Atrial Fibrillation in Flying Personnel

Report of 60 Cases

By Lawrence E. Lamb, M.D., and Lawrence W. Pollard, Major, USAF, MC

Most data on atrial fibrillation are from populations with heart disease. The opportunity to evaluate its etiology, significance, and prognosis in a relatively healthy population is rare. This report of 60 cases of atrial fibrillation from the United States Air Force flying population presents the factors related to the onset of atrial fibrillation, the available follow-up information, and the significance of atrial fibrillation in such cases.

Materials and Methods

Cases of atrial fibrillation were accumulated for 7½ years from July 1, 1955, to January 15, 1963. They were detected by a routine annual examination or because of symptoms associated with the onset of atrial fibrillation. Fifty cases were evaluated at the USAF School of Aerospace Medicine, including electrocardiograms, stress testing with simultaneous electrocardiographic recordings, vectorcardiograms, chest x-rays, and in most instances blood cholesterol, thyroid-function studies (including protein-bound iodine in a high percentage of the cases), routine laboratory work, and other studies. Ten were evaluated at their base.

The USAF receives electrocardiograms from all flying personnel. The population at risk is in excess of 250,000 healthy individuals.

Over 8,000 subjects have had detailed specialized studies with continuous recording of electrocardiograms during hyperventilation, maximum breath holding, postural influences, exercise tests, and glucose administration. This time, plus the recording time for the population at risk, is in excess of 50,000 hours. It provides a giant screen for the detection of the unrecognized occurrence of spontaneous atrial fibrillation in relatively healthy people.

Results

The age varied from 22 to 49 years with a mean of 36.6 and a median of 37 years. Sixty-three per cent were 35 years old or older although the median age for the population at risk is 32 years (table 1).

In 51 cases the serum cholesterol varied from 153 to 355, with a mean value of 242 mg per cent.

Thyroid-function studies in 47 cases included a triiodothyronine red blood cell uptake in two subjects, protein-bound iodine determinations in 41, and basal metabolic rates in four. In no case was definite thyroid disease established. Specifically absent was clinical or laboratory evidence of thyrotoxicosis. Some studies suggested hypometabolism. Two triiodothyronine red blood cell uptakes were normal values. Protein-bound iodine determinations were over 4 µg in 33 and between 3.6 and 2.7 in six. The basal metabolic rates were from +5 to −19 per cent.

The average follow-up period in 59 subjects was 41.2 months. One patient died suddenly 6 weeks after the onset of atrial fibrillation while another remains well after 16 years.

Persistent Atrial Fibrillation

There were only three cases of persistent atrial fibrillation (tables 1 and 2). If other instances occurred, presumably they were secondary to major organic disease and automatically removed from the flying population. Available information on the individuals with significant cardiac events in the flying population suggests that this is unlikely.

The extreme rarity of spontaneous persistent atrial fibrillation in a healthy population is pointed out by the low incidence in this study. One case appears innocuous and may have originated in childhood. For 6 years he has demonstrated no significant changes. A second case had acquired atrial fibrillation, probably precipitated by acute myocardial infarction, and early demise. The third case occurred spontaneously in an individual with previous normal sinus rhythm. Persistent atrial fibrilla-
tion in the absence of demonstrable underlying heart disease appears to be the rarest of all forms of atrial fibrillation. The inability to demonstrate the presence of underlying heart disease by means currently available does not necessarily exclude an organic etiology.

**Recurrent Paroxysmal Atrial Fibrillation**

There were 21 cases of recurrent paroxysmal atrial fibrillation. This group has been followed from 11 to 192 months since the initial episode of atrial fibrillation or an average period in excess of 5 years. The vast majority of this group had symptomatology associated with fibrillation, such as faintness or substernal chest pain or an associated illness, such as infectious hepatitis, gouty arthritis, or acute alcoholism. The case that is truly free from symptoms related to fibrillation or completely free from other associated illness appears to be rare. The episodes are not necessarily associated with a poor prognosis or disability as indicated by one case followed for 15 years and another followed for 16 years.

