

The Periodic Medical Examination in the Republic of Singapore Air Force-A Review

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Abstract

Aeromedical Examinations (AMEs) have been done in the Republic of Singapore Air Force (RSAF) since its beginning for licensing and monitoring health status of essential personnel. The rapid progress in scientific advances and medical costs of recent years prompted a re-evaluation of the AME as a preventive tool, both in accident prevention and health promotion. A retrospective cohort study of 233 males spanning the time they joined the Air Force until 1990 was done and a descriptive analysis of the cohort with the incidence rate of cases picked up during this period was used as an indicator of usefulness of the AME. In the follow-up period of 2997 person-years, a small number of cases were picked up which resulted in two pilots being grounded permanently. Most procedures were found to be useful to varying extent except the routine chest X-rays which was found to be ineffective. Trends of biodata resulting from serial examinations are useful in planning and evaluation of intervention and health education programme, but only if the baseline measurements are accurate, hence quality control at all stages is important. The AME can be an effective tool for prevention if designed appropriately. Screening tests included must be scientific and the logic for selecting tests must be convincing. Most importantly, it is suggested that a clear and detailed medical history is the most useful component for early detection of problems. This is facilitated by a strong bond and rapport between doctors and subjects to ensure that the information is forthcoming and honest.

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Introduction

Aircraft accidents more often than not have dramatic and catastrophic consequences and hence flight safety is paramount in the flying environment. The key people in any air force or airline are pilots and personnel directly involved in flying-related activities. This group is usually implicated in aircraft mishaps and it is therefore important that these operators are healthy, ready and able to fulfil their roles. Aviation training is an expensive business. It follows that both selection and employment standards for the physical and psychological conditions be such that investments in aviation training will produce quality and long-term employment without compromising flight safety.

Since the formation of the Republic of Singapore Air Force (RSAF) in 1968, Aeromedical Examinations (AMEs) have been conducted on an annual basis. All pilots, navigators, air traffic controllers and their assistants have to clear the AME before they can continue in their vocation. The emphasis was on early detection of any conditions that may lead to flight safety compromises. The AME has since evolved. By the 1983/1984 period, the AME functions both as a licensing examina-

tion as well as a periodic medical examination with emphasis on preventive health as well as health promotion. This is a descriptive retrospective cohort study of the AMEs for the period from 1984 to 1990, to ascertain the AME's usefulness in its dual role.

Materials and Method

Aeromedical examination records from the start were kept in two different media and places. The earlier records were filed in the individual's medical documents and hence dispersed RSAF wide. The more recent records were held in the Aeromedical Centre's AME computer database. The population in the 1990 database was selected as the cohort. This was to ensure that the subjects' were still in service and hence their records available to the RSAF at the end of the study. Females formed a small proportion and were excluded to minimise confounding. Records from 1984 to 1990 were sorted by identity card numbers and names. Due to operational constraints some did their medicals twice in the same calendar year and none the next. To minimise shifts in the denominator and confounding, only persons represented in each calendar year (defined as from 1 January to 31 December of the year) in the study period

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were short-listed and entered into the study. Those with multiple erroneous or incomplete entries were rejected as they can give misleading results. From the final list, the cohort's pre-employment medical records were traced manually. The final cohort of 233 males consists of 155 pilots and 78 non-pilots. The data from the 1984 to 1990 period were re-sorted into their different years.

From this final cohort, their original pre-employment medical examination records were traced to allow an appreciation of their basic biodata upon admission into the system. In the search, only 41 records of the 78 persons in the non-pilot group were traceable. As the study was for the period of 1984 to 1990 for which records were complete, it was decided that the non-pilot group would remain at 78 rather than eliminate those whose pre-employment data is not available. Also as the pre-employment examination standards would have imposed a threshold on the group, it would be expected that the entry point data would be fairly homogenous and that they had zero medical conditions that would qualify them as cases in the study. The homogeneity of their biodata is seen in the similarity between the two groups of pilots and non-pilots as the "initial" data. Hence for the non-pilot group, their "initial" data would be based on 41 records.

