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Analysis of case of Diabetes Mellitus amongst Commercial Civil Aircrew

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During the past 15 years (1969-1983), there have been 145 commercial civil aircrew in India in whom glucose intolerance was detected on one or more times. Of these, 40 aircrew (27.6%) were declared permanently unfit for all flying licences due to diabetes mellitus (DM) or impaired glucose tolerance (IGT) as per the new WHO criteria of classification of DM. In 17 of these cases (42.5%), there were also associated diseases like ischaemic heart disease (IHD), hypertension, lenticular opacities etc. 85 aircrew (58.6%) were able to resume flying duties after biochemical recovery, but 14 of them eventually became permanently unfit on account of IHD, hypertension, lenticular opacities etc. 20 aircrew (13.8%) did not report for review. Over 72% of the affected aircrew were in the age group of 41 to 55 yrs and about two-thirds of them had flying experience ranging between 5,000 and 20,000 hrs. Incidence was more among airline pilot licence holders and flight engineers.

This paper analyses the problem of carbohydrate intolerance among these aircrew with special emphasis on its aeromedical significance.

Introduction

In clinical practice, diseases are usully approached by both the doctor and the patient in a three-dimensional way, viz., from the angles of diagnosis, therapy and prognosis. However, in Civil Aviation Medicine there is a very significant fourth dimension —the cost factor; to the operator the loss of the services of an experienced aircrew and to the flyer himself his very means of livelihood. Aircrew belong to a highly select group which is under regular medical surveillance of a very high order. Diseases are often detected at a very early, usually are symptomatic stage in an apparently healthy individual. Relevant clinical history may at times be denied to the licensing medical examiner by the licence holder for fear of any unfavourable influence on the medical assessment. These factors pose special problems during medical evaluation.

Diabetes mellitus (DM) is known to be more pre-

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valent among the urbanised[14] and the affluent[4], and in India has a peak incidence in men[1] of the age group 45 to 55 years[13]. Over 50% of the diabetics are usually asymptomatic at the time of diagnosis[13] and in fact very expensive massive screening programmes will be required to identify all diabetics in a population. Considering that a majority of our professional civil aircrew, particularly the very experienced, belong to this epidemiologically vulnerable section of our population, this study was undertaken to evaluate the magnitude of the problem of carbohydrate intolerance among our commercial civil aircrew. Moreover, an earlier study[9] had indicated that among commercial civil aircrew in India, DM accounted for 22.4% of permanent medical unfitness and 28.9% of temporary unfitness for flying duties.

Materials and Methods

Medical records of all civil commercial flying licence holders, viz., airline pilots (ATPL), senior commercial pilots (SCPL), commercial pilots (CPL), commercial helicopter pilots (CHPL), flight engineers (FEL), flight navigators (FNL) and flight radio operators (FROL), for the 15 years period between 1969 and 1983 were scrutinised. Medical evaluation findings of all the aircrew who had revealed abnormal glucose tolerance at any time in this period were analysed regarding indications for evaluating the glucose metabolism, diagnosis compared to the currently practised WHO criteria[5,17] association of other diseases, relapses of glucose intolerance and final disposal regarding fitness for flying duties.

Observations

Between 1969 and 1983, a total of 2470 aircrew have been exercising the privileges of commercial civil flying licences at one time or another. Among them 145 licence holders were detected to have abnormal glucose tolerance on one or more occasions resulting in temporary or permanent denial of the renewal of their licences. Thus, the prevalence rate of diabetes mellitus among commercial civil aircrew in India is found to be 5.9%.

Licences : Table I compares the incidence of glucose intolerance among the various licence holders with the normal average distribution of the different licences at any given time during the period under study. It is seen that incidence of diabetes was significantly high among flight engineers, flight radio operators and airline pilots and to a lesser extent among the senior commercial pilots. The incidence was appreciably low among commercial pilots of both aeroplanes and helicopters.

