ELECTROENCEPHALOGRAPHIC EXAMINATION OF HEALTHY AIRCREW

By

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Introduction

It is well known that electroencephalogram (EEG) can be of aid in the diagnosis of neurological disorders, especially epilepsy. Perhaps it might be of help in assessing the fitness of a candidate for flying. Many workers like McFarland, Buchthal and Lennox, Picard, Tompkins, Ades, Bennet, etc., have carried out work in the field of electroencephalography in relation to flying and episodes of altered consciousness in aviators. The relation between an E.E.G. pattern and flying aptitude has not yet been established and accepted in clinical electroencephalography. The correlation between non-specific E.E.G. patterns and predisposition to epilepsy or syncope has not yet been well established.

The electroencephalographic examination of healthy aircrew in the Indian Air Force was introduced in 1963, carried out as a part of assessment of fitness to fly high performance aircraft.

Material

320 subjects have been taken into consideration for the purpose of this report. The distribution of these subjects, age-wise and service-wise (total service in IAF) is shown in Tables I and II respectively.

TABLE I

Age in years	*22-25*	*25-30*	*30-35*	*35-40*	*40-45*
Number of subjects	162	86	46	23	3
Percentage of total	50.6	26.9	14.4	7.2	0.9

TABLE II

Total Service in years	*2-5*	*5-10*	*10-15*	*15-20*	*20-25*
Number of subjects	202	48	52	16	2
Percentage of total	63.12	15.0	16.25	5.0	0.63

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Method

Medical Examination

These subjects were thoroughly examined by Medical Specialist, Ophthalmologist, Otolaryngologist, and other specialists if necessary. The various investigations carried out as a routine were X-ray chest, E.C.G., routine Haemotological Tests, Urine routine examination, G.T.T., Pure Tone Audiogram and Explosive Decompression Run.

Electroencephalographic Examination

The records were taken in a recumbent position in a low lying couch with a back rest, during morning hours. It was made certain that subjects had taken some food before the recording in order to avoid the possibility of hypoglycaemia. Earlier the records were taken on a Grass Model 8 Channel Machine and later, on a Grass Model 16 Channel Machine. The '10-20 system' for placing the Grey Walter pad electrodes on the scalp, was followed. Unipolar and bipolar runs were taken. Provocative techniques like three minutes of hyperventilation followed by two minutes recovery period and photic stimulation were used in all the cases. Some other techniques like ocular compression, carotid compression and valsalva manoeuvre were also used. The recordings were also repeated on empty stomach with a check on blood glucose and after ingestion of 100 gm. of glucose; during hypoxia and after drug induced sleep as and when indicated. The changes, if any, during hyperventilation and photic stimulation are the subject of this report.

Results

The results are shown in Table III below.

It will be seen from Table III that the incidence of abnormal E.E.Gs. in this particular group is 9.4% while that of Borderline E.E.Gs. is 2.5%.

The important features of these abnormal E.E.Gs. were as follows:

(*a*) Six records showed poorly developed alpha with poor voltage and poor contents. Excessive fast activity/ almost flat record seen. One E.E.G. also showed occasional slow wave activity in theta range with low voltage.

(*b*) Twenty-four records on hyperventilation mostly showed paroxysmal bursts of slow waves/high voltage slow waves discharges in theta-delta range with voltage as high as 100-250 microvolts, the onset of which was ushered in within one and a half minutes of hyperventilation and which persisted for a variable period, after stoppage of hyperventi-

TABLE III

Total number of E.E.Gs.	*Normal E.E.Gs.*	*Borderline E.E.Gs.*	*Abnormal E.E.Gs.*
320	282	8	30
Percentage of total ..	88.1	2.5	9.4

lation, extending from half a minute to two minutes but mostly from one minute to two minutes. The E.E.Gs. showing the above-mentioned changes on hyperventilation, shall be referred to as showing "Marked reaction" to hyperventilation in the rest of the paper.

(*c*) Nine out of these twenty-four records mentioned above, also showed occasional/transient slow wave activity in resting record in theta range with low-moderate voltage.