Case Definition

A case is defined as any subject with a new medical condition, or clinical diagnosis or an investigation recording or measurement that warrants attention (or follow up). The conditions picked up need not be a disease or abnormality or have any direct bearing or consequences on the outcome of the person's employment. However, it would need to have implications on the aeromedical management of the subject.

Treatment of Data

The AME records and codes 80 medical conditions. These had been regrouped into 17 broad categories. Electrocardiograph findings and diagnoses were also similarly summarised. The raw numbers in each year reflect the incidence rate. To achieve this, during data cleaning, conditions that were deemed to be chronic, for example sensori-neural hearing loss or diabetes, were entered at the time of diagnosis. Episodic conditions such as fractures were recorded as different occurrences. For the less clear-cut cases, judgement was exercised as whether or not the condition should be included the next year. When there were doubts, the actual notes were traced and checked as far as possible.

The eye examination data were limited to visual acuity (VA) according to the standard back lit Snellen. The range of measurements is summarised into 3 groups. Normal VA was defined as those with 6/9 and less. Those with VA of 6/12 to 6/18 were defined as mildly

myopic. Moderate and severe myopia for this study were considered together in a group whose VA was worse than 6/24. The VA data reflect prevalence.

Results

On enlistment (Tables Ia & Ib), the mean ages of 155 pilots and 41 non-pilots (the number with available data) were 19.3 and 19.7 years, respectively. The mean height for both groups was 1.70 m and pilots seem to be heavier at 58.8 kg compared to 55.4 kg during enlistment. Otherwise the two groups were similar.

There were no significant medical conditions picked up on enlistment for both groups, nor were there any in the chest X-ray and laboratory investigations. The electrocardiograph records showed 3 cases of arrhythmia, 2 cases of indeterminate axis and 1 case of partial right bundle branch block in the pilot group.

The Period from 1984 to 1990

By 1984, the pilot group of 155 pilots has clocked 1021 person years. The 41 other persons whose records could be traced clocked a total of 345 person years. Hence the cohort has a total of 1366 person years. The mean age for pilots was 26.3 years and for non-pilots was 27.6 years and the average number of years from enlistment was 7 and 8, respectively (Tables Ia & Ib). Weight increases for both groups since enlistment and the cohort's percentage body fat showed similar patterns between the two groups through the years except for the last year (1990) where there was a significant drop in percentage body fat in both groups.

Visual acuity consistently deteriorated in both groups,

TABLE Ia: BASIC CLINICAL DATA OF 155 PILOTS ON ENLISTMENT FROM 1984 TO 1990

	Initial (SD)	1984 (SD)	1990 (SD)
Age(y)	19.3 (3.0)	26.3 (4.7)	32.4 (4.8)
Height(m)	1.70 (0.1)	1.70 (0.1)	1.73 (0.1)
Weight (kg)	58.8 (7.0)	65.3 (8.3)	68.1 (8.3)
% Body Fat	—	19.3 (6.2)	18.4 (3.9)
BP Systolic (mmHg)	125 (11.3)	121 (10.3)	116 (8.7)
BP Diastolic (mmHg)	76.0 (6.8)	72.0 (9.6)	74.8 (7.9)

SD: standard deviation; BP: blood pressure

TABLE Ib: BASIC CLINICAL DATA OF 41 NON-PILOTS ON ENLISTMENT FROM 1984 TO 1990

	Initial (SD)	1984 (SD)	1990 (SD)
Age(y)	19.7 (3.4)	27.6 (6.5)	33.6 (6.5)
Height(m)	1.70 (0.1)	1.70 (0.1)	1.71 (0.1)
Weight (kg)	55.4 (7.6)	64.4 (9.4)	68.1 (9.7)
% Body Fat	—	20.3 (7.0)	19.1 (5.5)
BP Systolic (mmHg)	120 (11.2)	120 (8.3)	117 (9.1)
BP Diastolic (mmHg)	74 (6.2)	73 (10)	75.3 (8.6)

SD: standard deviation; BP: blood pressure

more markedly in the non-pilot group. The sharpest decline occurred in the period between enlistment and 1984. Pilots who started off with a 98.6% normal VA had only 84% by 1990—a decrease of 14.6% (Table II). The non-pilots on the other hand for the similar period had a deterioration of 21%. The non-pilots as a group not only had a steeper rate of deterioration in VA at least in the interval between the initial examination and 1984, but there also seemed to have a larger proportion with VA3 as well, compared to the pilot group.