Table I

Relative incidence of glucose intolerance among various commercial licence holders

Average normal distribution of Licences 1969 to '83 (n=2470) %	Licences	Aircrew with abnormal glucose tolerance (n=145) %
46	ATPL	63.4
8	SCPL	9.0
36	CPL	14.5
3	CHPL	0.7
5	FNL	4.1
1	FEL	5.5
1	FROL	2.8

Age : The age distribution of the aircrew at the initial diagnosis is shown in Table II. The age of onset ranged from 27 to 58 years (Mean age 44.4 years). 51.7% cases first developed glucose intolerance in the fourth decade of life and this incidence increased to 72.4% in the age group of 41 to 55 years.

Table II

Age Distribution (n=145)

Age (years)	No. of aircrew	%
<30	7	4.8
31 - 35	10	6.9
36 - 40	18	12.4
41 - 45	31	21.4
46 - 50	44	30.3
51 - 55	30	20.7
56 - 60	5	3.4

Sex : Among the 145 aircrew, there were 144 men and a lone woman airline pilot who at the age of 40 years was found to have impaired glucose

tolerance (IGT) following asymptomatic glycosuria during a routine medical evaluation. She was able to resume flying duties after 3 months when her glucose tolerance became normal.

Flying Experience : Table III indicates the flying experience of the aircrew at the initial diagnosis of glucose intolerance. About 67% cases had flying hours between 5,000 and 20,000 hrs.

Table III

Flying Experience (n = 145)

Flying hrs	No. of aircrew	%
<1,000	13	9.0
>1,000-5,000	17	11.7
>5,000-10,000	41	28.3
>10,000-20,000	56	38.6
>20,000	18	12.4

Indications for Blood Glucose Estimations : Blood sugar level (BSL) estimations or oral glucose tolerance tests (OGTT) are not being done routinely as part of the periodic medical evaluations for issue or renewal of civil flying licences. These are carried out only in cases of obesity, recent history of loss or gain of weight, family history of DM and whenever indicated by other clinical abnormalities like hypertension, ECG abnormalities, eye changes such as lenticular opacities and retinal exudates, etc. BSL estimations were done by modified Folin-Wu method on venous blood. For OGTT, the loading dose of glucose used to be 100 gms till the middle of 1982 and has since been reduced to 75 gms[17]. Indications for BSL/OGTT evaluations in the 145 cases are given in Table IV. Obesity, assessed clinically and by referring to standard height : weight charts, was the most common (46.2%) reason for BSL/OGTT evaluation. In 20% cases investigations for asymptomatic ECG abnormalities revealed the glucose intolerance. These ECG abnormalities were ST-T wave changes (76%), ectopics (17%) and heart blocks (7%). Glycosuria on routine urinalysis was present in 18.6%. Investigations following detection of hypertension and changes in the eyes (particularly presence of lenticular opacities and retinal

Table IV

Indications for BS/OGTT Evaluation

Indications	Aircrew (n=145)	
	No.	%
Obesity	67	46.2
ECG Abnormality	29	20.0
Glycosuria	27	18.6
Clinically Indicated	17	11.7
Hypertension	12	8.3
Eye Changes	11	7.6
Past History DM	8	5.5
Family History DM	2	1.4

exudates) in asymptomatic aircrew led to t detection of carbohydrate intolerance in abo 16% cases. In about 12% cases glucose toleran was evaluated for clinical conditions like hepat megaly, previous head injury, tremors, chronic health etc. Only about 5.5% cases gave history earlier diagnosis of DM. In 1.4% cases strong fami history of DM combined with obesity resulted in t detection of abnormal glucose tolerance.

Diagonsis : The diagnostic criteria laid down b World Health Organisation (WHO) in 1965[16] an the recommendations of International Civil Aviatio Organisation (ICAO) in 1974[7] were being follow for the classification of cases of abnormal glucos tolerance till October, 1982. Since then the WH criteria of 1980[17] have been accepted. These tw sets of diagnostic criteria are graphically compare in Fig. 1.

