DG MEMORANDUM

HEALTH PROBLEMS DUE TO EFFECTS OF HIGH ENVIRONMENTAL TEMPERATURE (HEAT) AND DESERT CONDITIONS

1. INTRODUCTION

2. DESERT ECOLOGY & HUMAN PHYSIOLOGY

3. ILLNESSES IN DESERT

4. PREVENTION

INTRODUCTION

1. Deserts around the world present a peculiar set of environmental conditions, which puts increased stress on human physiology. Human body can adapt over a period of time to desert conditions. Inappropriate acclimatization and prolonged stay in desert causes deleterious effects on health, which in turn reduces the efficiency of individuals.

DESERT ECOLOGY

2. Desert areas of world extend between 20 – 30 degree north and south of the equator, especially on western side, with hot and dry climates. The Indian arid zone consists of 12% of the total area of the country and is characterized by conditions of high aridity with low average annual rainfall. The data generated by Central Arid Zone Research Institute Jodhpur reveals that there is upward trend in average rainfall and relative humidity over the past one decade. The range of annual rainfall is 192 mm and 392 mm, relative humidity 30% in Jaisalmer to 20 % in Jodhpur respectively.

1. The zone is characterized by wide ranging temperature (less than 0° C in wintry nights to more than 50° C on a summer day). Sandstorms are common from Apr to Jun. Although the ecology is changing fast, vegetation is sparse with few full-grown trees.

THERMOREGULATION AND HUMAN PHYSIOLOGY

4. The external temperature within which the haemostatic mechanism of thermoregulation is not stressed and the basal heat production rate is at its minimum is called the zone of thermoneutrality. In the resting person, this is 2° C on either side of 29° C depending on whether the person is clad or not.

5. Deviation from this zone sets the homeostatic thermoregulatory mechanism in action. On the hotter side; the heat loss is increased while on the cooler side the heat conservation is stimulated. Body loses and gains heat by conduction, convention and radiation. In addition heat loss occurs by evaporation as well.

6. During high ambient temperature even under resting conditions shunting of blood to skin produces a fall in BP and rise in heart rate. This phenomenon is further aggravated by dehydration. During exercise, blood is shunted to working muscles in addition to the skin. In unacclimatized persons, this can lead to cardiovascular instability characterized by rising heart rate and fall in stroke volume. With acclimatization, plasma volume and stroke volume are restored resulting in fall in heart rate. Besides the body conserves sodium through up regulation of aldosterone and increased renal retention. There is increased fluid requirement and enhanced responsiveness to sweating.

7. Heat tolerance can be achieved by daily normal physical work in tropical climate or hard physical training in a cool environment. The adaptive processes rapidly develops over 3-4 days and is complete in 10 days, and lasts upto 2 weeks after leaving the area.

HEAT RELATED DISORDERS

8 There is no universally acceptable classification of medical problems in desert. These medical illnesses are also present in other parts of country but become exaggerated under desert conditions. The predominant effect of heat is deterioration of performance and loss of efficiency known variously as acute heat neurasthenia, tropical fatigue or heat neurotic reaction. It is undefined and likely to be multifactorial. A tentative classification is as under: -

(A) Illnesses due to high ambient temperature.

9 Heat cramps: Heat cramps results from salt depletion or water intoxication and are seen in persons sweating profusely while consuming large quantities of unsalted fluids. It may also be seen frequently in persons who exercise regularly and have low salt intake. They usually last from 01 – 03 min. but may recur for several hours. Intake of liberal quantities of salt in drinks, especially with citrus fruits e.g. lemonade will usually cure the condition. For severe cramps, IV Normal saline (500 – 1000ml) may be required.

10 Heat edema (Deck ankles or Colombo flop): Unacclimatized people arriving in the tropics may notice mild pedal edema, which usually resolves in a few days. The exact cause is not known, but it is postulated to be due to the adaptive mechanisms (cutaneous vasodilatation, aldosterone and antidiuretic hormone hyperactivity) resulting in venous stasis and / or expansion of extra cellular fluid volume.

