Electrocardiography in the Selection of Royal Canadian Air Force Aircrew

By G. W. Manning, M.A., M.D., Ph.D., F.R.C.P. (C)

The electrocardiograms of 5000 healthy adult male applicants for aircrew training have been reviewed. Abnormalities were observed in the tracings of 158 subjects and these were further investigated. T-wave abnormalities occurred in 95 applicants, prolongation of the QRS (including the Wolff-Parkinson-White syndrome) in 28, prolongation of the P-R interval in 23, and miscellaneous changes in a group of 12 men. In many instances the apparent abnormality could be explained as a variation of normal on repeat study (including multiple lead electrocardiograms). In 27 men (0.54 per cent), 15 of whom revealed some associated clinical cardiovascular findings, a significant abnormality persisted and these were considered as unfit for pilot training.

During the first two years of World War II, routine electrocardiograms were taken on all Royal Canadian Air Force aircrew trainees at Initial Training School level. These studies were initiated in order to establish the normal for the age group and to ascertain the value of this procedure in the medical selection of aircrew. Graybiel and his co-workers carried out similar studies. It was soon apparent that many variations, particularly with regard to axis deviation, T-wave amplitudes, and even conduction time, were frequent, depending on cardiac position and physiologic changes. Tracings showing changes beyond the so-called upper limits of normal were studied in some detail and a follow-up study is being carried out on this 1940-42 group. Trainees who were clinically normal were allowed to continue aircrew training regardless of the electrocardiographic abnormality. Studies on the effect of posture and respiration on axis deviation, A-V conduction time and T-wave direction and amplitude were carried out. The effects of posture and deep inspiration on the negative T-waves in lead III were observed. These studies, made before the use of the unipolar limb leads, indicated that the physiologic negative T waves in lead III (due to cardiac position) practically always became upright or showed a decrease in negativity during deep inspiration. Further work on this phenomenon, including the use of the unipolar leads in both the normal and pathologic cases of negative T waves in lead III, is presently being carried out.

Although our follow-up studies are by no means complete, it would appear that certain specific abnormalities in the electrocardiogram should preclude aircrew training. Significant abnormalities that cannot be accounted for by cardiac position and other physiologic variations (known to produce electrocardiographic changes) in the light of our present knowledge in all probability indicate a cardiac disorder.

From earlier studies, and also from the data presented in this report, it is apparent that significant electrocardiographic abnormalities occurring in a large series of healthy young male subjects are indeed rare (0.54 per cent). Not infrequently one finds some cardiac disorder to account for electrocardiographic abnormality when further, more detailed cardiac investigation is carried out. There remains, however, a small group (0.2 or 0.3 per cent) in whom the abnormality in the light of our present knowledge cannot be explained.

Although the significance of many long-standing electrocardiographic abnormalities may be unexplained for many years, the evidence at the present time, including our

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own experience, is that many such abnormalities do frequently indicate a cardiac disorder. There are numerous examples of this. The Wolff-Parkinson-White syndrome for example may be acquired or congenital, and there are a number of case reports now indicating that this electrocardiographic pattern may not be innocent. Paroxysmal tachycardia occurs more readily in this group of cases and may give rise to distressing symptoms that could well impair a pilot's ability to handle an aircraft in a crucial maneuver, such as landing or take-off. We have recently encountered a case of Wolff-Parkinson-White syndrome in a 45 year old ex-Royal Canadian Air Force man who in 1943 suffered bouts of paroxysmal tachycardia. He was recently admitted to hospital with symptoms suggestive of cardiac infarction. The electrocardiogram showed a Wolff-Parkinson-White syndrome. The literature contains an increasing number of such cases some of which are of the acquired type due to coronary heart disease and others congenital, later revealing cardiac manifestations.