Table V compares the diagnostic classification the 145 civil commercial aircrew as per the earl and the current criteria. According to the previo criteria, almost 78% of the cases were diagnos as DM whereas this figure reduces to about 41 when the new criterion are applied. The cases Borderline Abnormality (now classified as Impair Glucose Tolerance—IGT) have increased from 16 to 50%. The few cases showing normal bloo

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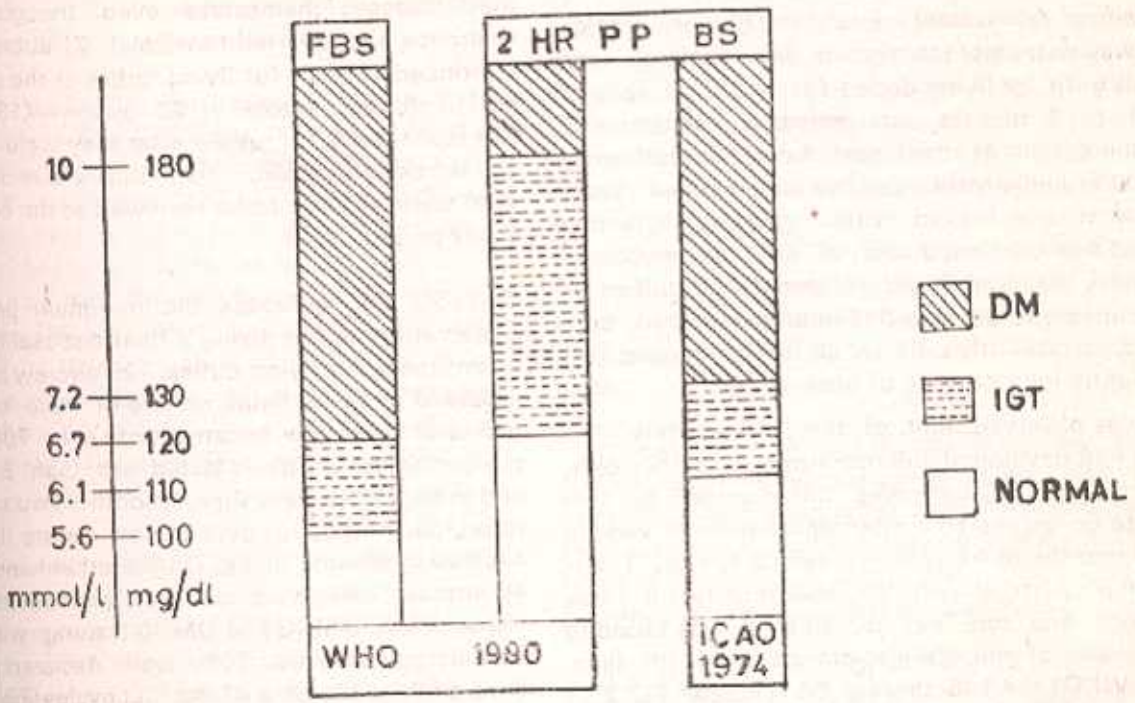

Fig. 1

Table V

Diagnosis in 145 Cases : Comparison of ICAO & WHO Criteria

Diagnosis	ICAO 1974		WHO 1980	
	Aircrew No.	%	Aircrew No.	%
DM	113	77.9	60	41.4
BL/IGT	23	15.9	73	50.3
NORMAL	9	6.2	12	8.3

DM = Diabetes mellitus
BL = Borderline Abnormality (ICAO 1974)
IGT = Impaired Glucose Tolerance (WHO 1980)

glucose levels as per both the criteria included individuals in whom either only the peak BSL was high or there was marked glycosuria with boderline BSL or BSLs were unusually low giving a 'flat curve' often suggesting undisclosed hypoglycaemic therapy. For all practical purposes this group of individuals could be considered to be cases of IGT as far as aero medical assessment is concerned. Thus, the 145 cases could be classified into 113 cases of DM (77.9%) and 32 cases of Borderline Abnormality (22.1%) as per the old criteria and 60 cases of DM (41.4%) and 85 cases of IGT (58.6%) according to the current diagnostic criteria respectively. However, since in both DM and IGT (or Borderline Abnormality) the aircrew had to be denied renewal of flying licences till the glucose tolerance returned to normal without the use of any drugs, the revised criteria do not indicate any unnecessary 'medical grounding' of aircrew in the past. The new criteria have the important merit of avoiding the label of "diabetic" in a large number of individuals thus minimising the psychological and social stigma associated with diabetes. This may be of tremendous significance particularly in the case of commercial flyers. Practically all the 60 cases of DM in this study were cases of Non-Insulin Dependent DM (NIDDM) judged from available data.

