

Episodic neurological dysfunction and flying

Wg Cdr A Krishnamurthy * Gp Capt GS Nayar ⁵ Wg Cdr AK Roy ⁶

* *Classified Specialist (Av Med)*, ⁵ *Senior Adviser (Av Med)*
Institute of Aerospace Medicine, IAF, Bangalore - 560 017

⁶ *Prof of Neurology*
St. Johns Medical College, Bangalore - 560 034

While evaluating an aircrew with a history of altered sensorium the dilemma for the aeromedical consultant is to answer the question as to whether it was a fit or a faint? The disposal of an experienced pilot who has suffered from episodic neurological dysfunction (END) is difficult and complex. Aircrew with a history of END whose case records were available at IAM were studied. The current practices of disposal of cases of END in the IAF were analysed and compared with practices in other Air Forces. A policy for disposal of cases of END is suggested.

Keywords: Aircrew evaluation, loss of consciousness, epilepsy, syncope, inflight incapacitation.

A very important consideration during the aeromedical evaluation of an aircrew is to exclude any possibility of sudden incapacitation in flight. While evaluating an aircrew with history suggestive of an episode of altered sensorium, however brief the period, the immediate dilemma for the aeromedical consultant is to answer the question as to whether it was a fit or a faint. Was it a matter of the head or of the heart? While the causes of a faint are more likely to be demonstrable, treatable and even disposable with a fair amount of ease and objectivity, the case of an episodic neurological dysfunction (END) tends to be more challenging and enigmatic. It is easy to deny a flying licence to an aspirant flyer with a history of unexplained END. The disposal of an experienced pilot with a similar history, however, becomes more difficult and complex. The paper attempts to analyse the

current practices in the Indian Air Force (IAF) for the evaluation of aircrew with one or more instances of END, i.e., epilepsy, non-epileptic disturbances of consciousness (NEDC), episodic unconsciousness and loss of consciousness.

The incidence of epilepsy is 20/10,000 population [1]. 2.5% of the population would have had one seizure in their life time [2]. In India the prevalence has been reported to be 30-50/10,000 [3]. Many cases go undetected due to the infrequency of seizures or due to non-reporting on account of the attendant social stigmata or fear of adverse career effect. Eight cases of inflight grand-mal epilepsy were reported among United States Air Force (USAF) pilots who had previously been in good health [4]. No inflight mishap had ever occurred in their cases. One may wonder if some of the causes of

unexplained aircraft accidents would be due to this reason. Loss of consciousness (LOC) on ground is a more frequent occurrence [5]. LOC in aircrew during flight could be the result of a physiological or pathological process [6]. In a USAF study, 43.2% of aircrew with LOC were permanently grounded while 56.8% were gradually reintroduced to flying or given a change of aircraft due to non-availability of adequate information or investigations [5]. In a review of cases by Rayman in 1973, it was noted that out of 89 cases of inflight incapacitation there were 23 fatalities [4]. In another review of 23 cases of inflight incapacitation, in the USAF between 1978-87, 11 resulted in loss of consciousness while flying [15].

Materials and methods

Aircrew who had a history of END and who were evaluated at the Institute of Aerospace Medicine (IAM) between January 1986 and June 1995 were included in the present study. The clinical details, results of investigations and aeromedical disposal were examined in depth and compared with current international aeromedical practices.

Table 1 shows that of the 9 subjects, 3 had seizures; fortunately none had seizures inflight. 6 had loss of consciousness, 2 on the ground and 4 inflight. The numbers are too small to draw any conclusions from the cases of LOC in flight i.e. flying experience vs LOC. However, in Table 2 which shows more details of the cases of LOC

in the air, 2 cases of LOC took place soon after their conversion to a different type of aircraft. *Eye witness account (EWA):* An accurate history is very important in the diagnosis of any END. Thus there is always the necessity for a reliable eye witness account of the episode. Attention to details would make it easier for the treating physician as well as towards the final disposal. This becomes a problem when the pilot of a single seater aircraft becomes unconscious during flight.

