial dust.

*Air.* The air in its dry state has 78 % nitrogen and 21 % oxygen; the remaining 1 % has hydrogen, CO<sub>2</sub>, ozone and a mixture of inert gases such as argon, neon, krypton, xenon, and radon. Oxygen is the 'vital' constituent of atmosphere as without oxygen no life can exist on earth. However, as pure oxygen would oxidize and eradicate all living matter, the presence of nitrogen dilutes it adequately. Ozone is mostly

concentrated in the upper atmosphere and acts as an umbrella against the dangerous radioactive and photochemical solar radiations.

*Water Vapour.* Atmospheric water exists in vapour form and condenses in the form of rain, and snow. Extremely dry air is not suitable for respiration as it interferes in the normal oxygen - CO<sub>2</sub> exchange in the lungs by desiccating alveolar epithelium.

*Radiation.* The radiation energy around the earth is received from the sun, earth and environments which ranges from the shortest radioactive waves to the long radio waves of one meter length. Atmosphere is, however, impenetrable to a vast majority of them due to ozone, dust and water vapour. Only the ultra-violet radiations and some of the infra-red radiations are permitted to penetrate the atmosphere.

### Adaptation In High Altitude Terrain

Acclimatization is the process by which the human body adapts against the vagaries and extremes of external environment and adverse climatic conditions. All living beings have some capacity of acclimatization, but humans are unique as regards the range of homeostasis and power of final adaptability is concerned. Individual acclimatization is a complex physiological and psychological process of adaptation through prolonged, continuous and successful functioning of the body mechanisms. Individual acclimatization is, however, not a permanently acquired state and de-acclimatization occurs rapidly after cessation of acclimatizing stimuli.

*Conservation of body heat.* Conservation of body heat and preventing its loss at low temperatures has the following mechanism: -

The immediate response is that of peripheral vasoconstriction brought about through the medullary thermoregulatory and vasomotor centers. Heat loss from the skin surface is thus restricted.

Production of body heat is increased by: -

1. The reflex involuntary rhythmic contraction of skeletal muscles causing shivering.
2. Voluntary bodily activity may also be undertaken by the individual causing heat generation.
3. Endocrinal adjustments counteract stress and increase in metabolism also occurs by extra activity of the pituitary-adrenal axis and thyroid gland

### Medical Challenges in High Altitude Regions

#### Adverse Effect of Solar Radiations

It profoundly affects the health directly and indirectly. The direct effects occur mainly through the two venues viz., *the skin and the eyes*. Very little of ultraviolet and longer infra-red rays are reflected from the skin surface and, therefore, they are absorbed in the horny layer of the skin. The infra-red portion which penetrates beyond the epidermis causes heating in the dermis and the deeper layers of skin. The skin manifestation of solar radiations may occur as Tanning, Erythema, Solar dermatitis and ageing of skin with wrinkling (Fig:1). Eye manifestations of solar radiations may manifest as Hyperemia of the superficial tissues, irritation/oedema of conjunctiva, posterior polar cataract and in extreme cases the retina may suffer from foveal oedema.



Fig 1: Skin manifestation

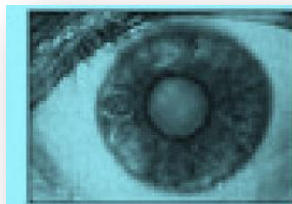


Fig 2 &3: Eye manifestation

## General Effects of Severe Cold Climate experienced in high altitude

**Hypothermia.** Hypothermia manifests itself either as accidental hypothermia or hypothermia secondary to acute illness. Accidental hypothermia develops due to lowering of body core temperature following exposure to severe cold. On the other hand, hypothermia secondary to acute illness is not accompanied by history of exposure to cold.

### Acute Mountain Sickness

Between 3350 mtr and 4300 mtr of height above mean sea level, headache, insomnia or disturbed sleep, occasional palpitation, nausea and vomiting are common symptoms. Between 4300 mtr to 4500 mtr, headache, depression, apathy, and drowsiness are marked. Memory is impaired and appreciation of time is altered. Above 4500 mtr, breathlessness on rest, palpitation, muscular weakness and fatigue have been experienced. Persistent cough, severe breathlessness on slight or no exertion and pain in the chest herald the most severe of all the hazards i.e., 'Pulmonary Oedema'. The following measures need to be adopted to obviate these effects: -

1. Thorough acclimatization at each stage i.e first, second and third stage of acclimatisation.
2. Intake of more fluid in the form of tea, coffee and cocoa at frequent intervals.
3. Avoidance of smoking, alcohol and late dinners.

1. **Frostbite.** It is caused by freezing of peripheral tissues. More exposed or distal areas like nose, earlobes, cheeks, hands and feet are the usual sites of these injuries (Fig 4).



Fig 4: Frost bite

2. **Trench Foot or Immersion foot.** It develops when the critical tissue temperature dips in combination with dampness in or around the tissue (Fig 5).

4. Aspirin for relieving headache and mental irritability.
5. People should be encouraged to report sick to the nearest medical centre if they get any abnormal feeling. They should not be left alone and 'Buddy system' needs to be followed strictly.

### High altitude Pulmonary Oedema (HAPO) and High-altitude cerebral oedema (HACO)

High altitude Pulmonary oedema and Cerebral oedema is the serious effect of rapid ascent to high altitude regions and have been experienced at altitude above 3000 mtr above sea level.

### Chronic Pulmonary Hypertension

Pulmonary hypertension is inevitable after about 6 months stay at heights above 3600 mtr.

### Psychological Effects

Lack of interest, irritability, insubordination, irrational reaction and prolonged reaction time have been observed in people staying in high altitude regions for prolonged periods.

