ELECTRO-ENCEPHALOGRAPHY AND EVEREST CLIMBERS*

LIEUTENANT-COLONEL P. ABRAHAM,
M.R.C.Psych, D.T.M.&H., R.A.M.C.

Royal Victoria Hospital, Netley Abbey

SUMMARY: E.E.G.s were recorded as part of a health check on would-be Everest climbers. The merits of doing so and the implications of the abnormalities found are discussed.

Introduction

In 1976 the Army Mountaineering Association sent 27 members, with 6 Royal Nepalese Army and Gurkha climbers and 25 Sherpa porters, to climb the highest mountain in the world. It was the first such expedition mounted by a club and they were successful.

This was also the first reported occasion that a group of high altitude mountaineers was systematically examined by electro-encephalography before setting off. The biggest single obstacle the climbers faced was hypoxia, and the cerebrum is peculiarly vulnerable to hypoxia. The effect of hypoxia is to impair every definable mental function. Hallucinations, memory failure, impaired judgement, and mood disturbances have been repeatedly reported. Inflexibility, callous unconcern for colleagues, irritability, and apathy have all been described. One need not elaborate on the drawbacks of these effects when tackling Himalayan mountains. To illustrate the problems of hypoxia on Everest one should remember that at its 29,000 ft. peak, the atmospheric pressure is one third of that at sea level, and the arterial pO_2 is approaching that of mixed venous blood at sea level. Even acclimatized mountaineers are troubled by hypoxia above 17,800 ft., which was the height of the expedition Base Camp. The climbers on this expedition used 0.5 litres per minute of extra oxygen at 24,500 ft. (Camp Four), even for sleeping. Until this year no man had come back alive from the summit of Everest without extensive use of supplementary oxygen (Fig. 1).

Aim

The role of E.E.G. is to demonstrate defects of cerebral function both local and general. Where such defects exist at sea level one might suppose that the chronic hypoxia of high altitude mountaineering would aggravate the consequent disabilities—perhaps to a dangerous extent. The primary aim of our survey was, as part of a systematic health study conducted by Colonel H. S. Moore, late R.A.M.C., to obtain clinical information which could be used to advise the leader of the expedition and his medical officer, to assist them in the selection and management of the expedition team.

A secondary aim was to acquire information on the E.E.G. and high altitude mountaineering since the literature on the subject was scanty. As this aim was

**This article formed the basis of a paper presented to the Electrophysiological Technologists' Association at King's College Hospital, London, on 19 March 1977.*

Fig. 1. Everest: showing route used by the Army Mountaineering Association Expedition 1976.

merely incidental to the first it was not possible to arrange for E.E.G.s to be recorded during or after the expedition.

Method

Subjects

The 29 army mountaineers studied came from a wide variety of backgrounds. Their ages ranged from 24 to 49, the mean being 34. Not all of them eventually took part in the 1976 expedition.

Electro-encephalographs

Half the E.E.G.s were recorded in January 1975. The 10/20 electrode placement was used. Since hypoxia was our prime concern and we were anxious to demonstrate any abnormality of cerebral function which might be related to changes in pO_2 or pCO_2 , each subject was required to hyperventilate for three minutes twice:—before and after the phase of the recording in which photic stimulation was carried out. This additional provocation procedure was described by Scott (1964) and results in an enhancement of abnormal patterns. It was not employed when the remainder of the E.E.G.s were recorded, rather more hurriedly using only 9 electrodes, in December 1975.

Results. Of the 20 E.E.G.s, 27 were normal, but 2 of these 27 showed interesting features. One showed a remarkable amount of sleep activity for a daytime recording. He did not go on the expedition. The other showed a particularly strong and prolonged delta response to overbreathing. Little attention was paid to this prior to the expedition, but it was noted that he reached the limit of his resources at an earlier stage of the climb than the others. He spent the remainder of the expedition carrying out chores in the lower camps. His contribution was not as modest as it

might seem at first sight. The lower camps were at a height greater than that of any mountain in Europe, and journeying between them involved negotiating the notorious Ice Fall.

Of the two abnormal records one showed high voltage irregular spike-and-wave activity in response to photic stimulation. He climbed to 27,550 ft. on Everest without ill effects, except at lower levels.