Table 1. Frequency of seizure

Episodic neurological dysfunction (n=9)	Branch	Subject	Age at onset (yrs)	Flying experience (hrs)
Seizures (inflight)	-	-	-	-
Seizures (on ground)	F(P)	PA	26	1370
	X(P)	SNN	38	1500
	Ground Duty	SKK	32	NA
Loss of consciousness (Inflight)	U/T F(P)	SPM	21	85
	U/T F(P)	S	21	NA
	F(P)	G	31	1600
	F(P)	RMC	39	4500
Loss of consciousness (on ground)	U/T F(P)	SK	22	75
	L(AI)O	BS	33	425

Investigations: An investigation/procedure yielding definite positive or negative findings was considered "valuable" when it helped in giving a final disposal/category, not necessarily restoring the person to flying. Inter-observer variability is

Table 2. Loss of consciousness (LOC) in the cockpit

Sub	Age (yrs)	Type of aircraft	Flying hrs Total	Flying hrs on Type	Time of occurrence	Phase of flight	Duration of LOC
SPM	21	Jet Trainer	85	20	Day	Mission	10-13
S	21	Jet Trainer	NA	NA	Day	Landing	05
G	31	Fighter	1600	40	Day	Mission	NK
RMC	39	Transport	4500	800	Day	Mission	A few min

Table 3. Value of investigations

Investigation	Value in diagnosis	%age	Value in disposal	%age
1. Eye witness account	8/8	100	8/8	100
2. EEG	6/8	75	2/8	25
3. CT Scan	6/6	100	1/6	16.6
4. Psychometry	3/4	75	1/5	20
5. Holter	2/2	100	2/2	100
6. TMT	4/4	100	0/5	0
7. Echo	4/4	100	1/4	25
8. Head up tilt (HUT)	4/4	100	1/5	20
9. Centrifuge evaluation	1/2	50	1/2	50
10. Vestibular evaluation	2/2	100	0/2	0

Table 4. Specialist opinion - Epilepsy/Seizures (sub. 1-3) and Non Epileptic Disturbances of Consciousness (NEDC) (sub. 4-9)

Subject	Category given by Neurologist (N) Neuropsychiatrist (NP) Med splst. (M) Cardiologist (C)	Category awarded by Medical Board
1. PA	a. A4G3 (N), A4G3 (NP)	A4G3
2. SNN	b. A3G3 (N) A3G2 (N), A1G1 (NP)	A4G3 A3G2
3. SKK	A4G3 (N)	A4G3
4. RMC	a. A4G5 (NP), A4G3 (N) b. A4G3 (N), A1G1 (C)	A4G5 A4G3
5. S	A4G1 (C)	A4G1
6. SPM	a. A1G1 (NP), A1G1 (Av Med) b. A1G1 (N), A4G2 (M)	A4G2
7. SK	A2G2 (S), A3G3 (M), A1G1 (Av Med)	A4G3
8. BS	A4G4 (N)	A4G4
9. G	a. A1G1 (M), A1G1 (C), Fit for flying duties (NP) - '84 b. A3G1 (NP), A4G5 (M) - '85 c. A2G1 (N), A2G1 (M) - '86	A3G1 A4G5 A2G1

definitely likely to produce confounding results. Similarly a procedure/investigation was considered "not valuable" when it did not help in restoring a person's category, inspite of the investigation being negative.

From Table 3, discounting the small number of cases (n=9), we do find that the eye witness account is the most outstanding feature both towards diagnosis and disposal. The role of investigations towards diagnosis leaves no doubt about their necessity; but towards disposal their value is less.

During evaluation, cases of END are examined by specialists in neurology, psychiatry, cardiology and aviation medicine. The opinions of the different specialists are given based on the current knowledge in their field and therefore, the

category annotated are also different. This may lead to (a) difficulty in awarding the eventual category by the medical board, (b) appeal by the officer-patient and (c) subsequent delays. Table 4 looks into this picquant situation.

In cases of NEDC we find that all the specialists play an equally important role. To restore a person to flying, therefore, requires a coordinated effort.

The reasons for delay, if any, were gone into and Table 5 brings out the findings.