Again in an earlier series (1940–42) there were 10 examples of abnormal T waves in a series of 2,500 routine electrocardiograms. Although the follow-up is not completed, it is known that some who showed this change revealed clinical evidence of a cardiac disorder within a few years, one such airman (fig. 1) died suddenly one year after the T-wave changes were discovered. This man was in apparent good health and had completed flying training. He was serving with Fighter Command and had made a number of operational flights. He died suddenly as he approached his aircraft for take-off. The cause of death was reported to us as coronary thrombosis. Other examples in addition to those described in this report have occurred in which the electrocardiogram indicated a cardiac disorder not recognized clinically (fig. 2).

It is of course known that coronary heart disease, particularly angina pectoris, can exist in the absence of any detectable electrocardiographic changes (using present routine methods). The incidence of cardiac disease in the presence of significant electrocardiographic abnormalities as determined from insurance data, our previous studies, and data collected by commercial airlines and other sources, certainly indicates that an obvious electrocardiographic abnormality should preclude aircrew training.

In view of the very high wastage among aircrew trainees from all causes, every effort is being made to select as far as possible only those likely to become successful. Although the present day selection routine includes...
many procedures applicable to flying aptitude, medical selection is of course of fundamental importance. When one realizes the performance capabilities of present-day military aircraft, not to consider the high-speed, high-altitude possibilities of the immediate future, it is apparent that our medical selection is of extreme importance not only with regard to wastage during training but with regard to the physiologic stress imposed by modern military flying.

Apart from the risk involved, the financial aspects must be considered. In view of the extremely high cost of aircrew training, it is of considerable economic importance that the man will continue first as a first-line fighter pilot, later as an instructor, and finally in an administrative or educational position as the case may be. If one in every 1,000 were justifiably rejected on the basis of abnormal electrocardiograms, the saving would be well worth while from a purely economic standpoint. On the other hand if all electrocardiographic abnormalities were considered as a cause for rejection then the aircrew manpower wastage might be too high. The purpose of this report is to indicate the frequency of obvious abnormalities occurring in men selected for aircrew training and the importance of considering such abnormalities in the light of the risk involved and also in relation to the economic feasibility of training such men.

Procedure

In this study 5,000 routine electrocardiograms taken on applicants for aircrew training with the Royal Canadian Air Force have been reviewed. In all cases a complete history, physical examination, psychiatric assessment and ophthalmoscopic consultation, in addition to certain aircrew and officer aptitude tests, had been carried out. On the basis of these procedures the candidates were considered as fit for aircrew training. The routine electrocardiogram consisted of leads I, II, III and CF4. In subjects who showed variations from the so-called normal for these leads, a complete set of standard, unipolar limb leads and leads V1 to V4 were recorded, the effects of posture and respiration being investigated when indicated. If the abnormality could not be explained as a normal variation, the man was seen and carefully investigated by a cardiac consultant who usually carried out further electrocardiographic studies. In most instances where the candidate was considered unfit for aircrew training on the basis of the electrocardiographic findings, all aspects were reviewed and further opinions were obtained as to whether such a man should be accepted for aircrew training.

Results

In 158 of these 5,000 routine electrocardiograms, the initial electrocardiogram was abnormal or showed significant variations from the normal, which suggested repeat studies. There were 95 with T-wave abnormalities, 28 with prolongation of the QRS in its various forms, 23 with prolonged P-R intervals, and a group of 12 with different changes classed as miscellaneous. From this entire group, 27 of these 158 subjects were considered as unsuitable for pilot training (table 1). There were, however, in addition to this, many who showed variations within the so-called normal range. In reviewing these tracings it was again apparent that the so-called textbook "normal tracing" is indeed a rarity, and that minor variations from the so-called classic normal are the rule.

T-Wave Abnormalities

There were 95 of the 158 subjects who showed abnormalities of the T-wave in the initial tracing (table 2). In seven it was apparent from the repeated studies that lead I had been incorrectly recorded during the initial tracing, lead I showing a reversed or "mirror image" pattern.