Analysing the BSLs during OGTT it is observed

that fasting blood glucose levels were within normal levels in about 50% cases, 2 hr post glucose BSLs were normal in 17.5% and peak BSLs were below 180 mg/dl in 15% cases.

Medical Assessment : Everytime glucose intolerance was detected, the aircrew was declared temporarily unfit for flying duties for a period ranging from 1 to 3 months and reviewed subsequently, with the details of treatment from the authorised medical attendant, till a finality was reached. Those aircrew who achieved normal glucose tolerance without the continued use of any hypoglycaemic drug were assessed fit to resume flying duties.[7,12] Those unable to achieve this requirement were considered permanently unfit for all flying licences after sufficiently long periods of observation.

It was observed that of the 145 aircrew, 119 (82%) had developed glucose intolerance once only, 18 aircrew (12.4%) showed the disorder on two separate occasions (the intervening periods varying from 6 months to 11 years—mean 3.4 yrs), 7 aircrew (4.8%) had shown the abnormality on three occasions and one aircrew (0.7%) was found to have relapse of glucose intolerance a fourth time. (Table VI) Of the 145 aircrew, 54 aircrew (37.2%) had been declared permanently unfit for all flying duties—23 (15.9%) due to DM/IGT, 17 (11.7%) due to DM/IGT and associated diseases like ischaemic heart disease (IHD), hypertension, lenticular opacities etc and 14 cases (9.6%) due to the associated diseases themselves even though glucose tolerance had reverted to normal. 71 aircrew (49%) continued to be fit for flying duties at the end of the period studied. A total of 20 aircrew (13.8%) did not report back for review after they were assessed as temporarily unfit; this includes 3 recent cases who were not due to be reviewed at the end of the study period.

Table VII indicates the maximum periods of observation before giving a final disposal of fitness or unfitness for flying duties. 120 aircrew had been assessed as fit for flying on one or more occasions (some of them later became unfit). In 70% cases the period of unfitness lasted less than 3 months and in 86% cases less than 6 months. Two cases had to be followed up for over 2 years before they were allowed to resume flying. On the other hand, of the 40 aircrew who were declared permanently unfit either due to DM/IGT or DM/IGT along with other associated diseases, 20% were declared permanently unfit at the time of the first evaluation though about 57% of cases were followed up for >3 to 18 months.

Table VI

Summary of Medical Assessment
(n — 145)

No. of Times fresh Diagnosis of DM/IGT was made	No. of Aircrew	Final Assessment		
		Perm. Unfit	Fit	Not Reviewed
1	119	46	55	18
2	18	5	11	2
3	7	2	5	—
4	1	1	—	—
Total	145	54*	71	20

* Include 23 cases of DM/IGT, 17 cases of DM/IGT + IHD, hypertension, lenticular opacities etc. and 14 cases of IHD, hypertension, lenticular opacities etc. but after glucose tolerance had returned to normal.

Table VII

Cases of DM/IGT: Period of Observation before Final Assessment

Aircrew Declared Fit (%)	Period of Observation (Months)	Aircrew Declared Perm. Unfit (%)
—	Nil	20.0
70.0	up to 3	15.0
16.0	>3-6	17.5
6.5	>6-12	22.5
5.7	>12-18	17.5
0	>18-24	2.5
0.8	>24-30	2.5
0.8	>30	2.5
n — 120 Medical Evaluations		n — 40 Medical Evaluations

Diseases associated with DM: Clinical detection of certain cardiovascular and other conditions had in fact resulted in the search for and detection of DM (Table IV). Important among these conditions were obesity, IHD, hypertension and lenticular opacities resulting in substandard vision.