Medical Conditions

Yearly incidence rates of the cohort's medical conditions diagnosed for the period (Table III) averaged 143 cases per 1000 person years. The overall rates for the period from 1984 to 1987 were between 24 to 34 cases per 1000 person years. This contrasted with the last 3 years of follow-up period where the rates were 7 to 9 per 1000 person years. The possible explanations will be dealt with in the discussion.

The "Non specific" category is the most commonly occurring in the cohort. In pilots (Table IV), the next most common conditions diagnosed are ear, nose and

TABLE II: VISUAL ACUITY DISTRIBUTION OF PILOTS AND NON-PILOTS

	Pilots			Non-pilots		
	VA1	VA2	VA3	VA1	VA2	VA3
INITIAL	98.6	1	— *	95	5	~ *
1984	95	4	1	81	5	14
1985	94	3	3	81	8	11
1986	93	2	5	85	5	10
1987	88	6	6	79	10	11
1988	89	4	4	77	8	15
1989	89	4	7	77	9	14
1990	84	11	5	74	9	17

* The size of the initial non-pilot group is 41.

All values are expressed as a percentage of each groups' population.

VA1: visual acuity better than 6/9; VA2: visual acuity between 6/12 to 6/18; VA3: visual acuity 6/24 and worse.

TABLE III: YEARLY INCIDENCE OF MEDICAL CONDITIONS DIAGNOSED IN 155 PILOTS AND 78 NON-PILOTS FOR THE PERIOD FROM 1984 TO 1990

Year	Pilots*	Non-pilots**	Total†
1984	28.6 (31)	44.0 (24)	33.7 (55)
1985	29.5 (32)	23.8 (13)	27.6 (45)
1986	30.4 (33)	36.6 (20)	32.5 (53)
1987	27.6 (30)	16.5 (9)	23.9 (39)
1988	10.1 (11)	7.30 (4)	9.20 (15)
1989	3.70 (4)	14.7 (8)	7.40 (12)
1990	11.1 (12)	5.50 (3)	9.20 (15)
Total	141 (153)	148.4 (81)	143.5 (234)

() represents raw data

*, **, † Incidence rates expressed as per 1000 person years

throat (ENT) cases followed by cases with spinal conditions. For ENT, there was a total of 4 sinusitis cases, 2 mild hearing deficits picked up on audiometry and 2 sinus barotrauma. The rest of the cases were mainly vasomotor rhinitis and tonsillitis. In the category of "spinal" conditions, half were spondylolysis or spondylolisthesis with 1 case of prolapsed intervertebral disc. There were 10 cases of hepatitis B carrier picked up on screening and a case of peptic ulcer disease. These were main contributors to the 15 cases in the gastrointestinal group. Within the pilot group, a few significant cases were diagnosed. One pilot was found to have glycosuria on routine urine lab stick and the final diagnosis was insulin-dependent diabetes mellitus. Another pilot was found to have cervical lymphadenopathy in 1987 and investigations and biopsy showed early nasopharyngeal carcinoma. A third was diagnosed to have a giant cell tumour of the sacrum in 1988 initially on suspicious radiological findings (the air force does a one-off full spinal radiological study for all pilots as a baseline, although in this case it was not strictly routine as he had concurrent backache attributed to spondylolisthesis). The rest of the medical conditions of significance were cases of hypertension (2 cases), hyperthyroidism (3 cases), ankylosing spondylolysis (1 case), thalassaemia minor (2 cases) and gout (1 case).