### Local Effects of Severe Cold Climate experienced in high altitude

The peripheral tissues get injured on exposure to cold depending upon intensity of cold, duration of exposure and presence or absence of moisture



**Fig 5: Trench Foot**

3. **Chilblains.** The parts involved, are usually hands and feet. They become red with intense irritation, especially when warming is attempted (Fig 6)



**Fig 6: Chill blains**

### *Logistic Challenges in High Altitude Regions*



**Fig 7: Landslides**

#### **Breach in Road and telephonic communication.**

As the mountainous terrain is prone to frequent landslides (Fig 7), it leads to breach in road communication and also disrupts the telephonic communication of forward medical dets with the district hospital. Consequently, the supply of medicines, Oxygen cylinders and rations to forward medical dets also gets affected. Moreover, due to disrupted road communication, the casualties have to be carried on stretchers over long distances till the nearest motorable road head.

#### **Reliability of ambulances**

The ambulances presently provided to the forward medical centres have not been found successful in high altitude areas due to the following constraints:

1. *Lack of cold start device.* These ambulances being devoid of cold start device pose

problem in starting the engine especially in subzero temperatures. This adversely affects timely evacuation of casualties from forward medical centres to the rear hospitals.

2. *Inability to use non-skid chains in Ambulances.* The forward medical centres by virtue of their deployment are located at heights which are prone to heavy snowfall and subzero temperatures. Vehicular movements in these areas is difficult without nonskid chains. The ambulances presently available with these centres are not compatible to nonskid chains thereby hindering their mobility in snow bound areas.
3. *Poor engine power of Ambulances.* As the ambulances are of old vintage, they have poor pulling power and experience great difficulty

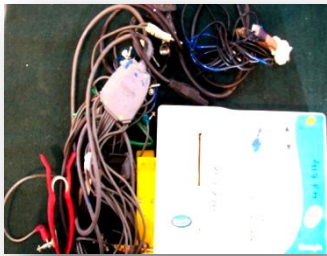
in climbing steep gradient in high altitude regions.

### Infrastructure constraints

Subzero temperature coupled with high wind chill factor predisposes the personnel staying at these heights to effects of cold. These can be effectively negated by provision of well insulated infrastructure/shelters. The infrastructure presently available needs upgradation to cope with the extreme cold climatic conditions in super high-altitude areas.

### Repair and Maintenance of Medical Equipment

Essential Medical equipment's (Fig 8) like the Blood Pressure instrument, ECG machine, Pulse Oxymeter, NIBP Monitor and other electro medical equipment play a very crucial role in effective management of patients in high altitude. However, the repair back up of this medical equipment does not exist with the local market due to which the equipment has to be backloaded to district or zonal hospitals for repairs. This process not only increases the down time of the equipment but also non availability of equipment with these medical centres for further medical use. Equipment manufacturers are reluctant to enter into AMC for the equipment due to remote location of the forward medical centres in high altitude regions.



**Fig 8: Medical equipment**

### Difficulty in timely evacuation of casualty/Patient

Timely evacuation of serious casualties within the 'Golden hour' assumes prime significance. This can be achieved by evacuation through air (Fig 9). However, the adverse climatic conditions prevailing at high altitudes do not always permit air evacuation

and the patients per force have to be evacuated by road through the ill developed roads which takes away considerable time. This gets further compounded due to breach in road communication by frequent landslides



**Fig 9: Air evacuation of patient by helicopter**

### Personal protective clothing

Personal protective clothing or extra cold climate clothing in the form of woolen balaclava, snow goggles, gloves, warm layered clothing, snow boots

etc. have a significant role in providing protection to medical personnel deployed in high altitude/ super high-altitude areas. It is essential that the items of these clothing are available in adequate quantities and

of high quality. Poor quality exposes medical personnel to adverse effects of extreme cold climate.

### ***Human Resource Challenges in High Altitude***

#### **Functional deficiency of medical manpower**

Availability of trained technical manpower is the backbone of effective medical support in high altitude region. However, the posted deficiency of manpower hampers effective functioning of forward medical centres. In addition, the personnel who have been posted to these centres by the state govt do not report on duty and continue to remain absent without leave thereby compounding functional deficiency of manpower.

#### **Long distances to be covered on foot**

It is indeed a challenging task to provide effective medical support to every village or habitation due to wide frontage and long distances to be covered on foot.

#### ***Environmental Challenges in High Altitude***

The mountainous terrain in high altitude poses various environmental challenges. Consequently, a high state of operational readiness is required at all times to effectively counter these challenges. The challenges experienced are:



**Fig 10: Earthquake damage to roads**

#### **Natural disasters**

Mountains and high-altitude region are prone to natural disasters which can happen anytime, unannounced. The major life line i.e., the roads get breached and damaged (Fig 10) in this process thereby posing a great challenge in medical care and logistics. Natural disasters frequently encountered are: -

1. Earthquakes
2. Landslides
3. Avalanche
4. Flash floods

#### **Difficult Terrain and narrow roads**

Tortuous mountainous roads (Fig 11) with difficult maneuverability are prone to Road traffic accidents at all times. The terrain is also prone to frequent landslides and road blocks.



**Fig 11: Tortuous roads (aerial view)**

#### **Conclusion**

Provision of effective and efficient medical support in High Altitude Area is a daunting task. Upholding

and abiding by the medical motto of “Sarve Santu Niramaya” (May all be free from illness) the forward medical centres located in high altitude regions, in addition to combating the vagaries of nature, also

manage, treat and evacuate a large number of patients suffering from the adverse effects of High altitude, and other diseases thereby ensuring safety of precious human lives at all times. Efficient management of the above challenges by the local/State Govt authorities will immensely benefit not only the health care workers but also the local population staying at these localities in achieving positive state of health.

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