ILL-HEALTH ON HIGH MOUNTAINS

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SUMMARY: The mechanism by which disease specifically attributed to the hypoxia and low barometric pressure of high mountains are discussed.

A description of these illnesses is given together with a review of the literature and it is concluded that most of the acute conditions are avoidable.

Introduction

"Mountaineering implies a physical relation between a man and a mountain"

The Right Honourable Lord Hunt

The urge to venture upon mountains for the sheer exhilaration of doing so has found growing popularity within recent times. Many benefits are felt to accrue from such pursuits. These may vary from the simple enjoyment of a ski holiday to the absolute professionalism of record-breaking climbs which are noteworthy either for their technical difficulty or for their extreme height. Whatever the reason may be, and for the most there is some promise of accomplishment, the advent of modern travel has made access to high mountains a far easier proposition. In several parts of the world it is now quite possible to be lifted from sea-level to altitudes of 10,000 feet or even higher within a matter of hours. It is roughly at this height that man enters the threshold of an environment which will provoke, in the susceptible, the onset of one or other forms of altitude sickness.

It is unlikely that the British Armed Forces will be called upon to operate at the sort of altitudes above which altitude sickness has been noted to occur, with the possible exception of road engineering projects. It is however increasingly common practice for adventurous training to take place in such circumstances. The natural sense of well-being in a youthful and fit person, coupled with the challenge and companionship of a mountain climb—and the encouragement to do so—must be tempered with a knowledge of the risks involved and evidence of the necessary foresight to meet the unseen hazards of moderate and high altitude. He must learn not so much to pit his exuberance against a tough climb as to pitch his wits towards the sustained function of his entire party when exposed to the rarified air of high mountains.

The response of the human frame to altitude is noticeable even at 5,000 feet. At this level some loss of physical capacity will be found in people who live normally at sea level (Denison, Ladwith and Poulton 1966). In a large measure it is the rate of exposure to increasingly thin air at high altitude which determines the human response. Thus, the 1969 Olympic Games held at Mexico City at a height of 7,347 feet above sea-level, followed only after extended periods allowed for physiological acclimatisation.

It is of interest to note that no form of altitude sickness has been recorded in Antarctica, although in any one year several hundred men may move across the South Polar Plateau at 10,500 feet. There have, however, been some anecdotal accounts of symptoms which have been attributed to altitude especially when associated with strenuous physical exertion (Fuchs 1973).

Ten thousand feet is an altitude which most people can reach from sea level within a few hours without serious untoward effects. At 14,000 feet it may take about three

days for the symptoms of acute mountain sickness to resolve (Folk 1966), and thus it is generally reckoned that periods for acclimatisation should commence at about 10,000 feet if altitude sickness is to be avoided.

The mechanism of altitude sickness

There appears to be no correlation between the severity of illness and increasing altitude and furthermore, anyone predisposed to acute mountain sickness is said invariably to suffer ill-effects on every trip to the same altitude, although the severity may vary on each occasion (Singh et al 1969).

At very high altitude, say about 20,000 feet, acclimatisation is thought to be incomplete to the extent that there always is an underlying process of deterioration above this height (Pugh 1964).

We are thus presented with a population model, a proportion of which is predisposed to adverse physiological effects following abrupt exposure to heights in excess of about 10,000 feet, and that above about 20,000 feet all are affected to the extent that permanent life above this altitude is unattainable.

The normal reaction to altitude in the unacclimatised is for a round-the-clock diuresis with a fixed low specific gravity (Rennie and Joseph 1970) although the reasons for this are not known. Hrzynicki et al (1971) showed that during exposure to altitude not only a diuresis, but also a dehydration occurred and suggested that the ensuing water loss may have been an adaptive process which follows a shift of fluid under the stress of hypoxia from the circulating blood into the interstitial and intracellular volume.

It is certainly true that dehydration adds a considerable survival load to the human frame at altitude. High wind speeds, together with the lower temperatures associated with altitude make hypothermia, especially in the injured, a very serious hazard. Energy expenditure in the face of high winds is also increased considerably (Pugh 1971) with the result that collapse from fatigue, dehydration or exposure might be encountered and must certainly be considered in the differential diagnosis of any member of a climbing party who feels unwell or behaves in a disorientated fashion on the mountain-side.

There is a time lag, between arrival at high altitude and the onset of symptoms. This varies between six hours and four days and is thought therefore to rule out hypoxia itself being the direct mechanism by which altitude sickness is provoked. Altitude sickness appears to be a consequence in those who are susceptible to the stimulus of rapid exposure to decreased partial pressures of oxygen (Hansen and Evans 1970). This in turn leads to an immediate hypoxaemia. At 11,000 feet, for example, the arterial blood is only 85 per cent saturated (Folk 1966). Singh has concluded that there must be some intermediate factor and it seems probable that a hormone mediated anti-diuresis forms the physiological basis of fluid retention which leads to altitude illness in those individuals who show this tendency. Indeed Viswanathan, Jain and Subramaniam (1969) feel that such an aberration may be genetically determined.