There were 53 of the remaining 88 subjects with abnormally low or negative T waves in leads I or II, or CF4 or in a combination of these leads in the initial tracing. In 46 of these, repeat studies showed no clinical findings
TABLE 2.—T-Wave Abnormalities—95 Cases

<table>
<thead>
<tr>
<th>Abnormality</th>
<th>Cases</th>
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<tbody>
<tr>
<td>Incorrect lead application</td>
<td>7</td>
</tr>
<tr>
<td>Low to negative T₁, T₂ or CF₄ regarded as normal on repeat studies</td>
<td>46</td>
</tr>
<tr>
<td>Significant T abnormality persisting on repeat study</td>
<td>7</td>
</tr>
<tr>
<td>Q₃T₁ pattern</td>
<td>8</td>
</tr>
<tr>
<td>Deep T₃, flat T₂</td>
<td>25</td>
</tr>
<tr>
<td>R-T₃, S-T deviation</td>
<td>2</td>
</tr>
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88 cases allowed to continue aircrew training.
62 readily explained on multiple lead study.
26 (14 not repeated) 12 not explained but all clinically normal and passed.

with regard to the cardiovascular system, and the abnormality on further investigation had either disappeared or could be accounted for when multiple precordial and unipolar limb leads were obtained (fig. 3). In a few subjects, however, the electrocardiograms could not be explained as completely normal tracings after repeat studies, including analysis of QRS and T vectors (fig. 4). Since these were borderline cases and the subjects were completely fit from the clinical aspect, flying training was permitted but they were to be followed. It has been suggested that such electrocardiographic variations may be the result of neurocirculatory asthenia. Since this view is open to question and particularly since the electrocardiographic changes considered significant in this study were persistent, the possibility of such functional or physiologic variations has not been considered in this report. It may be noted however, that all men had been carefully studied by experienced psychiatrists as part of the selection procedure, which should tend to minimize such cases in this group. In any event, if the electrocardiographic variation on repeat studies had disappeared or could be satisfactorily explained, the man was considered as fit from the electrocardiographic or cardiovascular standpoint, no consideration being given to the possibility of the electrocardiographic variations being due to neurocirculatory asthenia.

Seven of the 53 subjects referred to in the preceding paragraph continued to show...
significant T-wave abnormalities and were considered unfit for pilot training. Five of these seven men on further cardiovascular investigation revealed, in addition to the T-wave abnormality, clinical findings suggestive of a possible cardiovascular disorder (figs. 5 and 6).

There were 33 cases with a deep, negative T wave in lead III. Nine of these showed a Q3T3 pattern. Six of these nine subjects could be accepted as having normal electrocardiograms when a complete electrocardiographic study was carried out (fig. 7), in one the abnormality remained (fig. 4) and in the remaining two no further study was obtained. In 24 of these 33 subjects, a deep negative T wave in lead III occurred with either an absent or insignificant Q, most of these presenting a low or flat T wave in lead II. The initial questionable findings in the electrocardiograms of 18 of these 24 subjects could be explained as normal variations due to cardiac position or rotation, when a repeat multiple lead study was carried out; in the remaining six subjects no further study was possible.

A number of examples in the 5,000 tracings
tive of significant abnormality, although some deviation of the segment persisted.

To sum up the T-wave findings: there were 88 subjects who revealed some defect in the T waves. On further examination seven of these continued to show significant abnormalities; five of these seven subjects also showed clinical findings suggestive of cardiovascular disorder which we felt were likely related to the electrocardiographic abnormality. All seven were therefore considered as unfit for aircrew training.

**Prolonged QRS, Bundle Branch Block, and Wolff-Parkinson-White Syndrome**

There were 28 subjects who showed prolongation of the QRS interval of 0.12 second or longer. Six of these 28 subjects revealed a classic Wolff-Parkinson-White syndrome (table 3) and on further clinical examination, three of the six revealed, cardiac findings suggestive of a possible cardiac disorder. These six subjects were considered as unsuitable for pilot training (figs. 8 and 9). In addition to the six subjects just discussed, four subjects showed P-R intervals of 0.12 second or less and QRS complexes of 0.12 second or more. While the Wolff-Parkinson-White syndrome was strongly suggested, the T waves were not abnormal and this diagnosis was not positively made (fig. 10). In one of these four subjects the repeat study was normal; in another, further clinical examination revealed the presence of mitral stenosis and aortic incompetence; the remaining two were passed as fit but were to be followed. Of the 10 subjects placed in the Wolff-Parkinson-White group there were, therefore, 7 considered to be unfit for pilot training.