Discussion

Before any conclusions are drawn from the above Tables, a look at the current IAF policy for

Table 5. Reasons for delay in disposal

Reason for Delay	Time off flying (months)				Total	
	1-3	3-6	6-9	9-12	Min	Max
Administrative delay in seeking appointment	y				1	3
Non availability of documents						
Procedural lapses				y	9	12
Interservice delay	y				1	3
Want of medical executive report						
Want of Super Splt opinion	yy				6	12
Interpretation of policy	y			y	12	18
Total time off flying (n = 8)					29	48

Table 6. Questions in relation to IAP 4303 (paras 5.10.5 - 5.10.10)

S No.	IAP Para	Question
1.	5.10.5	Do fits and convulsions cover all aspects of these disorders ?
2.	5.10.6	Is it enough to group fits into 3 sub groups ?
3.	5.10.9	What are the remediable and relative innocent causes ?
4.	5.10.10	Should treatment be started after the first seizure ?
5.	5.10.10	Can instructional duties in aircraft be allowed ?
6.		What is to be done with cases of G-LOC ?

trained personnel on the above two conditions, is warranted. Para 5.10.5 - 5.10.10 of the IAP 4303 deals with the subject of Fits and Convulsions and para 5.10.7 subdivides cases of fits into true epilepsy, fits as a result of remedial causes and borderline cases (episodic unconsciousness).

Table 6 brings out the unanswered questions in the above form of approach.

From the above Table, therefore, it is evident to us that a rethinking into our policy is a requirement. Epilepsy, including solitary seizure, must be dealt with separately and so also non-epileptic disturbances of consciousness (NEDC).

The National General Practitioners Study of Epilepsy (NGPSE), a prospective community based study, showed recurrence rates of 46% within two years after the first seizure occurred [8]. It is also becoming increasingly evident that treatment should be started as early as possible to avoid worsening of prognosis, which would occur when the seizure number increases [9]. Therefore every effort must be made towards early recognition of the type of seizure and its classification according to that of the ILAE-1989 [10]. This would enable early treatment, elimination of secondary causes and also improve the prognosis. A diagnosis of Idiopathic/Cryptogenic Epilepsy precludes flying duties as the 5 year seizure free (YSF) interval is 68% and therefore, chances still exist in 32% of individuals of developing a seizure 5 years after the index seizure [11]. When epilepsy is symptomatic with specific etiology, once the cause is removed, resumption of flying duties should be considered on the basis of a seizure free (SF) interval, which has to be specified, i.e., 3 YSF / 5 YSF.

In summary, therefore, cases of Idiopathic/Cryptogenic Epilepsy are unfit for flying duties. Solitary seizures, etiology unknown will also fall into the above category and preclude from flying

duties. However, symptomatic epilepsy with a specific etiology eg. tuberculosis, cysticercosis, can probably resume flying duties after:

- (a) the cause is eliminated and treatment completed,
- (b) an adequate SF interval (3 YSF vs 5 YSF),
- (c) determining the disease process is non-progressive.

In our series, of the 2 pilots who developed seizures, one had a solitary seizure, while the other had 2 seizures (one following the other). Both have been returned to flying after 4 - 4½ YSF interval. It is our opinion that the resumption of flying duties should be gradual and only in dual seated aircraft and instructional duties should not be permitted.

In a review of 88 cases of syncope in USAF aircrew Sundaram [5] found that 56.8% were gradually returned to flying duties. This further clarifies the necessity to demarcate clearly epilepsy and NEDC.

The importance of the eye witness account (EWA) when dealing with episodic neurological dysfunction needs to be emphasised. The fact that the EWA is only available from the case sheet and not in a predesigned format leaves those caring for and reviewing such problems at a disadvantage. Though the EWA was the single most important factor both towards diagnosis and disposal, this aspect of recording of data could be improved upon.

It was noted that all the investigations contributed towards the diagnosis of episodic neurological dysfunction. However, their role towards the disposal was variable. It is recorded that 88% of epileptics with the first EEG being normal, will remit [12]. In the same study Shafer et al also showed that the chance of finding a waking, normal EEG is 24.4% while a sleep record would pick up 54.4% of abnormal records.

They advocated the use of routine activation procedures as well as classifying the EEG findings to eliminate non-specific abnormalities. The USAF also lays down criteria for EEGs which are not disqualifying (para A.23, Chapter 16 special evaluation requirements). Some of these non-specific abnormalities are given in Table 7.