Obesity, known to be associated with DM,[8,9] was clinically evident in over 46% of cases. Body mass index (BMI = weight in Kg ÷ (Height in m)^2), values >25 in men and >27 in women indicating obesity, has been found to be a reliable method of assessing obesity and its prognostic significance in IGT.[8,11,12] Analysing the 145 cases, it is seen that 53 aircrew (36.5%) were obese as per BMI. In about 58% of them reduction of body weight alone resulted in normalisation of glucose tolerance. Among them 83% were cases of IGT. In those in whom weight reduction was not beneficial 67% were cases of DM.

ECG abnormalities (20%) and hypertension (12%) detected in some asymptomatic aircrew had on further investigations resulted in the detection of abnormal glucose tolerance (Table IV). In 17 cases of DM/IGT who became permanently unfit for all flying licences, there were associated diseases like IHD (10 cases) and hypertension (6 cases). The non-specific ECG abnormalities such as ST-T changes and ectopics detected in a few cases of abnormal glucose tolerance disappeared in most of the cases with improvement of glucose tolerance.

In 14 cases of DM/IGT, glucose tolerance had been normalised following diet and drug therapy but development of diseases like IHD (6 cases), hypertension (2 cases) and lenticular opacities (4 cases), resulted in permanent unfitness for flying duties.

Bio-chemical investigations such as blood levels of cholesterol, urea and uric acid and routine haematological investigations did not reveal any significant abnormality in any of these cases.

Aero Medical Significance of DM

ICAO medical requirements for commercial flying licences preclude cases of metabolic, nutritional or endocrine disorders likely to interfere with the safe exercise of the privileges of the licences. Proven cases of DM shown to be satisfactorily controlled without the use of any anti-diabetic drug may be considered fit.[12]

As far as safe operation of an aircraft is concerned, hypoglycaemia is of more immediate dangerous consequences than hyperglycaemia. Hypoglycaemia may occur in IGT or in diabetics under drug therapy. In IGT, glucose concentrations are elevated during the initial several hours after a meal and may fall to abnormally low levels after 3 to 5 hours. This pattern may be caused by a delay in insulin secretion, with the late peak causing hypoglycaemia at a time when no more carbohydrate is entering the circulation from the gastrointestinal tract.[6] In diabetics under medication, hypoglycaemia results from overdose of antidiabetic drugs or from skipping of meals.

Diabetes is a serious metabolic disease causing considerable morbidity. Hyperglycaemia and atherosclerorosis are associated and thus a diabetic is more prone to myocardial ischaemia, cerebral thrombosis and infarction and hypertension. These can become causes of sudden incapacitation in flight.

The following two brief case reports from our medical records highlight the flight safety problem posed by diabetes :

(a) BNM, a 47 yrs old airline pilot with 4850 hrs of flying experience was flying a HS-748 aircraft on a routine domestic passenger flight when he suddenly lost control of the aircraft. The co-pilot was able to take over in time and avoid any disaster. The pilot was sent for a special medical examination. He had been noted to be underweight during the previous medical examinations but no cause could be established. However, this time an oral glucose tolerance test (OGTT) revealed that he was a moderately severe diabetic. After a period of follow up he was declared permanently unfit for all flying licences as his diabetic state could not be controlled without drugs.

(b) BPB, a 46 years old airline pilot flying on international routes was detected to have an abnormal glucose tolerance associated with obesity during a routine medical evaluation. After 3 months he was reviewed and his OGTT was found to be normal as he had reduced 9 Kg of body weight. He was cleared for flying. However, he started taking oral

hypoglycaemics on his own and later switched over to an Ayurvedic drug. Ultimately, more than 2 years later while on a flight from London to New York he developed grand mal seizures just before approaching New York. The co-pilot was able to land the aircraft safely. Subsequent investigations however revealed that the clandestine self medication with the Ayurvedic drug which had a high lead content had resulted in lead encephalopathy[19]. The pilot was able to resume flying duties after prolonged observation.