In the non-pilot group (Table V), gastrointestinal and musculoskeletal conditions top the list. In this group, gastrointestinal problems included a case of peptic ulcer disease picked up on history and subsequent investigations. The rest were due to gastritis and non specific GIT

TABLE IV: FREQUENCY OF MEDICAL CONDITIONS DIAGNOSED FOR THE PERIOD FROM 1984 TO 1990 FOR 155 PILOTS*

No.	Condition	Incidence rates
1	Others/non specific	24.0 (26)
2	Ear, Nose and Throat	22.1 (24)
3	Spinal	16.6 (18)
4	Gastrointestinal	13.8 (15)
5	Musculoskeletal	12.0 (13)
6	Immunological	11.1 (12)
7	Central Nervous System	7.4 (8)
8	Haematological	5.5 (6)
9	Endocrine	4.6 (5)
10	Eye	4.6 (5)
11	Vascular	3.7 (4)
12	Skin	3.7 (4)
13	Metabolic	3.7 (4)
14	Cardiovascular	2.8 (3)
15	Renal	2.8 (3)
16	Respiratory	1.8 (2)
17	Infections	0.9 (1)
Total		141 (153)

* All incidence rates are expressed as numbers per 1000 person years

() Raw data

complaints. Of significance in the other medical condition groupings were findings of migraine in 2 cases and 2 cases of hearing loss one of which was severe. As expected, the ENT problems in this group were more due to tonsillitis and vasomotor rhinitis than sinusitis or barotrauma as in the pilot group.

Electrocardiograph (ECG)

The overall incidence rate for the cohort was 61 cases per 1000 person years (Table VI). The rate for 1984 was higher than most years mainly from the pilots. A third of the rates picked up in the pilots were diagnosed as partial Right Bundle Branch Blocks (RBBB) and another third attributed to sinus arrhythmias. Otherwise the incidence ranged between 5 and 11 per 1000 person years. The most common finding was arrhythmia (Table VII), followed by RBBB of which only one case was a complete RBBB; the rest were read as partial blocks. Two cases of Wolff-Parkinson-White Syndrome were

picked up. Both were asymptomatic.

Chest X-Rays

The incidence rates for chest X-ray were 16 and 10.7 per 1000 person years for pilots and non-pilots respectively or a total of 20 cases in the entire period. Of these, mild thoracic scoliosis was the dominant finding making up 67% of the total diagnosis for pilots and 80% for non-pilots. In pilots there was one case of pulmonary scarring due to either old tuberculosis or infection. The other diagnoses were bony islands and old fracture of ribs. There was no pick up for tuberculosis or for carcinoma in this study.

Discussion

The aim of this study was to evaluate the effectiveness of the AMEs as a preventive tool. Here, the term preventive tool comprises two components which are not mutually exclusive. The first relates to preventive medicine, in how the AME can hope to detect early disease so as to enable effective intervention to minimise health deterioration and maximise health promotion. The second component, if not more crucial in the air force view than the first, is related to flight safety and accident prevention. Here the AME is used to help detect early, not just diseases but any pertinent departures from normal (which in themselves may not constitute a disease state) and trends that may compromise flight safety or the future health of the group. This latter concern therefore leads to a tendency to be more sensitive to slight departures from normal than would the normal medical practice. Hence, what the usual practitioner may pass off as acceptable may be given emphasis by the Aeromedical Centre. For example, the detection of a 0.5 dioptre myopia in normal practice does not need correcting in most cases, but in the air force this requires correction in case of the pilot and he would need to wear glasses when on flying duties.

TABLE V: FREQUENCY OF MEDICAL CONDITIONS DIAGNOSED FOR THE PERIOD FROM 1984 TO 1990 FOR 78 NON-PILOTS *

NO.	Condition	Incidence rates
1	Others/Non Specific	25.6 (14)
2	Gastrointestinal	20.1 (11)
3	Musculoskeletal	14.7 (8)
4	Renal	14.7 (8)
5	Ear, Nose and Throat	12.8 (7)
6	Eye	12.8 (7)
7	Spinal	12.8 (7)
8	Vascular	12.8 (7)
9	Haematological	5.5 (3)
10	Immunological	3.7 (2)
11	Cardiovascular	3.7 (2)
12	Endocrine	3.7 (2)
13	Central Nervous System	1.8 (1)
14	Respiratory	1.8 (1)
15	Skin	1.8 (1)
Total		148.4 (81)