There were 14 examples of bundle-branch block, 13 being right bundle-branch block. Seven of these subjects were considered to be unfit for pilot training. Five of the seven showed some associated clinical cardiovascular findings, such as top-normal heart size or systolic murmurs, which in the absence of the electrocardiographic findings would likely have been ignored. Two of these seven subjects were categorized as fit for aircrew positions other than pilot. Of the remaining seven

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**Fig. 7.** Aircrew applicant, W. B. B., age 22. Routine tracing leads I, II, III, and CF₁, taken March 1952 showed obvious Q₂T₂ pattern. This repeat series shows this to be normal variation. Note effect of deep inspiration in lead III.

**Fig. 8.** Aircrew applicant, J. F. B., age 19. Routine tracing taken in October 1952, showed inverted T₁ and T₅. This repeat series taken three weeks later shows classic Wolff-Parkinson-White pattern.

revealed slight R-T or S-T deviation particularly in lead CF₄. These were considered to be of no significance with the possible exception of two instances, but repeat studies with a full set of leads were not considered to be indica-
FIG. 9. D. J. M., age 23, not accepted for pilot training. Routine tracing showed classic Wolff-Parkinson-White. This repeat series taken November 1952, shows same findings with temporary change to normal conduction with subject in standing position. History of one "fainting spell." No other findings of significance from history or clinical examination. Blood pressure 106/70. Fluoroscopy normal.

FIG. 10. Aircrew applicant, R. L. D., age 18. Routine tracing made in September 1952. Repeat studies showed same findings. History of chorea at age 7. Loud, split, first heart sound, accentuated second pulmonic sound and loud third heart sound, but no murmurs heard. Blood pressure 150/74. Fluoroscopy showed straight left border but otherwise normal.

Subjects, four were not seen again and nothing further was done, one had a normal repeat study and was passed for training, and one showed the same findings on repeat study and was considered as fit for service. There was one subject in whom left bundle-branch block seemed to be shown in classic and unipolar limb leads but was not apparent in the precordial leads. This man was completely fit in all respects and was allowed to continue training, but was to be followed with repeat electrocardiographic studies.

There were four additional subjects with QRS complexes of 0.12 second in duration but no other abnormal findings. In three of these the QRS was within normal limits when repeat studies were carried out, and in one the duration remained the same. All four were considered fit.

In summary, then, of the 28 subjects in the group with prolonged QRS complexes, 12 were considered to be unfit for airc rew training, and an additional two subjects were categorized as fit for airc rew training other than pilot. Eight of these men showed some clinical evidence suggestive of cardiac abnormality which in the initial routine clinical examination had either been ignored or considered to be of such a minor degree as to be insignificant. In the presence of electrocardiographic abnormalities (learned of after the clinical examination) such findings, however, had to be considered in a different light.

Prolongation of the P-R Interval

There were 23 subjects whose electrocardiograms showed prolongation of the P-R interval of 0.24 second or more (table 4). In 14 of these subjects repeat studies showed either a normal P-R interval or one that could be brought into the normal range by assuming the upright
TABLE 3.—Prolongation of QRS—28 Cases

<p>| | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>Classic W.P.W.</td>
<td>6</td>
</tr>
<tr>
<td>Borderline W.P.W.</td>
<td>4</td>
</tr>
<tr>
<td>R.B.B.B.</td>
<td>13</td>
</tr>
<tr>
<td>L.B.B.B.</td>
<td>1</td>
</tr>
<tr>
<td>QRS 0.12</td>
<td>4</td>
</tr>
<tr>
<td><strong>Unfit for pilot training</strong></td>
<td></td>
</tr>
<tr>
<td>Basis of E.C.G. only</td>
<td>6</td>
</tr>
<tr>
<td>Assoc. clinical findings</td>
<td>14</td>
</tr>
</tbody>
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TABLE 4.—Prolongation of P-R Interval—23 Cases