11 Heat syncope or Heat collapse: Unacclimatized persons exposed to prolonged standing, or working in heat can suffer from this disorder. It usually occurs due to peripheral vascular pooling and collapse of venomotor tone causing cerebral anoxia. Clinically the patient has bradycardia with slow sighing respiration. Shifting the patient to a cool or shaded area in a head low position will usually restore consciousness.

12 Hidromeiosis: When high humidity is associated with high ambient temperature, evaporation of sweat is prevented, leading to sustained wetting of skin. This leads to diminished sweat production called hidromeiosis or sweat gland fatigue. This occurs actually due to obstruction of sweat glands by swelling of the keratin layer of skin when water is absorbed at high skin temperature. This can lead to hyperthermia. Shifting the patient to dry environment reverses this process.

13 Prickly heat: It results from plugging of orifices of sweat gland ducts that leads to inflammation of the glands. Generally it results from exposure to humid heat. Shifting the patient to cool room and keeping the skin dry can prevent it. Use of talcum powders does not have any therapeutic role.

14 Heat exhaustion (HE): It can result from depletion of salt, water or both.

(a) Salt Depletion HE: - This is commonly seen in unacclimatized individuals in first few days of exposure to desert heat. These individuals lose large quantities of salt in sweat. Intake of large quantities of pure water without salt may aggravate this problem. Clinical findings include giddiness, fatigue, vomiting and muscle cramps. Thirst is not a feature. Laboratory investigations show raised blood urea and low sodium and chloride levels. This condition usually does not predispose to heat stroke. Treatment consists of bed rest, total daily intake of salt up to 20g/ day and plenty of cool drinks. Comatose patients will require isotonic saline, 2-4 liters in 24 hrs. They should be watched for fluid overload. Complete recovery may take 5 to 7 days.

(b) Water Depletion HE: - This is commonly seen in people who undertake severe physical exertion losing large quantities of water, which is inadequately replaced, especially when water supply is inadequate or losses are increased

due to vomiting/diarrhea. Clinical features include intense thirst, fatigue, weakness, anxiety and impaired judgment. Urine is scanty and concentrated. Lab investigations reveal increased sodium level and haemoconcentration. The condition can be fatal if not treated, the ultimate cause of death being oligaemic shock and heat stroke due to loss of thermoregulatory control. Treatment consists of rest in cool surroundings and controlled rehydration with N/2 or N/4 saline. Administration of 5% dextrose may aggravate hyponatraemia.

15 Heat stroke (HS): It is the most severe form of heat related illnesses and is characterized by body temperature higher than 41°C, associated with absence of sweating and neurological dysfunction. Two distinct varieties of HS are seen namely exertional heat stroke (EHS) and classical heat stroke (CHS). The former generally affects young individuals undergoing strenuous physical exertion for prolonged period in hot environment and latter affects chronically ill, sedentary workers, elderly individuals and very young persons.

(a) EHS is characterized by hyperthermia, diaphoresis and altered sensorium. Other symptoms include abdominal and muscular cramps, nausea, vomiting, diarrhea, headache, dizziness, dyspnoea and weakness. Risk factors for EHS are preceding viral infection, dehydration, fatigue, obesity, lack of sleep, poor physical fitness and unaccustomed physical exertion in hot environment.

(b) On the other hand CHS manifests by hyperthermia, anhidrosis, and obtunded sensorium in the setting of high ambient temperatures (Heat wave). Other predisposing factors are chronic cardiovascular illnesses, skin diseases, extremes of age and drugs such as diuretics, anticholinergics and psychotropic agents. CNS symptoms range from minor irritability to delusions, irrational behavior, hallucinations, seizures, cerebellar dysfunction and cranial nerve palsies. Patient may have a hyperdynamic circulatory state but in severe cases hypodynamic states may be seen.