* All incidence rates are expressed as numbers per 1000 person years
() Raw data

TABLE VI: YEARLY INCIDENCE OF ELECTROCARDIOGRAPH DIAGNOSIS FOR 155 PILOTS AND 78 NON-PILOTS

Year	Pilots	Non-pilots	Total
1984	23 (25)	12.8 (7)	19.6 (32)
1985	4.6 (5)	5.5 (3)	4.9 (8)
1986	7.4 (8)	0	4.9 (8)
1987	a.3 (9)	5.5 (3)	7.4 (12)
1988	12.9 (14)	7.3 (4)	11.0 (18)
1989	7.4 (8)	7.3 (4)	7.4 (12)
1990	7.4 (8)	3.7 (2)	6.1 (10)
TOTAL	71 (77)	42.1 (23)	61.3(100)

() Values in parenthesis represent raw data. All incidence rates are expressed as per 1000 person years

TABLE VII: INCIDENCE OF ELECTROCARDIOGRAPH (ECG) DIAGNOSIS MADE FOR 155 PILOTS AND 78 NON-PILOTS DURING THE PERIOD FROM 1984 TO 1990*

Diagnosis	Pilots	Non-pilots	Total
Arrhythmias	33.3 (36)	25.5 (14)	30.6 (50)
Right Bundle Branch Block**	18.4 (20)	5.5 (3)	14.1 (23)
Inter Ventricular Conduction Defects	4.6 (5)	1.8 (1)	3.7 (6)
1° Heart Block	1.8 (2)	1.8 (1)	1.8 (3)
Wolff-Parkinson-White	1.8 (2)	0	1.2 (2)
Nodal Escapes	1.8 (2)	0	1.2 (2)
Axis Deviations	1.8 (2)	0	1.2 (2)
ST/T waves	3.7 (4)	1.8 (1)	3.1 (5)
Others	3.7 (4)	5.5 (3)	4.3 (7)

() Raw values

* All rates are expressed as number per 1000 person years

** Includes both partial and complete Block.

Trends

A series of observations over time gives more information than an isolated value. The results of isolated medical examination or screening have limited value especially when the results are “within normal limits”. In a closely monitored population such as this, biodata trend is available and is useful. Trends are used as indicators for health monitoring, planning, evaluation and management of health promotion programme.

Weight and Body Fat

The initial weights on enlistment for the pilot and the non-pilot groups were different but not statistically significant (pilots: 95% confidence interval (CI) 57.7 to 59.9 kg and non-pilots: 95% CI 53 to 57.8 kg). However, this difference narrowed through the years and by 1990 has become virtually nil. There was a sharp drop in body fat percentage for both groups in the last year of observation (1990), after a rising trend and despite rising weight is interesting. This sudden and significant drop compared with the preceding four years could be due to a few factors. One obvious explanation could be observer error. Another possibility could be that the drop reflects a true decrease in the body fat and that the increase in weight is due to increase in muscle mass. The Singapore Armed Forces earlier noted a trend in declining general fitness in the personnel indicated by the results from the Individual Physical Performance Tests (IPPT), and in 1987 to 1988 period, the Ministry of Defence (MINDEF) introduced measures against those who cannot pass their IPPT. This may have contributed to the sharp drop in body fat as a result of the increase pursuit of physical fitness.

Visual Acuity

The trend for the cohort was one of consistent deterioration of VA with age (Table II). The first precipitous drop in the year 1984 in the non-pilot group may be due to biases. Bias for this group could be in the enlistment data as only 53% of the total group were represented in the initial statistics (having only 41 of the 78 files available) and this could contribute to the magnitude of the differences observed. Observer errors or bias due to the test may also contribute to this difference but these alone may be insufficient to account for the large drop. Furthermore, the same group of medical orderlies would be doing the VA testing for the pilots in the same period and we would expect a similar plunge but none was seen in the pilot group. The change could therefore on the other hand be due to other reasons. It is postulated that with age, persons get more myopic and this stabilises at the age of 25 to 30 years.¹ However, this does not explain the difference between the non-pilot and pilot groups. Hence, it is also possible that the pilot group may be different in constitution with respect to their VA. Research in this area may be warranted if we could

minimise bias by re-evaluating series with a much larger group and tracing all the results.