Table 7. Non-specific EEG abnormalities

1. Small sharp spikes
2. Rhythmic mid temporal discharges
3. Phantom spikes (6 Hz spike and wave)
4. Benign epileptiform transients of sleep
5. Wicket spikes
6. 14 Hz positive spikes

The routine use of other non-invasive investigations like CT scan, Holter monitoring, 2-D colour Doppler Echo, centrifuge and vestibular evaluation should be advocated as they have proven to be of value in the diagnosis of cases of END. One other investigation which deserves special mention in this battery is HIV testing. As brought out by Perry [13] LOC may be the first manifestation of an individual suffering from AIDS.

The approach to a case of END is multidisciplinary, especially so in cases of NEDC. Amongst the latter disorder, syncope forms a sizeable number. A review of 88 cases of LOC in aircrew showed that syncope on ground formed a major portion, 80 cases [5]. Lamb in his review of LOC in 1,980 AF personnel, found that 37.5% experienced LOC and 20% experienced more than one episode. He felt that as long as physiological basis existed there should be no bar to flying [6, 14]. Therefore, it becomes absolutely essential to investigate each case in detail, if we are to conserve trained manpower, regardless of the financial implications.

The fact that a neurologist, psychiatrist, psychologist, cardiologist, endocrinologist, physi-

ologist and aviation medicine specialist must form part of the team is seen from Table 7, which also attempts at classifying the NEDC.

From Table 8 it is evident that such a multidisciplinary disorder will lead to differences of opinion as regards functional ability and thereafter medical categorisation, as brought out earlier. It is our feeling, therefore that if only the opinion was given, the Medical Board would be able to award the categories based on current IAF policy and the opinions of the various concerned specialists. This approach may also obviate any undue loss of flying which may arise due to differences in opinion, category and the current policy of the IAF with regards to "Fits and Convulsions".

Suggested Policy

Epilepsy (Seizures): Epilepsy should be diagnosed on the occurrence of two or more seizures. Every attempt should be made to classify the seizures according to the ILEA-89 classification. Disposal should be accorded on the basis of the etiological classification. Towards this the following are to be considered as mandatory:

- Eye witness account.
- Neurological (if necessary psychiatric and neuropsychological) assessment.
- EEG along with routine activation procedures.
- Sleep deprivation EEG may be done in cases where a doubt exists.
- CT scan be done in all cases of localised (focal) epilepsy.

Disposal:

1. Idiopathic Epilepsy

- (a) At entry - rejected
- (b) Ab - into training - Invaliding Medical Board (IMB) to be held

(c) Trained personnel. (Ground duty)

(i) Within 5 years of service - IMB to be held.

(ii) After 5 years of service - Trial with anti-epileptic drugs (AED)

- Cat CEE/A4G5 while on AEDs. When seizure free for 3 years (3 YSF) drug withdrawal to be started.
- If seizures continue > 1-12 per year while on AEDs, IMB to be held.
- If seizures < 1 per year while on AEDs, Category A4G4/CEE permanent. To follow seizure precautions. Executive report required during annual medical examination (AME). Medical specialist's opinion during AME.
- If seizure does not occur 2 years after drug withdrawal individual to be placed in category A4G2/BEE permanent. To be followed up by the Medical specialist every year for 5 years during AME.

(iii) Trained personnel. (Aircrew)

No flying permitted. Disposal to be given as for ground duty personnel.

2. *Symptomatic epilepsy*

(a) Cause removed. No seizures. On AEDs

(i) Ab initio - IMB to be held.

(ii) Trained personnel

- Ground duty: 3 YSF interval before putting back to full duties and A4G1/AYE.
- Aircrew: 3 YSF interval, no residual on CT scan, no EEG abnormality, psychometric assessment normal. No drugs for 1 year. Dual flying only A2G2.

(b) Cause not removed. No seizures. On AED.

- Flying not permitted.
- Disposal as per cause pertaining to the cardiovascular system, central nervous system, metabolic etc.

3. *Solitary seizure-cryptogenic* (Cause obscure)

Complete work-up as for idiopathic epilepsy and to be started on AED's, for 1 year:

(a) If further seizures appear disposal as in idiopathic epilepsy.

(b) If no seizures occur, withdraw drugs and observe for 2 years in category A4G4/CEE. When no seizures have occurred 3 years after the index seizure, upgradation to A4G2/BEE with annual review for the next 5 years by the Medical specialist at the time of AME.