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<tr>
<td>Normal on repeat (posture)</td>
<td>14</td>
</tr>
<tr>
<td>Heart block</td>
<td>3</td>
</tr>
<tr>
<td>P-R 0.24–0.28</td>
<td>6</td>
</tr>
<tr>
<td><strong>Unfit for pilot training</strong></td>
<td>3</td>
</tr>
</tbody>
</table>

Fig. 11. J. D. V., age 20, considered unfit for pilot training. Tracing taken in May 1950 shows marked prolongation of P-R interval with P wave in preceding T wave. Reported to show no clinical cardiovascular abnormalities.

posture or by respiratory maneuvers. These subjects revealed nothing of significance on clinical examination of the heart. The P-R interval was never greater than 0.26 second and in the majority was approximately 0.24 second in the initial tracing. These 14 men were, therefore, considered to be normal and were passed as fit since normal findings were discovered when the repeat tracings were made. There were three additional subjects in this group who were considered to be unfit for aircrew training following the discovery of definite heart block (figs. 11 and 12). There were six other subjects with the P-R interval ranging from 0.24 to 0.28 second in duration in whom repeat studies revealed the same conduction time. These subjects were passed as fit, since nothing could be found on clinical examination to suggest a cardiac disorder; they were to be followed throughout their service career. Eighteen months later, one of these men, while flying at approximately 3,000 feet in a jet fighter aircraft, crashed into a lake. Investigation of the accident suggested that he likely became disoriented due to low cloud formation. The cause of the crash, however, remains obscure since little or nothing of the aircraft or body was recovered. The electrocardiogram in this case showed a P-R interval of 0.28 second which could be reduced to normal by exercise. Moderately severe exercise (standing, running), however, simultaneously produced a definite change in the T wave of lead II (fig. 13). Although this fatal crash was probably unrelated to the heart of the pilot, its occurrence in such a case is somewhat disturbing.

To sum up: In the prolonged P-R group, there were a total of 23 subjects, 14 of whom were considered to be normal on repeat study.
hypertrophy. One young man showed definite right ventricular hypertrophy in the electrocardiogram, a loud pulmonary second sound and cardiac enlargement on clinical examination. In view of the clinical findings as well as the routine and repeat electrocardiographic findings this man was considered to be unfit for aircrew training. The remaining six of the seven men referred to above showed little other than axis deviation, some of which could be attributed to cardiac rotation. They were considered to be fit for training but were to be followed.

Two of the 12 subjects showed deep Q waves, but in both of these a study of the limb and precordial leads appeared to explain

There were nine subjects who continued to reveal varying degrees of A-V block, three of whom were considered unfit for pilot training.

Miscellaneous Electrocardiographic Abnormalities

There were 12 subjects in this group. In seven, marked left or right axis deviation was the questionable findings (table 5). In some, the electrocardiograms were suggestive of the Q-wave abnormality, and these men were passed as fit since nothing could be found on repeat studies to suggest a cardiac disorder.

Three additional men showed abnormalities of rhythm. In one subject with tachycardia and right axis deviation, further electrocardiographic investigation confirmed the presence of paroxysmal auricular tachycardia with a ventricular rate of 160 per minute. Because of this he was rejected for pilot

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FIG. 13. R. W. R., age 18, a jet pilot, crashed into lake December 1953. Cause undetermined, but considered as likely pilot error. Lead II before (left) and after (right) exercise taken July 28, 1952.