Medical Conditions

The accuracy of assessing the incidence rate of cases was limited. These limitations were linked to the way the data were being coded and recorded. Due to this, it was difficult to assess if a diagnosis constituted a case as defined. It would have been more accurate to use the International Disease Coding system, though tedious. As it stands now, the diseases were already sub-grouped. For example, persons with recurrent headaches or migraines were classified under the same disease coding. Although both conditions qualify as cases, the Aviation Medical Practitioner would be interested to follow up either the pilot or Air Operations and Communications Officer (AOCO) with recurrent headaches, but the degree of interest would differ. Collapsing data also resulted in a large group classified as the “Others or Non Specific” group which may have significance. The numbers therefore cannot distinguish rates between diagnosis within a group and this was a severe limitation to the quality of the data. In order to distinguish one has to re-look into all the notes.

A second major limitation was in the decision as to whether a condition warrants attention or follow up which subsequently determines if it was coded and captured as a case. Different national service (NS) medical officers (broad guidelines are provided) tend to take differing attitudes towards this. Hence, one doctor may feel that a condition like recurrent headache may not be significant whilst another may decide to follow up. This difference in professional opinion is evident in Table III, where there was a sharp drop in the overall (total) rates in 1988 from 1987. The reason for this was due probably to a change in policy in that the active NS medical officers would screen all cases and only highlight problematic cases to the aviation medical specialists. Previously, all cases were screened by the aviation medical specialists before the cases were cleared. Naturally, due to the difference in training of the junior NS medical officers and the aviation medical specialists, emphasis and perspective of the conditions found would differ and could possibly account for the data observed. However, there is always a possibility that there was a true decrease in incidence since the cohort was constant, but it is the opinion of the author that the former reason seems more plausible.

The bulk of the conditions was picked up based on the history of some complaints in the past. This is important because if a good medical history was not asked and the personnel was simply put through the tests and physical examinations, the condition may not be highlighted and we would be in the dark as to the total health picture of the personnel. Hence, a careful and inclusive health

history is a very important tool to help detect potential health problems.² The detection of the diabetes mellitus case on “routine” urine lab stick testing, the nasopharyngeal carcinoma case and cases of thalassaemia, hypertension and those with electrocardiograph abnormalities such as Wolff-Parkinson-White Syndrome resulted from a combination of history and subsequent follow up and not necessarily picked up on the actual day of the AME. However, even with these limitations there is value in that the data can be used to support the health education of pilots. For example, the predominance of ENT problems in the pilot category (73% higher in incidence rate than non-pilot group) was not unexpected to the Aeromedical Centre. Due to the nature of their job, pilots are more predisposed to barotrauma and consequent sinusitis or vice versa, especially when they persist in flying even with a mild upper respiratory tract infection or even just mild rhinorrhoea. This is an important finding to emphasise to the pilots that they should not fly with those symptoms.

Electrocardiography

The total electrocardiograph (ECG) pick up rate for this study was 60 per 1000 person-years. Of these, 17% of the diagnosis were of significance to aviation medical practice. The ECG as a routine screening for apparently healthy persons is not recommended by the Canadian Task Force group.³ Similarly another study,⁴ concluded that the ECG should not be used in screening men without evidence of cardiac diseases or cardiovascular risk factors in particular for the purpose of predicting cardiac disease. In the Royal Air Force (RAF) and the Civil Aviation Authority (CAA) in the United Kingdom, ECGs are done during periodic medical examinations according to a set schedule,^{5,6} in which the interval between ECG recordings decreases as one grows older. The United States Air Force (USAF) on the other hand does an annual ECG for their flying personnel.² It is obvious that there are widely differing views on whether to do the ECG and its periodicity if it is to be done. Though this study indicates that the pick up rate is small, there are cases which are important to detect early, for example the case of pre-excitation syndrome or the cases of ventricular premature beats which otherwise would have remained undetected. Some of these conditions have a bearing on flight safety particularly in pilots of high performance aircraft. A prolonged arrhythmia during flight in a high speed aircraft can have disastrous consequences. Even though ECG tends to vary very little normally, kept over the years, trends can be compared and changes found on comparison can be significant.⁷ A mild left axis deviation in itself may not be significant, but if there is a progressive swing from an originally right axis through time, this may indicate an early problem and further investigations may be neces-

sary. For these reasons, the author is inclined towards the USAF practice and would advocate the current practice.