Case 10 also demonstrates the influence of both startle reaction and physical trauma on the precipitation of acute fibrillation. Some cases appear to be an isolated acute event and later prove to belong to the recurrent paroxysmal group.

**Single Isolated Episode of Fibrillation**

The most common type of atrial fibrillation noted in the flying population is the isolated single episode. A variety of different precipitating factors are commonly implicated. In this series these included alcohol, acute diarrhea, other gastrointestinal symptoms, drugs, respiratory diseases, fatigue, physical exertion, and heart disease or symptoms ordinarily referable to heart disease. This does not imply that heart disease was absent in the other cases, but in these three instances the association was more specific.

**Discussion**

**Etiology**

The etiology of atrial fibrillation in apparently healthy persons is distinctly different from hospital and clinic surveys. Rheumatic heart disease occurred in only one case.

When identified as a factor, alcoholic ingestion was usually excessive. The bout of fibrillation usually occurred in the early morning hours or on arising following excessive ingestion of alcohol.

Gastroenteritis with probable electrolyte disturbance was an occasional factor.

The significance of associated gastrointestinal symptoms is uncertain, since it may precede or follow the onset of coronary insufficiency.

Of particular interest was the absence of any clinical indication of thyrotoxicosis. Some subjects suggested the possibility of underlying hypometabolism. Although major attention has been directed toward thyrotoxicosis, the occurrence of atrial fibrillation in myxedema is not unknown. Whether fibrillation is due to myxedema or other associated forms of underlying heart disease apparently has not been demonstrated. Atrial fibrillation in the presence of myxedema has been reversed by thyroid therapy suggesting that the fibrillation was due to myxedema.

When obvious disease has been excluded, the most common form of underlying heart disease is coronary artery disease.

In those individuals with no significant disease as a precipitating factor, reflex mechanisms or other neurohumoral factors must be considered.

**Symptomatology**

Even though most did not have clearly demonstrable underlying heart disease, the vast majority had symptoms that interfered with their performance capacity. When fatigue, exertion, and related factors were associated with the onset of fibrillation the individuals were obviously below an optimal physiologic state. In the absence of underlying medical disorders, fibrillation disturbed normal physiology, manifested by faintness, epigastric discomfort, lightheadedness, palpitations, and other related symptoms.

Certain individuals fibrillate without significant symptomatology, particularly with
### Table 1
Data on 60 Cases of Atrial Fibrillation

<table>
<thead>
<tr>
<th>Case number</th>
<th>Age at onset (years)</th>
<th>Height (inches)</th>
<th>Blood Pressure (mm. Hg)</th>
<th>Blood pressure at onset (beats/min.)</th>
<th>Blood cholesterol (mg. %)</th>
<th>Protein-bound iodine (μg.)</th>
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### Isolated episode of atrial fibrillation

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<th>Blood cholesterol (mg. %)</th>
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<th>Months of follow-up</th>
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Chronic atrial fibrillation and a slow ventricular rate in the absence of heart disease. Acute or paroxysmal fibrillation more commonly produces symptoms, particularly with ventricular rates of 100 or more beats per minute.

**Prognosis**

Atrial fibrillation is not necessarily associated with poor prognosis. The prognosis is directly related to the cause of the arrhythmia. Normal life with normal activity can be expected in the absence of associated demonstrable significant disease. Recurrence of atrial fibrillation as a second episode occurred as late as 6 years.
### Table 1 (Continued)