Sickness attributable to altitude

In a recent ascent by three hundred unacclimatised soldiers to a height of 16,300 feet, sixteen cases of acute altitude sickness were reported, although a far larger pro-

portion, in fact one third, did not complete the climb for one reason or another (Lewis 1973). Sick men of course have to be escorted down the mountainside by fit companions. This in itself leads to a higher rate of attrition in the party than is accounted for in the statistics of ill-health.

Pugh (1965) has indicated that about half of those who ascend rapidly from sea-level to 12,000 feet will suffer some acute effect, usually referred to as mountain sickness.

A variety of altitude sicknesses are categorised within the International Classification of Diseases, I.C.D. No. 993. 2 as follows:

a. Alpine Sickness. b. Andes disease. c. Anoxia due to high altitude. d. Mountain sickness. e. Hypobaropathy. f. Other and unspecified conditions of high altitude.

The distinctions which are drawn however, seem to be more geographic than pathogenic in their emphasis and reflect the relatively recent span within which these syndromes have come to be described as recognisable clinical entities.

The following descriptions of sickness attributable to altitude are based upon an examination of modern concepts and are presented in the hope that they may provide a timely and useful reference for those responsible for the maintenance of health in mountaineering parties reaching moderate and high altitudes. This will not include an account of exposure to cold as an environmental parameter since it is not specific to altitude although, for example, 20 per cent of climbers on Mount McKinley, Alaska (21,000 feet), experience frostbite each summer (Scott 1968). Also excluded is the use of oxygen in very high climbs for which reference should be made to specialist texts.

Acute mountain sickness

This is by far the most frequent disorder associated with abrupt exposure to high altitude. In South America it is known as 'Soroche'. By far the largest series of cases are found in a report upon the clinical observations of 1,925 Indian soldiers during the 1962 Sino-Indian conflict. Their experience of a variety of altitude sicknesses included 332 men who had developed acute pulmonary oedema when transported from the plains of India to face Chinese troops who had been acclimatised by many months spent on the Tibetan plateau at 16,000 feet (Singh 1965).

The nine commonest symptoms which constitute this syndrome are listed below:

1. Anorexia. 2. Headache. 3. Fatigue. 4. Nausea. 5. Insomnia. 6. Muscular weakness. 7. Vomiting. 8. Disturbance of vision. 9. Staggering gait.

It is well known that an immediate cure can be affected by descent to lower altitudes, but in any event with most people the symptoms gradually lessen during a period of a few days. There is a difference of opinion amongst mountaineers as to whether or not repeated visits to the same altitude diminish the likelihood of a recurrence. As already pointed out, Singh feels the difference to be only one of severity of symptoms at an altitude that is critical for any particular individual. Whereas, Mitchell (1971) in a non-medical paper seems to imply some degree of adaptation for repeated visits to altitude. If that is so, it could in part be psychologically explained in that those who had previously experienced the effects of altitude will be more attuned to the inconvenience of mild indisposition.

It has recently been demonstrated that Acetazolamide (Diamox) confers worthwhile protection from the most prominent symptoms of acute mountain sickness (Forward et

at 1968). An appropriate regime should be 2 or 3 tablets taken for two days after rapid ascent above 10,000 feet. It is considered potentially harmful to take Diamox for longer periods in such circumstances (Gray et al 1971).

Retinopathy

Retinal blood flow has been shown to increase markedly in persons exposed to high altitude, particularly following rapid ascent (Frayser et al 1971). Pilot studies on Mount Ranier have revealed retinal signs in 2 per cent of those reaching 12,000 feet. Houston (1973) and Frayser et al (1970) have recently provided the first report of retinal haemorrhage in healthy individuals exposed to high altitude on Mount Logan in the Canadian Yukon. Some 20 per cent of those going to 17,500 feet showed retinal haemorrhage with a special susceptibility amongst those whose ascent was rapid. Houston points out a surprisingly similar incidence to retinal haemorrhage reported amongst the new-born which has been ascribed to the hypoxic environment of the foetus.