Chest X-Ray

The chest X-ray (CXR) in the 14 years of follow up of the cohort scored nil for either carcinoma or active lung diseases like pulmonary tuberculosis (PTB). When all CXR records for the RSAF were traced, there were a few positives for scarring due to old PTB. However, there was no active PTB picked up during this period of follow up. The USAF only does a pre-employment CXR as a baseline. They do not do periodic CXR. The RAF and CAA have a schedule detailed according to age.^{5,6} In the clinical sectors, most authorities do not do routine CXR,⁸ nor is it recommended by the Canadian Task Force or the US Preventive Services Task Force.⁹ The Mayo Clinic however, in one study,¹⁰ suggests that the CXR may be more effective in picking up early stage carcinoma of the lung than previously thought. However, others disagree that the CXR is the modality for screening of lung carcinoma as there is no difference in mortality rates, with other modes and hence the CXR cannot be considered to be better.¹¹

In 1988 the incidence rate of PTB in Singapore was 58 per 100 000 which is low. The age group relevant to the study group, had an incidence rate of 40 to 49 per 100 000. This rose sharply in the older than 40 group in which the incidence was 100 per 100 000.¹² Hence, it is not surprising that the pick up of active cases of PTB is nil in the study and in the population undergoing AME. In view of the above and the lack of significant cases in this study, the CXR is a tool that needs review both as a routine screening procedure as well as in the periodicity.

Laboratory Tests

Although no data were highlighted for this, the two routine tests done were the test for haemoglobin (Hb) level and the routine urine lab stick which have produced results indirectly in the form of diagnosis of cases of thalassaemia and glycosuria, and diabetes. These are simple and relatively inexpensive procedures. The Hb test is an important test to do irrespective of whether there are abnormalities, due to the requirement to maintain a minimum level which is higher than the general population. This has relevance in flying high performance aircraft. Hence these will continue to be used.

Costs

The estimate in 1991 by the Finance division in MINDEF is that the entire AMEs cost the RSAF S\$135 per person. This works out to S\$31,455 for the cohort per year. For 14 years of AMEs the total cost would be S\$440,000. A CXR was priced at S\$20 per large film. In terms of training, it is estimated that the RSAF spends

a million dollars to train one basic qualified pilot. Similarly it is not cheap to train navigators and air traffic controllers, which cost S\$250,000 and S\$150,000 respectively to train. All these estimates do not take into account the conversion to other aircraft types for the pilots and navigators. The cost of an aircraft vary from tens of thousands for the older training planes like the Marchetti to S\$60 million for an F-16, the most expensive in the inventory.

Effectiveness

The assessment of effectiveness was limited in some areas by the way the information was captured and the quality of the database. The main weakness in data collection was the inability to ascertain observer errors and bias. This was evidenced in some of the findings which were inconsistent, for example the blood pressures. Some form of quality control on the methods of measurement needs to be in place to minimise bias. Differing medical opinions in diagnoses and their implications can limit the degree of reliance placed on the incidence of cases. Consistency is also needed in the medical officers' treatment of diagnosis and management and the final assessment should be done by a specialist to minimise variation in standards. Changes in policies as to who should be doing the final screening and making the decisions and who should be highlighted for closer follow up must be sound.