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| 36          | 35                   | 69              | 168           | 120/70                  |                                               |                          |                           |     |                | No                       | 37                  |
| 37          | 33                   | 75%            | 170           | 118/80                  |                                               |                          |                           |     |                | No                       | 37                  |
| 38          | 35                   | 71              | 165           | 122/82                  |                                               |                          |                           |     |                | No                       | 37                  |
| 39          | 44                   | 69              | 164           | 135/85                  |                                               |                          |                           |     |                | No                       | 37                  |
| 40          | 41                   | 68              | 157           | 120/72                  |                                               |                          |                           |     |                | No                       | 37                  |
| 41          | 31                   | 73              | 182           | 142/70                  |                                               |                          |                           |     |                | No                       | 37                  |
| 42          | 44                   | 64              | 140           | 120/70                  |                                               |                          |                           |     |                | No                       | 37                  |
| 43          | 38                   | 70              | 177           | 110/72                  | 130                                           | 200                      | 3.1                       | +1  | No             | No                       | 37                  |
| 44          | 42                   | 73              | 185           | 162/98                  | 200                                           | 223                      | 4.7                       | -6  | No             | No                       | 37                  |
| 45          | 34                   | 70              | 187           | 132/86                  | 120                                           | 302                      |                           |     |                | No                       | 37                  |
| 46          | 46                   | 71              | 166           | 128/82                  | 268                                           |                           |                           |     |                | Questionable              | 37                  |

### Aeromedical Implications

Cardiovascular dynamics may be seen significantly altered by fibrillation in the absence of demonstrable disease. In addition to decreased cardiac output, atrial fibrillation has an undesirable effect on cerebral circulation. By flow meter technics in experimental animals a marked reduction of as much as 23 per cent of cerebral blood flow was demonstrated in 55 of 61 paroxysms. The greatest reductions

Circulation, Volume XXIX, May 1964
**Table 2**

**Clinical History**

<table>
<thead>
<tr>
<th>Case number</th>
<th>History</th>
</tr>
</thead>
</table>

**Persistent atrial fibrillation**

1. Persistent atrial fibrillation was found on a routine electrocardiogram. He flew combat missions throughout the Korean War.

2. Abnormal T waves were noted at age 40. A routine record at age 42 demonstrated atrial fibrillation. He had collapsed with an episode of acute epigastric pain 1 month prior to examination. Two weeks after examination he expired suddenly without premonitory symptoms. Postmortem examination demonstrated an old myocardial infarction with arteriosclerotic heart disease.

3. Atrial fibrillation was first noted on a routine examination. All previous records were normal. He is physically vigorous and a champion badminton player.

**Recurrent paroxysmal atrial fibrillation**

4. Atrial fibrillation began while he was chopping wood. Episodes as often as every 2 weeks without apparent precipitating factors, associated with palpitations and dyspnea, have occurred since.

5. Atrial fibrillation was first noted during an annual examination and has since recurred in a paroxysmal fashion with occasional dizziness and faintness.

6. Atrial fibrillation was detected on routine examination at age 25 and at age 41. On both occasions the rhythm returned to normal spontaneously within 24 hours.

7. Atrial fibrillation was first noted on routine examination, and as intermittent paroxysms since.

8. Atrial fibrillation was detected on routine examination. Another paroxysm was precipitated by the ingestion of glucose. He has intermittent paroxysms and gouty arthritis.

9. Atrial fibrillation during infectious hepatitis on two occasions and recovered 1 year later. All three instances were associated with ingesting something cold. The third episode was terminated by eating hot soup. There have been three other subsequent episodes.

10. Atrial fibrillation occurred at age 26 after he was knocked down by an automobile and at age 30 when awakened from a deep sleep by an automobile collision in front of his home. At age 38 atrial fibrillation became recurrent, associated with dizziness. At age 41 he was in good health with above-average physical fitness and exercise capacity.

11. Irregular heart action was present for 4 to 5 years with ill-defined symptomatology. Physical appearance suggested hypometabolic state. Atrial fibrillation subsequently documented. Radioactive iodine uptake 22 per cent (normal). Recurrent bouts of fibrillation continued, associated with neurotic depressive tendencies and excessive symptomatology.