(c) Lab findings include leucocytosis, hyperkalemia and raised serum enzymes (SGOT, SGPT, LDH and CPK).

16. Salient differences between classical and exertional heat stroke are:

Features	Classical Heat Stroke	Exertional Heat Stroke
(i) Age group	Infants, elderly	16-65yrs old
(ii) Health status	Chronic illness	Usually healthy
(iii) History of febrile illness	Occasional	Common
(iv) Activity	Sedentary	Highly active
(v) Drug use	Diuretics, phenothiazine	Amphetamines, cocaine
(vi) Sweating	Usually absent	Usually present
(vii) Respiratory alkalosis	Dominant	Mild
(viii) Lactic acidosis	Absent or mild	Often marked
(ix) Rhabdomyolysis	Seldom severe	Severe
(x) Hyperuricaemia	Modest	Severe
(xi) Creatinine	Mildly elevated	Markedly elevated
(xii) Phosphokinase	Mildly elevated	Markedly elevated
(xiii) Hypoglycemia	Uncommon	Common

17. Principals of Management: Heatstroke is a medical emergency where rapid reduction of the core body temperature is the cornerstone of treatment because the duration of hyperthermia is the primary determinant of outcome. All patients must be hospitalized.

18. Aims of treatment:

(i) Reduction of body temperature by at least 0.2° C/ min to bring down to approximately to 39° C and limit production of heat.

(ii) Optimize circulation

(iii) Attention to the airway

(iv) Treat complications

19. If patient is comatosed, secure airway.

20. Record rectal or oral temperature (axillary record unreliable), BP, heart rate and respiratory rate.

21. Keep IV drip with 5% dextrose in ½ strength normal saline ready. Collect venous blood samples for the following tests (which can be done in local laboratory)

(i) Complete blood counts

(ii) Malarial parasite

(iii) PT, PTTK, FDP (where available)

(iv) S electrolytes, Creatinine, B urea

(v) Blood glucose, Calcium, Creatinine kinase

(vi) SGOT, SGPT, Alkaline Phosphatase

(vii) Arterial blood gases

(viii) Blood culture

22. Start IV infusion

23. Start cooling the body. Remove clothing. Keep patient in lateral recumbent position, or if alert, on hands and knees to expose as much skin surface as possible. Spray entire body with water at 15 – 25 degrees Celsius and sponge. Pass ambient/ cooled air across the patient's body with large fans or other means at an approximate velocity of 100 feet per minute. Reduce the body temperature within 30 minutes to one hour to 39 degrees Celsius (Rectal).

24. For shivering administer Inj Diazepam 5 – 10 mg IV over 10 minutes.

25. If eqpt is available, monitor CVP. Distinguish between cardiogenic shock and hypovolaemic shock. Administer IV fluids to ensure urine output of 50 ml per hour. Place in dwelling catheter in bladder. Send urine sample for analysis.

26. Record ECG. Look for arrhythmias and evidence of dyselectrolytemia especially hypo/ hyperkalemia.

27. Consider Inj Mannitol 0.25 gm/kg IV and Inj Soda bicarbonate (4%) 250 ml where indicated.

28. Watch for seizures. Treat with diazepam.

29. Watch for evidence of

(a) Renal failure

(b) Hypokalaemia

(c) Arrhythmias

(d) DIC

(e) Hepatic failure

30. Watch for temperature rebound in 36 hours.

31. If patient is refractory to cooling consider gastric lavage with ice-cold water or peritoneal dialysis with cold dialysate.