An aircrew may be having clinically undetected glucose intolerance or he may be taking hypoglycaemic drugs on the quiet—both situations can be potentially hazardous to air safety. The fact that early detection of DM during the mandatory periodic medical evaluations helps in prevention of long term morbidity and mortality due to DM and associated cardiovascular diseases must be fully realised by the aircrew. By minimising the period of noneffectiveness with the help of judicious application of modern diagnostic and therapeutic regimes, the confidence and morale of aircrew found to have glucose intolerance can be built up. Every time an aircrew is detected to have DM or IGT, the full aero medical implications of the disorder must be explained to him by the licensing medical examiner as well as the authorised medical attendant so that a comprehensive plan of action can be worked out to minimise the period of non-effectiveness.

Conclusions

During the 15 years between 1969 and 1983, of a total of 2470 commercial flying licence holders 145 (5.9%) were detected to have abnormal glucose tolerance—60 were cases of DM and 85 of IGT. A total of 40 aircrew (1.6%) were declared permanently unfit for all flying licences due to DM/IGT either alone or in combination with other diseases such as IHD, hypertension and lenticular opacities. 49% of the aircrew detected to have glucose intolerance were assessed fit for flying within six months of the initial detection of the abnormality. Obesity was present in about 46% cases. In 83% cases of IGT associated with obesity, reduction of body weight resulted in normalisation of glucose metabolism. Since the incidence of DM is more among the older and experienced aircrew the cost factor involved due to their non-effectiveness may be significant. Self medication particularly with indigenous medicines poses a serious threat to air sa
Proper indoctrination of aircrew is important in
comprehensive medical programme aimed at m
mising the morbidity caused by glucose intoler
among them.

References

1. Aigaonkar SS : The problem of treatment of diabetes in tropics. In Diab Proc Seventh Cong International Diabe Fed Excerpta Medica, Amsterdam-1971, p 832.
2. Baird JD : In Davidson's Principles and Practice of Me cine 13th Edition. Ed J Macleod ELBS and Churchill Livi stone-1981, p 502.
3. Birmingham Diabetes Survey Working Party. Ten y follow-up report on Birmingham Diabetes Survey of 19 Br Med J 2 : 35, 1976.
4. Datt SP, Singh Verma NP, Gopalakrishnan R and Ghe BN : Survey of diabetes mellitus in Pondicherry. In P World Cong Diab Trop 1968, p 33.
5. Davidson MB : In Diabetes Mellitus Diagnosis and Tre ment. John Wiley and sons, New York, 1981, P 460.
6. Foster DW : Diabets mellitus in Harrison's Principles Internal Medicine 10th Ed Mc Graw Hill International Boo Co. New York, 1983, p 661.
7. ICAO : Manual of Civil Aviation Medicine 1st Edition 197 II-4-1.
8. National Diabetes Data Group. Classification and diagnos of diabetes mellitus and other categories of glucose intole ance. Diabetes 28 : 1039, 1979.
9. Nayar GS : Analysis of disability pattern among commerci civil aircrew in India. Aviation Medicine 27(1) : 25, 1983.
10. Nayar GS : An unusal cause of sudden incapacitation i flight : a case report. Journal of Aviation Medical Exam ners 1 : Suppl, 1983.
11. O'Sullivan JB and Mahan CM : Prospective study of 35 young patients with chemical diabetes. N Eng J Med 27 1038, 1968.
12. Personnel Licensing—Annex 1 to the Convention on Inte national Civil Aviation 7th Edition, 1982.
13. Vaishnava H : Diabetes mellitus. In API Text Book o Medicine 3rd Edition vol I, 1979, p 252.
14. Viswanathan M, Moses SGP and Krishnamurthy M : Preva ence of diabetes in Madras. In Proc World Cong Diabete in the Tropics, Diabetic Assoc India, Bombay, 1968, p 23
15. West KM : In Epidemiology of Diabetes and its Vascula Lesions. New York : Elsevier—North—Holland, 1978.
16. WHO Technical Report series No. 310, Diabetes mellitus Report of a WHO Expert Committee, WHO 1965.
17. WHO Technical Report series No. 646. WHO Expert Committee on Diabetes Mellitus Second Report, Geneva, WHO 1980.