12. History of three to four episodes of irregular pulse and mild subternal dull ache. Subsequent documented atrial fibrillation lasted for 13½ hours with dull substernal chest ache, headache, and fatigue. Six to seven recurrences from 10 to 15 minutes in duration with faintness, dizziness, and pallor have subsequently been noted.

13. Atrial fibrillation was detected on a routine electrocardiogram. Past history included palpitation 2 to 3 years earlier after excessive fatigue and alcohol ingestion and loss of consciousness at age 23 following alcohol ingestion. He demonstrated excellent physical tolerance. Recurrent paroxysms have occurred approximately twice a month since.

14. There was a past history of atrial fibrillation at age 22. A second episode at age 25 started spontaneously while he was bending over to tie his shoe.

15. Palpitation, proved to be atrial fibrillation, began while he was resting in bed. There were no unusual events. A similar episode 2 years earlier had awakened him from sleep.

16. Two episodes of atrial fibrillation 6 months apart occurred after excessive alcoholic ingestion. Both episodes were associated with upset stomach and vomiting. A third episode occurred approximately 15 months later.

17. Atrial fibrillation with dyspnea was precipitated by violent anger. There was a 10-year interim history of fluttering sensation in the chest approximately once a month. Atrial fibrillation was again documented at age 42 after excessive alcoholic ingestion. One year later there have been no recurrences.

18. The patient was awakened from sleep with atrial fibrillation manifested by a "fluttering sensation" in the chest approximately 4½ hours after excessive alcoholic ingestion and vomiting. Past history included four to five similar episodes associated with mental or physical stress.

19. Atrial fibrillation occurred spontaneously accompanied by distention, nausea, dizziness, and faintness. He was taking Chlortrimeton, Propadrine and Isopropamide for a head cold. While lying on the bathroom floor he noted cardiac irregularity documented as atrial fibrillation. A year later he was having recurrent episodes.

20. Atrial fibrillation accompanied by epigastric fullness occurred the morning following 48 hours of excessive drinking, lack of sleep, and dexedrine administration. A second episode occurring
after alcohol, lack of sleep, physical and emotional stress occurred 9 months later. During the eleventh month atrial fibrillation was precipitated during treadmill stress testing.

21 Palpitation and tachycardia were first noted after excessive alcoholic ingestion. For a period of approximately 2 weeks recurrent episodes of atrial fibrillation were noted. He has subsequently remained asymptomatic. Laboratory findings of an abnormal glucose-tolerance test and recurrent staphylococcal infections suggest probable early diabetes.

22 He was awakened with epigastric fullness, nausea, dyspnea, tachycardia, and palpitation due to atrial fibrillation following dietary indiscretion. Symptoms suggestive of an episode occurred following vigorous exercise during high school. He has had several subsequent episodes of paroxysmal atrial tachycardia.

23 At an altitude of 10,000 feet progressive dyspnea occurred for several months. Examination disclosed atrial fibrillation. Normal sinus rhythm occurred following digitalization and quinidine. There were persistent residual nonspecific T-wave changes in lead I, aV_1, and the lateral precordium. Six years and 2 months later, on routine examination, transitory atrial fibrillation recurred spontaneously.

24 Atrial fibrillation was detected on routine examination at age 28. Past history included an episode of atrial fibrillation at age 23. He has had one recurrence since detection.

Isolated episode of atrial fibrillation

25 Atrial fibrillation followed excessive alcoholic ingestion associated with multiple psychic and physical stresses. No recurrences.

26 Past history included palpitation and tachycardia at age 25 the morning following alcoholic excess and vomiting. A similar episode at age 30 following intoxication was atrial fibrillation. No recurrences.

27 The patient was awakened from sleep with atrial fibrillation manifested by rapid irregular heart rate following an evening of excessive alcoholic ingestion and mild diarrhea.

28 Atrial fibrillation occurred after a heavy meal and excessive alcoholic ingestion associated with epigastric fullness. The electrocardiogram demonstrated nonspecific T-wave changes for 4 years prior to the episode of fibrillation with QRS changes suggestive but not diagnostic of old inferior wall myocardial infarction.