<table>
<thead>
<tr>
<th>Table 5.—Miscellaneous Group—12 Cases</th>
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<tbody>
<tr>
<td>Marked axis deviation.................. 7</td>
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<tr>
<td>Deep Q in classic leads............... 2</td>
</tr>
<tr>
<td>Abnormality of rhythm.................. 3</td>
</tr>
<tr>
<td>UNFIT FOR PILOT TRAINING............... 3</td>
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training, but since the examination was in other respects normal, he was passed as fit for other aircrew duties. In another young man, frequent ventricular extrasystoles were noted in the initial tracing. In the repeat studies these occurred in runs of three (fig. 14). Although this man showed nothing of significance on clinical cardiovascular examination, the presence of frequent ventricular extrasystoles, at times occurring in short runs, rendered this man unfit for pilot training; however, he was passed as fit for training for other aircrew duties.

In summary then, in this group of 12 subjects with miscellaneous electrocardiographic abnormalities nine were accepted for pilot training; one man was considered to be unfit for any form of aircrew training following the discovery of right ventricular hypertrophy, and two others were accepted for training but only for aircrew duties other than pilot.

Discussion

In this study the routine electrocardiograms of 5,000 applicants between the ages of 18 and 24 for aircrew training with the Royal Canadian Air Force were reviewed. These men had passed the initial aircrew medical examination, which included x-ray study of the chest, and, on clinical grounds, were considered to be acceptable for flying training. One hundred and fifty eight applicants showed some abnormality in the initial electrocardiogram which suggested repeat study. Following further electrocardiographic and clinical studies, 27 or 5.4 per 1,000 were considered as unsuitable for pilot training: 15 of these 27 men showed some associated clinical cardiovascular findings in addition to the electrocardiographic abnormality. Four applicants were considered to be unfit for pilot training but were categorized as fit for aircrew training for duties other than that of pilot.

It is difficult to decide how much importance should be attached to an isolated electrocardiographic abnormality. If clinical evidence of some cardiac defect becomes apparent when the repeat studies are carried out, the decision, of course, is not difficult, for the candidate is then known to have some cardiac disorder which is probably responsible for the electrocardiographic abnormality. It is interesting to note that in 15 instances associated clinical cardiovascular findings were observed when repeat studies were carried out, which either had been overlooked or considered to be insignificant at the time of the initial medical examination. These men, however, would have been permitted to continue pilot training if routine electrocardiograms had not been taken immediately following the initial selection procedures.

Using this more rigid criteria (that is disqualifying only those who show some clinical finding in addition to the electrocardiographic variation) 3 per 1,000 or 0.3 per cent of those included in this study would have been considered to be unfit for pilot training. From the economic standpoint alone it is obvious that the elimination of even three physically unfit subjects out of 1,000 applicants makes the cost and trouble of obtaining 1,000 routine electrocardiograms a trivality. Apart from the economic aspects, of course, there are many other reasons both from military and civil considerations why medical selection at the present time must of necessity be most rigid. Since so few recruits show significant electrocardiographic abnormalities, there is no problem as far as the loss of manpower is concerned, and it would appear reasonable not to accept this group for aircrew training. On the other hand there are many who will say that an isolated electrocardiographic abnormality in the absence of any clinical findings should be disregarded. Although our follow-up evaluation of this small group with significant electrocardiographic abnormalities is by no means completed, a number of examples have occurred both in our own experience and in the experience of others to indicate that the chances of an organic cardiac disorder developing in this group is certainly far more likely than in the group showing rigidly normal electrocardiograms. Although an abnormal electrocardiogram may be the result of physiologic variation unassociated with heart disease, the chances are that it means something, particularly when one considers the very low incidence of significant abnormali-
ties in any large series of normal, healthy young men.

Long-term follow-up studies should of course answer the problem as to the significance of such findings. Since the incidence of significant abnormalities is so low, many thousand routine tracings have to be taken in order to obtain a sufficiently large group for follow-up purposes, and although the Royal Canadian Air Force has obtained many thousands it will take a number of years yet before significant information in this regard can be accumulated. If however, those with obvious electrocardiographic abnormalities are excluded from enlistment, not only will the follow-up become more difficult, but we will not have the opportunity to follow such cases under the added stress and strain of military flying. Considering everything, however, it is not feasible to train such candidates, particularly as pilots. If a routine electrocardiogram is recorded in all aircrew prior to flying training then the occurrence of an abnormality in a later tracing will have much greater significance than the finding of an isolated electrocardiographic abnormality.