32. Antipyretics have no role in such patients.

33. Consider the following differential diagnosis

(a) Falciparum malaria

(b) Encephalitis

(c) Neuroleptic malignant syndrome

(d) Thyrotoxicosis

34. Mortality rises with the rise of body temperature from 15% at 41°C to 61% at 45°C. Timely treatment will considerably reduce the mortality

(B) Illnesses due to solar radiation exposure

(i)	Skin tanning	(ii)	Solar dermatitis
(iii)	Solar erythema	(iv)	Ageing of skin
(v)	Rodent ulcer	(vi)	Cataract
(vi)	Pterygium	(viii)	Retina degenerative changes

35. They affect the health directly and indirectly, mainly affecting eyes and skin. The effects generally are not due to high ambient temp, but are the result of exposure to solar radiation.

36. On immediate exposure the effects are generally seen as on adaptation/acute reaction to radiation and cause skin tanning, solar erythema and dermatitis.

37. On long-term exposure, various permanent changes occur in the form of lenticular opacities, ageing of skin, rodent ulcer, pterygium and retinal degeneration. The permanent residents of deserts worldwide have high incidence of pterygium and rodent ulcer.

(C) Illnesses due to Dust

38. Dust particles are common irritant of skin, mucous membrane of eyes, nose and upper respiratory tract as also to ears. Dust particles besides causing nuisance also lead to few illnesses on long-term exposure. The persistent irritation results in redness of eyes, chronic conjunctivitis and hyperemia of sclera. High incidence of trachoma is also attributed to dusty conditions. Local inhabitants have incidence of pneumoconiosis and related illness, mainly attributable to inhalation of dust particles.

(D) Snake Bites and Scorpion Stings

39. All the predators in desert like snakes, lizards, rodents and insects like scorpions etc usually come out in night for prey. They may bite the troops accidentally.

PREVENTION

40. Acclimatization - It is the most valuable imp prophylactic measure against the effect of heat. Ability to do hard work can be achieved in about two weeks by gradual acclimatization. At first the tps should exercised for short period to produce vigorous sweating but not to cause exhaustion. After a week the length and duration of this exercise should be increased until men can work without stress for long hours. During this period, exhaustion and other deleterious injuries should be avoided.

41. Fluid Intake - Moderate work in desert conditions may require 8-12 litres of water per day. During long marches and strenuous exercises the requirement can go up to 16 litres/day. Water should be cold enough otherwise it will not be consumed in right quantity. It can be increased in the form of coffee, tea and limejuice. Fluids

should preferably be taken at regular intervals in moderate quantities rather than large amounts at one time.

42. Salt Intake - Should be sufficient to compensate for loss in sweat. On an average 15- 20 g of salt is needed daily.

43. Training - Should be restricted to cooler hours in morning and evening.

44. Rest - Sleep should be adequate esp in early hours of morning. Reveille generally should not be before 0530hrs.

45. Bathing - Personal hygiene should be of optimum standard, troops must take bath daily.

46. Clothing: - Must be light, loose and permeable to water vapour and air.

47. Food - Adequate calories must be consumed by tps as contained in their ration Dinning halls should be airy, cool and comfortable.

48. Accn - Living area must be spacious well ventilated and cool.

49. Hygiene Sanitation of Camp - It is essential to maintain strict hygiene/sanitation of camp, especially when tps are deployed for a short duration in field conditions. In temp camps, apart from chlorinated water supply, the organic waste should be promptly disposed in small pits, ensuring it is covered with sand to avoid fly-nuisance, which is usually heavy in desert conditions resulting in diarrhea/dysentery.

50. Kitchen waste should be disposed off by deep burial. Modified soakage pits are required for liquid waste. DTLs should be used in semi-permanent camps. Riveting of DTLs should be done to prevent collapse. For shorter period of stay, incinerator latrines may be used.

51. Health Edn: - AMA should give regular small talks before the onset of summer in non-desert areas and before and after induction of troops to desert areas on different health matters.

52. Heat Stroke Centers & Cool Rooms: - These will be maintained according to current orders on the subject to manage effects of heat. Wherever electricity supply is available an air-conditioned cool room may be made available in the hospital and MI rooms.