29 Postalcoholic symptoms with vomiting and substernal distress were associated with acute atrial fibrillation.

30 A near syncopal episode and atrial fibrillation occurred during parade formation the day following excessive alcoholic ingestion accompanied with severe gastroenteritis. Atrial fibrillation ceased spontaneously.

31 Dyspnea and palpitations followed severe diarrhea following tetracycline therapy for acute respiratory infection.

32 Atrial fibrillation followed acute severe staphylococcal gastroenteritis.

33 Palpitations, epigastric distress, and headache were noted while he was flying at 8,500 feet. Examination revealed atrial fibrillation followed by post-tachycardia T-wave changes. Similar symptoms have been noted intermittently for several years.

34 Vomiting and weakness occurred while he was taking ephedrine for an "allergy." Atrial fibrillation converted to normal sinus rhythm following a sedative and a night's sleep.

35 Bitemporal headaches and nausea were noted on arising. Subject attempted to vomit without results. His blood pressure was 196/110 mm. Hg. Atrial fibrillation was noted. Similar symptoms had occurred on two or three occasions over 10 to 15 years. Later he experienced one episode of dull chest pain without other findings.

36 Nausea and epigastric distress followed by vomiting, diarrhea, and fibrillation occurred in flight. Post-tachycardia T-wave changes were noted. Past history included a bleeding duodenal ulcer.

37 Ill-defined symptoms and dyspnea were noted during a check-out ride in a T-33 aircraft. Symptoms of nausea, dyspnea, and fatigue persisted for a day and a half. Examination revealed atrial fibrillation.

38 Atrial fibrillation followed localized injection of procaine for a fractured rib. Symptoms included faintness, dizziness, and sweating.

39 He took a Sparine tablet, slept, and on arising a syncopal episode occurred. Examination by two physicians demonstrated grossly irregular pulse interpreted as atrial fibrillation.

40 Atrial fibrillation followed the intravenous injection of grains 1/50th of atropine sulfate for evaluation of first degree A-V block.

41 Atrial fibrillation occurred during hospitalization for influenza and persisted for over 2 months and then converted medically.

42 Atrial fibrillation occurred during an acute febrile respiratory illness. There were postprandial T-wave changes.

43 Following recovery from "flu," during annual examination, atrial fibrillation was noted. There was spontaneous recovery.

44 Atrial fibrillation followed severe sleep deprivation, inadequate diet, and excessive coffee. Symptoms included weakness, dyspnea, abdominal fullness. There was a general appearance of acute illness.

45 On awakening, symptoms of palpitation, rapid irregular heart beat, and dyspnea were noted.
secondary to atrial fibrillation. This was preceded by several weeks of severe emotional stress, fatigue, excessive smoking, and excessive coffee intake. Past history included rheumatic fever at age 18.

46 Atrial fibrillation was first documented following a double Master's exercise tolerance test. Past history included nonexertional substernal chest discomfort and frequent palpitations secondary to atrial premature contractions for over 4 years.

47 An irregular pulse was noted while he was mowing the lawn. Examination disclosed atrial fibrillation. Temaril was being used at the time. The electrocardiogram showed moderate left axis deviation of $-30^\circ$.

48 Palpitation and tachycardia occurred during a volley ball game. On resuming exertion symptoms recurred and were persistent. An electrocardiogram demonstrated atrial fibrillation. He had had a mild respiratory infection and taken aspirin.

49 Epigastric, left precordial and left neck discomfort with paresthesias down the left arm occurred during flight. Examination disclosed minor T-wave variations and paroxysms of atrial flutter. A diagnosis of coronary insufficiency or myocardial infarction was entertained with no further substantiating evidence. Recovery was spontaneous.

50 Atrial fibrillation occurred with sudden massive congestive heart failure as a complication of long-standing mitral insufficiency and advanced rheumatic heart disease. Digitalization induced compensation and normal sinus rhythm. There have been no recurrences or subsequent complications.