The second abnormal record (Fig. 2) was more disturbing. In essence it showed an excess of theta and beta in place of alpha in the resting record, while over-breathing enhanced the theta even more. The appearance suggested an acquired, possibly cerebrovascular, disorder, not confined to one area. Although the subject was currently alert and fit the concern was two-fold. A sub-clinical disability could at high altitude become a clinical one, and faulty decisions could jeopardize the success of the expedition, and possibly lives as well. Happily, as well as having had considerable Himalayan experience, he is exceptionally shrewd and careful. He remained at Camp Two (22,000 ft.), and not only did he ensure that every important decision was seconded by another experienced mountaineer, he even made sure that others monitored his condition, in case as a result of hypoxia he lost insight into his own impaired judgement. In spite of remaining at the lower levels he had some difficulty in carrying out his assigned role. To his credit he was successful nevertheless.

Discussion

The finding of 27 normal records out of 29 potential Everest climbers is not surprising, but there is a widespread myth that a substantial number of normal people have abnormal E.E.G.s. Amongst healthy people this is not so.

The coincidence between a prolonged E.E.G. delta response to hyperventilation and early exhaustion on Everest may be fortuitous, but is reported in case the repetition of such coincidences suggests a significant link.

The occurrence of high voltage spike-and-wave activity in response to photic stimulation is not a normal phenomenon. It is quite unusual in a population of healthy subjects. Only 0.5 per cent in a group of 1,000 men otherwise fit for aircrew training in the Army Air Corps showed this feature. It is associated with an increased risk of epileptic seizures. Nevertheless this climber was one of the "top ten" on the expedition. It is in fact remarkable that amongst the many disorders and medical mishaps referred to by Ward (1975) as arising in high altitude climbers, there is no mention of a single epileptic seizure. Similarly Prior (1973) states that "reports of epilepsy in patients who have survived . . . acute anoxic brain insults are not frequent", and then goes on to describe only one surviving patient in her series of 115 who appeared to have had a straightforward major seizure. One of the problems involved in determining the effect of hypoxia on cerebral excitability is the difficulty of isolating the effect of hypoxia *per se* from the more complex effects of restricted cerebral circulation which include for instance hypoglycaemia. It could be that the climber with spike-and-wave activity was actually protected by chronic hypoxia, coupled with exercise and carbohydrate ingestion, from having an epileptic attack!

In connection with the second abnormal record (Fig. 2) which showed features compatible with an acquired disorder, it should be mentioned that one of the

Fig. 2. E.E.G. of an experienced Himalayan mountaineer showing abnormal activity.

hazards which high altitude climbers face is an increased risk of thrombosis. There are a number of reasons for this ranging from polycythaemia to haemoconcentration resulting from dehydration. A number of strokes have been reported. This particular climber was known to have had some tough experiences on other Himalayan expeditions. There may be a case for systematic E.E.G. recordings before and after such expeditions to determine whether any permanent damage occurs as a result, whether it be sudden, or gradual and cumulative. There may even be a case for using E.E.G. recordings to monitor changes in cerebral function occurring during the expedition.

It is felt that the discovery of the second abnormal record, which enabled appropriate precautions to be taken, was alone sufficient justification for the 29 recordings we did.

Acknowledgements

The contributions of Warrant Officer II J. S. Dally, R.A.M.C., E.E.G. technician, Lieutenant-Colonel Dick Hardie, R.A.M.C., expedition doctor, and Surgeon-Commander E. P. Beck, R.N., of the Institute of Aviation Medicine, and the support of my wife, are gratefully acknowledged.

REFERENCES

- PRIOR, Pamela (1973). *The E.E.G. in Acute Cerebral Anoxia*. Excerpta Medica. Amsterdam.
- SCOTT, J. W. (1964). *The Use and Abuse of the E.E.G. in Aircrew Selection*.
- AGARDOGRAPH series: Advisory Group for Aeronautical Research and Development. Lisbon Meeting (September).
- WARD, M. (1975). *Mountain Medicine—A Clinical Study of Cold and High Altitude*. Crosby, Lockwood, Staples. London.