Thrombophlebitis

Mongé (1928) described something of the re-distribution of circulating blood at high altitude when "blood supply increases, and more of it is contained in the thorax to fix the relatively scarce atmospheric oxygen." This most illuminating concept accords with more modern observations upon haemodynamics at altitude which include the phenomenon of increased blood viscosity (Hurtado 1967). Further evidence of blood volume depletion is felt to be the increasing frequency with which thrombophlebitis is being noted, a mishap which has been the mechanism of at least one death at 24,000 feet on K-2 (Houston 1973). Steele (1971) feels that it may be wise for women climbers to avoid the contraceptive pill at high altitude because of the debated association with deep vein thrombosis. This may not be as drastic as it sounds since he also reports a loss of libido above 12,000 feet.

Sickle cell crisis

Haemoglobin S is said to be present in some 30 per cent of Nilotics. In such people reduction in oxygen tension is known to provoke intravascular haemolysis with resultant disruption to local circulation in the body. Horrobin (1972) has urged that Africans should therefore undertake a test for the presence of haemoglobin S before exposure to high altitude. This condition is believed to be the explanation for much ill-health of mountain parties in East Africa and to be the cause of some confusion over nomenclature with other ailments associated with altitude. The author has recently interviewed an African graduate of the Royal Military Academy who developed an abdominal crisis after a climb on Mount Kilimanjaro (19,340 feet).

Oedema at high altitude

Singh holds that there is no distinction to be drawn between acute mountain sickness and high altitude oedema other than to say that they are to be regarded as clinical variants of the same condition.

Sheridan and Sheridan (1970) give an account of peripheral oedema occurring in several members of their party whilst on Mount Kinabalu (13,455 feet), the highest mountain in South East Asia. It seems likely that this phenomenon is an inconsequential effect of the redistribution of body fluids which occurs at altitude. At any rate the condition resolved with a spontaneous diuresis on descent.

Brain oedema is regarded as a non-specific response to a variety of insults (Leading Article 1973a). The clinical effects are related to the degree of brain swelling and subsequent tentorial herniation, such as, headache, disturbance of consciousness, abducens nerve palsy, bilateral papilloedema and Cheynes-Stokes respiration. In one recent unpublished case from Mount Kenya, the victim is reported to have made almost full recovery after remaining unconscious in hospital for ten days (Barber 1973).

Amongst the more bizarre stimuli to cerebral oedema are intoxication by vitamin A—a condition known to Eskimo folklore in its association with Polar Bear liver—and more recently (Fitch 1964) abrupt exposure to high altitude. Glucosteroids are reported by Singh to effect a dramatic reduction in the amount of brain swelling.

In pulmonary oedema there is an abnormal accumulation of liquid in the extra-vascular tissues and spaces of the lung (Robin, Cross and Zelis 1973). Many causes for this condition have been described, the most newly so being as a result of abrupt exposure to high altitude. The condition must be regarded as a medical emergency since the severity of the oedema, which can develop rapidly, determines the degree of hypoxaemia (Leading Article 1973b).

In the case of an Asian youth, this young man died before the donation of the automatic lung ventilator to the Consolata Mission Hospital, Nyeri, Mount Kenya (Fig. 1).

Chronic mountain sickness (Monge's disease)

A condition described in native residents at high altitude who exhibit a failure to adapt to their environment. High altitudes give rise to circumstances which are characterised by severe hypoxia and low barometric pressure. This disease is distinguished by an excessive polycythaemia and cyanosis. It is reputedly difficult to differentiate from the respiratory insufficiency caused by the sudden pneumoconioses which are described amongst mine-workers in the high Andes.

Singh (1969) has also described this condition in the Indian sub-continent.

Psychological effects

Recently a Royal Marine officer at 19,000 feet descended some 2,000 feet from a night bivouac. On waking in the morning he had no recollection of the journey. Mood changes and occasionally more bizarre behaviour patterns are not uncommon. So far little research has been forthcoming in this field.

Conclusion

One can conclude that the speed of exposure and the high altitude reached, the degree of physical exertion and the state of hydration, the length of time spent at altitude and the presence of other conditions such as foul weather, which may be detrimental to the maintenance of general health, are all contributory factors in the onset and therefore the prevention of diseases at high altitude. To this must be added the screening of climbers of negroid stock for haemoglobin S. A previous history of acute mountain sickness or pulmonary oedema might not necessarily bar a person from returning to high altitude, but should serve to alert those responsible for his welfare of the increased likelihood of a recurrence of either of these conditions.

Fitness itself does not confer any specific protection. There is no doubt, however, that to climb a mountain without training for endurance is to divest the exercise of

(courtesy of Dr. Ponte, Nyeri)

Fig. 1. Radiograph of an Asian youth who died from pulmonary oedema.

much of its purpose, reducing one's enjoyment of the event to the point of becoming an increasing burden of responsibility to the party.

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Northern Ireland Service Awards

In the Operational Gallantry List announced on 18th June 1974, Major K. H. Hedges, R.A.M.C. was awarded a mention in despatches for his distinguished service.