In this limited study, the AME process has resulted in early detection and intervention of some clinically significant cases, for example the personnel with nasopharyngeal carcinoma who is still currently employed as an active pilot and another two pilots who were grounded, one for asymptomatic insulin-dependent diabetic and another with berry aneurysm. The latter gave a history of a singular episode of fits on the ground which led to a computed tomographic (CT) scan investigation. The AME also picked up cases of hypertension and migraines requiring closer monitoring and a case of visual hallucination due to sleep deprivation who was returned after a period of observation. Cases picked up ranged from relatively benign conditions like mild sinusitis to conditions with long term impact like carcinomas and diabetes. In the air force and the RSAF in particular, small numbers and "harmless" conditions are also important because they have an impact on the total costs and safety of training and operations. Grounding of pilots, even temporarily for preventable conditions, imply wastage of expensive manpower resources and similarly, savings can be achieved if we can have firm diagnoses early and intervene appropriately. On the other hand, if a condition, for example migraine, went undiagnosed and a pilot has scotomata during his prodromal stage, the accident potential can range from a heavy landing to a mid-air

collision. An air traffic controller with the same symptoms is similarly at risks of improper air control. There are many examples where medical conditions which do not have serious implications on the ground can be high accident potential in the air if they went unchecked. Alternatively, the activity of flying can itself pose danger for the pilot in the case of mitral valve prolapse in a fast jet, or for persons with spondylolisthesis, their personal safety may be compromised during an ejection. Whichever way, the monetary considerations are large and can be in the millions but the most expensive cost is when it costs a life.

Often, these cost yardsticks are used and the pick up rate of even one significant case can be temptingly argued as "cost effective". But importantly, this should never be taken as licence to be complacent and ignore advances in scientific knowledge. Procedures, components or even the entire concept of the periodic medical examination should be modified accordingly if appropriate. To be truly cost effective, a balance between risk and safety needs to be achieved. There are some who believe that there is no difference in the long term disability rates regardless whether a periodic medical examination is done for the pilots and that the initial selection is more important.¹³ Others still feel that it is important.^{14,15} This depends on the organisational paradigms, on whether they are in the military or in commercial companies and even within similar organisations, on their thresholds.

In this study, procedures such as history (in particular), physical examination, eye and ENT examinations including ECG (despite limitations) have yielded useful information on which to act upon either on an individual basis or as a component of trend for the group as whole. The only exception is the chest X-ray which has so far yielded no real useful information and its continued use should be reassessed and justified. The AME is useful from the conventional preventive health point of view, in providing health trend information and allowing the air force medical team to monitor and counsel key vocationalists closely. It also contributed towards minimising accident potentials due to the various medical conditions picked up over the years which required management both clinically and occupationally. But AME is only one aspect of flight safety; flight safety also involves other aspects like the engineers, the operators themselves, an effective physiological training programme and a strong safety culture within the RSAF.

Conclusion

The value of the AMEs need not lie entirely upon its predictive value of diseases, or prevention of long-term conditions, given also that currently, there are no definite battery of screening tests that predict over long periods the absence of diseases. Apart from providing

a baseline of health data and trends, it gives personnel a chance to interact with the doctors other than when they are ill. This in turn gives the doctors a chance to promote health education and get to know “the boys” better. This rapport is vital because the most valuable part of the AME process appears to be in the history, the quality of which depends on the trust level, a crucial element in obtaining an accurate history. In occupational medicine there is always apprehension that information divulged to the medical examiner or what he finds on examination can sometimes be detrimental in terms of employment. This apprehension is magnified in the air force, because the personnel are highly role specific and pilots in particular tend to lose a lot of pay if they are grounded. Even if we do move them to non-flying related jobs, the loss of salary or job satisfaction can be very considerable. Hence, any modification in terms of tests and periodicity must be designed according to the needs. Tests chosen must be suitable, reliable and the logic for selecting the tests must be convincing.¹⁶ Similarly the personnel administering or interpreting the results should be qualified and quality control at every point is important.

In concluding, the AME in the RSAF context still has value in its dual role of accident prevention and health promotion in the current way it is done, although not all of its components are equally efficient or cost effective. There are areas which need improvement, like the use of some outmoded screening procedures such as the chest X-ray, and it can be more proactive in its use as a vehicle for health education as this is a big part in any preventive medicine effort. Ultimately, the effectiveness of any preventive medicine depends on the close interaction and attitudes between the patient or subject, the doctors delivering the services and that of the organisation.¹⁷

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