51 He was awakened with palpitation due to spontaneous atrial fibrillation. Normal sinus rhythm was restored with acute digitalization.

52 An examination for palpitations revealed fibrillation. There was spontaneous conversion to normal rhythm. Long working hours, excessive use of coffee and cigarettes were a customary habit. There were no other apparent precipitating factors.

53 Atrial fibrillation was detected on routine examination of a Japanese national.

54 Sleep was interrupted with precordial discomfort and palpitation due to atrial fibrillation. Associated factors included habitual excessive use of tobacco and coffee. Seven years earlier he was hospitalized for suspected myocardial infarction manifested by weakness, dizziness, and palpitation. No diagnosis was established.

55 Palpitation occurred spontaneously during rest due to atrial fibrillation without apparent precipitating factors.

56 Examination for palpitation revealed atrial fibrillation. The family had had mild "flu" 10 days previously. There was no other implication of acute illness or other precipitating factors.

57 Atrial fibrillation was noted on routine examination the day following excessive ingestion of alcohol.

58 Palpitation due to atrial fibrillation followed a day of heavy manual labor, three cocktails, and a heavy evening meal. The patient implicated chewing tobacco as a causative factor as he was unaccustomed to this habit.

59 Sleep was interrupted with forceful palpitation due to atrial fibrillation. Three weeks earlier he had noted occasional palpitation when using Neo-synephrine for nasal stuffiness.

60 Atrial fibrillation was noted on routine examination. There was spontaneous remission.

were associated with the most rapid ventricular rates. Corday et al. reported that cardiac arrhythmias such as atrial fibrillation cause cerebral angiospasm, and the effects may last as long as an hour after the arrhythmia has returned to normal.12 Cerebral vascular constriction with decreased cardiac output may predispose to syncope or syncopal-like reactions as well as a host of other symptomatology reducing the individual far below the optimum of his performance, either physically or mentally. The frequent occurrence of symptoms in this study of apparently healthy individuals is probably related to these alterations.

Atrial fibrillation caused by an acute illness has no future aero-medical significance if recovery is complete, and should have no bearing upon the future occupation of the person. This includes transitory episodes with acute pneumonia, acute gastroenteritis, or an acute drug reaction. If fibrillation is associated with a disease of serious magnitude, the disease becomes the primary consideration.

The importance of recurrent paroxysmal events is their frequent association with adverse alterations in cardiovascular dynamics impairing the individual's capacity to perform at a high level either mentally or physically. Occupations that require the individual to perform at peak level at all times are not compatible with recurrent episodes of atrial fibrillation with or without disease. Individuals who have had bouts of atrial fibrillation can be a passen-
ATRIAL Fibrillation

The sudden occurrence of atrial fibrillation in an individual in primary control of high-performance aircraft is potentially dangerous. An individual with recurrent atrial fibrillation may become incapacitated even though incapacitation does not occur with every episode of atrial fibrillation or in every subject. The etiology of the episode, its likelihood of recurrence, and the hemodynamic effects of the atrial fibrillation itself, both on cardiac output and cerebral circulation, are the major factors to be considered from an aeromedical point of view.

Summary

Sixty cases of atrial fibrillation from the USAF flying population are reported. Follow-up information in 59 subjects averaged 41.2 months.

Only three cases of persistent atrial fibrillation were detected and two of these had normal sinus rhythm prior to the onset of atrial fibrillation.

There were 21 cases of recurrent paroxysmal atrial fibrillation and 36 cases of isolated acute atrial fibrillation associated with a variety of precipitating factors. Thyrotoxicosis was notable by its absence in any of these cases of atrial fibrillation.

Symptomatology either related to the primary disorder precipitating atrial fibrillation or secondary to the arrhythmia itself was frequently observed.

The hemodynamic effects of atrial fibrillation on cardiac output, and cerebral artery spasm with diminished cerebral blood flow are important aeromedical considerations.

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