Two records showing the findings mentioned in para (*a*) above which were questionable and six records showing changes on hyperventilation which were also questionable, were labelled as "Borderline" E.E.Gs.

Discussion

The incidence of abnormal E.E.Gs. in this healthy group of 320 aviators has been found to be 9.4%. Bennett studied E.E.Gs. of 1,332 flying personnel which showed an 8% incidence of abnormalities. O'Connor carried out a study on 500 R.A.F. aircrew cadets when they started training and found the incidence of abnormal E.E.Gs. to be 10%. Buchtal and Lennox in a study of 682 volunteers for the Danish Air Force, reported an overall incidence of 20.5% of abnormal E.E.Gs. and even when the candidates with suggestive evidence of neurological disease were eliminated the incidence was 15.9%. Our results are in agreement with that of Bennett and O'Connor.

It is further seen that none of the E.E.Gs. showed focal or generalised spikes, sharp waves or spikes and slow waves. Photic stimulation did not produce any significant information.

The most common finding among the records, labelled as abnormal in the present series, was 'marked reaction' to hyperventilation. E.E.G. showing 'marked reaction' to hyperventilation indicates that the central nervous system of the individuals is sensitive to PH changes in the blood. Usually this sensitivity is compensated but under stressful environments it might break down. The studies carried out, at I.A.M., Toronto in 1955, on cases of episodic unconsciousness or diminished consciousness in flight revealed that a combination of physiological factors had been responsible for the disturbance in consciousness. None of these physiological factors, *e.g.*, hyperventilation, hypoglycaemia and prolonged low 'G' alone was sufficient to produce disturbance in consciousness but acting together in a susceptible individual had produced disturbances in consciousness. The E.E.G. showing onset of slow waves on hyperventilation was thought to be associated with a subclinical epileptic diathesis which activated by a decrease in brain metabolism on account of other factors, had precipitated the episode of unconsciousness. Powell *et al.* (1956) investigated eight cases of unconsciousness or diminished consciousness. The factors responsible in these cases were previous or concomitant 'G', hypoglycaemia occurring a few hours after a light carbohydrate diet and hyperventilation. The associated factors were anxiety or anger and early slow wave activity in the E.E.G. on hyperventilation. It was concluded that all these factors are responsible for diminished cerebral activity and their summation can cause episodic unconsciouness. Ades (1962) compared the E.E.G. findings of aviators who had experienced an episode of alteration in consciousness either in flight or on the ground with that of 1,375 presumably healthy persons. He found that either one or a combination of factors mentioned below was seen significantly more frequently in the group of

altered consciousness and in those involved in aircraft accident group due to pilot error than in the control group. The factors were, variation in amplitude within brief spans of time, resting record containing slow wave activity not attributable to drowziness and usually in theta range, high voltage bursts characterised by abrupt shifts in amplitude for periods of 0.5—2.0 seconds and prolonged hyperventilation reaction, *i.e.*, the persistence of any slow wave activity for one minute after the stoppage of three minutes hyperventilation.

It will be seen from the foregoing discussion that hyperventilation is an important factor in aviators, and E.E.G. showing 'marked reaction' to hyperventilation may have to be taken into consideration while assessing the fitness for flying.

The subjects, in the present series, showing abnormalities in their E.E.G. records denied any history of lapses in consciousness and all of them had completed at least a period of two years of flying while a few out of them had completed more than ten years of flying and their flying had been average or above average. Whether this would indicate that these abnormalities are compatible with flying, is difficult to state in the light of present day knowledge. Bennett and Duvoisin (1944) concluded that attempts to correlate non-specific E.E.G. patterns with predisposition to epilepsy or syncope have been fruitless. It will be worthwhile to follow up these aviators who have abnormal E.E.Gs., and for comparative studies, aviators with normal E.E.Gs. should also be followed up. These studies might help in assessing the significance of these abnormalities.

Acknowledgement

I am thankful to Gp. Capt. J. H. F. Manekshaw, Officer Commanding, Institute of Aviation Medicine, Bangalore-17, who has encouraged and enabled me to write this paper and I am indebted to Wg. Cdr. H. Lakshminarayan for his guidance and help.

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