(c) No flying to be permitted.

4. *Non Epileptic disturbances of consciousness (NEDC)*: All cases of NEDC should have a complete work-up which includes:

- Eye witness account.
- Squadron MO/SMO's report on the problem.
- Sortie profile/Flight data print out.
- Cardiovascular system examination - Clinical, ECG (R & TMT), Echo, 24 hr ambulatory monitoring (when recommended), tilt-table studies, centrifuge evaluation (as required).
- Central nervous system - clinical, EEG with routine activation procedures, CT Scan.
- Metabolic-Extended GTT, Thyroid functions (if required).
- ENT - Vestibular function tests.
- Psychiatric - Clinical and psychological tests.

Disposal:

1. (a) *Vaso-vagal syncope*: Typical features. Should be disposed at the SSQ after obtaining the Aviation Medicine specialist/medical specialist's opinion. No bar to flying.
(b) *G-LOC*. Should be disposed at the SSQ by the Aviation Medicine specialist.
2. All cases other than in 1 (a) & (b) above should be referred to IAM for further disposal.
 - (a) If the cause is obscure, observation for 6 months and if no further episode occurs, return to full duties should be considered.
 - (b) If the cause is determined the disposal should be according to the cause.

Conclusion

In conclusion, therefore, a fresh look at the current IAF policy is warranted and when reviewed with current literature and policies of other air forces, it is necessary to rethink and remodel our policy. We would therefore like to recommend:

- (a) A change in the existing IAF guidelines demarcating epilepsy and NEDC (Non-epileptic disturbances of consciousness)
- (b) Investigations like CT Scan/Holter/2-D colour Doppler/Sleep EEG/Psychometric assessment/centrifuge studies/ vestibular studies be done in all cases of NEDC.
- (c) A common CNS proforma, which includes END must be a part of any accompanying document that comes to IAM/AFCME.
- (d) The suggested policy as given above be considered for early implementation.

References

1. Harrison's Principles of Internal Medicine - 13th Ed. McGraw Hill, New York, 1994 : 2223.
2. Sander JWAS, Hart YM, Johnson AC, Shorvon SD - For the NGPSE; newly diagnosed epileptic seizure in a general population. *Lancet* 1990; 336: 1267-70.
3. API Text Book of Medicine. API Bombay, 1992: 825.
4. Rayman R B - Sudden incapacitation inflight. *Aviat Space and Environ Med* 1993; 44: 953-55.
5. Sundaram PM. Syncope among aircrew evaluated at the USAF School of Aerospace Medicine. *Aerospace Med* 1969; 40: 1126-33.
6. Lamb LE, Green HC, Combs JJ, Cheeseman SA, Hammond J. Incidence of loss of consciousness in 1,980 Air Force Personnel. *Aerospace Med* 1960; 31: 973-78.
7. Musicco M, Beghi E, Bordo B, Viani F. A randomised clinical trial on the efficacy of anti epileptic drugs in reducing the risk of relapse after a first unprovoked tonic-clonic seizure. *Neurology* 1993; 43: 478-83.
8. Hart YM, Sanders JWAS, Johnson AL, Shorvon SD. For the NGPSE Recurrence after 1st seizure. *Lancet* 1990 : 336 : 1271-4.
9. Reynold KH. Do anti convulsants after the natural course of epilepsy? Treatment should be started as early as possible. *BMJ* 1995; 310: 176-8.
10. Commission on classification and terminology of the ILAE proposal for revised clinical classification of epilepsies and epileptic syndromes. *Epilepsia* 1989; 30: 3898.
11. Cockerall OC, Johnson AL, Sander JWAS, Hart YM, Shorvon SD. Remission of Epilepsy. *Lancet* 1995; 346: 140-5.
12. Shafer SG, Hauser WA, Annegers JF, Klass DN. EEG and other predictors of epilepsy remission - a community study. *Epilepsia* 1988; 29 : 590-600.
13. Perry C. Letter to Editor., *Aviat Space Environ Med.* 1993; 573.
14. Dermaskan G and Lamb LE. Cardiac arrhythmias in experimental syncope *JAMA* 1958; 168 : 1623-30.