In some instances training for other aircrew duties than those of pilot might be considered. However, although the responsibility of the crewman is not as great as that of the pilot, the financial aspect is still a large factor and consequently one perhaps should consider such cases somewhat in the light of the insurance underwriter in evaluating the acceptability of a client for a policy of the same order.

Unfortunately we are not in possession of sufficient information at the present time to state with any degree of accuracy the prognosis in any particular electrocardiographic abnormality occurring in an otherwise fit individual. Packard, Grettinger and Graybiel have recently reported a 10 year follow-up study on 1,000 United States Army Air Force aviators. Here again relatively few (nine) abnormal electrocardiograms were encountered, and at the end of 10 years no cardiovascular disease had occurred in those from whom these electrocardiograms were obtained. Mathewson has reported the favorable course in men showing prolongation of the P-R interval. Others have reported on the favorable course in certain electrocardiographic abnormalities occurring in the absence of any significant clinical cardiovascular findings. On the other hand electrocardiographic abnormalities occurring in routine surveys have led us (on further cardiovascular investigation) to the discovery of clinical cardiovascular abnormalities (0.3 per cent). Furthermore a number of examples of the Wolff-Parkinson-White syndrome have been shown to be associated with significant heart disease which has at times produced sudden death. In our own earlier experience abnormal electrocardiographic findings in a few instances have been followed by significant cardiac disorders (sudden death in two cases). Paroxysmal auricular tachycardia or fibrillation, frequent extrasystoles, and other abnormalities of rhythm may not be of significance or importance as far as the outlook for a civilian subject is concerned but could well be of considerable importance to those responsible for an aircraft, particularly in the field of military aviation.

Considering everything the procedure of obtaining a routine electrocardiogram on all seeking to enlist is practical; those with significant abnormalities should not be accepted for flying training.

The present policy of the Royal Canadian Air Force is to record routinely six leads (I, II, III, V2, V4, V6) on all aircrew applicants before enlistment, and subsequently to record 12 leads (I, II, III, aVr, AVL, aVF, V1 to V6) in all questionable cases. If selection alone was the only consideration fewer leads might suffice. In fact lead I alone might prove to be of sufficient value from this standpoint. If, however, any tracing is to be obtained, the cost in time and money of recording multiple leads is trivial when compared with the value of a complete tracing for follow-up studies and for comparison with future tracings when the possibility of a cardiac disorder arises.

**Summary**

1. Routine electrocardiograms of 5,000 apparently healthy, fit Royal Canadian Air
Force aircrew applicants, between the ages of 18 and 24 years have been reviewed.

2. Possibly significant abnormalities were observed in 158 young men who were recalled for further study.

3. T-wave abnormalities occurred in 95 subjects, prolongation of QRS (including Wolff-Parkinson-White syndrome) in 28, prolongation of P-R interval in 23, and additional miscellaneous electrocardiographic changes in 12 applicants.

4. Twenty-seven of the entire group were considered to be unfit for pilot training (0.54 per cent). Fifteen of these 27 men showed some associated clinical cardiovascular findings.

Sumario Español

1. Electrocardiogramas rutinarios de 5,000 candidatos aparentemente saludables para tripulaciones de la Real Fuerza Aérea Canadiense, entre las edades de 18 a 24 años han sido revisados.

2. Posiblemente anormalidades significativas fueron observadas en 158 hombres jóvenes que fueron llamados para subsiguientes estudios.

3. Anormalidades de la onda T ocurrieron en 95 sujetos, prolongación de QRS (incluyendo el síndrome de Wolff-Parkinson White) en 28, prolongación del intervalo P-R en 23, y cambios adicionales misceláneos en 12 candidatos.

4. Veinte y siete del grupo entero fueron considerados ineptos para entrenamiento como pilotos (0.54 por ciento). Quince de estos 27 hombres mostraron algunos hallazgos clínicos cardiovasculares.

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