MEDICAL FACTORS IN U.S. GENERAL AVIATION ACCIDENTS

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I. Introduction.

General aviation activity in the U. S. exceeds that of any other country and presently involves 617,000 airmen and 115,000 active aircraft in a total fleet of 150,000. Annual general aviation flight hours are in the neighborhood of 21.3 million as compared to 6 million for air carrier aircraft, the latter numbering 2,150 of which about 1,700 are flying at any one time. Of the 617,000 airmen, seventy percent are student or private pilots, twenty percent fly for hire, twenty percent have instruments ratings and about 21,000 are air carrier pilots and 18,000 are women. The FAA fosters as high a level of general aviation safety as practicable and in accomplishing this activity attempts to thoroughly investigate all general aviation accidents. In this latter role, the FAA serves to assist the National Transportation Safety Board which has the statutory responsibility of determining the probable cause of civil aircraft accidents.

The FAA, through its Accident Investigation Branch within the Aeromedical Applications Division, coordinates a broad program of medical participation in general aviation accidents, especially fatal accidents. This program is discharged primarily through the seven Regions under the activity of the respective Regional Flight Surgeons, who, in turn, coordinate the work the approximately six thousand designated aviation medical examiners accomplish. When autopsies are obtained following fatal accidents, body fluids, and, or tissues, are analyzed by the Armed Forces Institute of Pathology in Washington, D. C., the FAA's Civil Aeromedical Institute in Oklahoma City, or a qualified civil pathology laboratory.

The increasing success of this medical program can be seen in the fact that pilot autopsy and toxicological investigations of fatal general aviation accidents in the U. S. rose from 29% in 1963 to 74% in 1967.

The scope of the accident activity in the U. S. is seen in the following data:

	Total Accidents in General Aviation	
	1966	*1967*
Total	5,786	6,231
Fatal Accidents	564	610
Fatalities	1,123	1,237
Airborne Collisons	28	26

Many of the above accidents result from circumstances having a medical basis and examples of these types of accidents are described in the following information.

II. Psychological Factors.

Emotions can result in the development of a "head of pressure" which induces a pilot to undertake hazardous activities (unwarranted low-level manuvers). For example, low level maneuvers such as "buzz jobs" may be undertaken as a result of such things as sexual frustration relative to a girl friend, a wife, or a recently divorced mate.

The very experienced pilot of a Stearman 75 made a series of low-level flight maneuvers over a river in Hawaii, including a flight under a bridge followed by an abrupt pull-up, in July of 1967. Afterwards he flew to a section of beach and waved at a girl in a Bikini who waved back. The pilot landed on the beach nearby, introduced himself to the girl, then borrowed her telephone, calling several bars to locate his girl friend. While doing so he drank a beer. The pilot then departed saying that if his newly met acquaintance keeps wearing her Bikini, he was coming back. He also said "Always think happy thoughts". On becoming airborne he executed two loops near ground level, and on the second loop impacted the ground with fatal consequences. It developed that the pilot had recently separated from his wife and in past years had been known at times as a very heavy drinker. The pilot had also told persons for some time that he was going to fly under the bridge if it were the last thing he ever did. The history above is, in its general theme, repeated in other sections of the U. S. often enough to warrant a

continued educational program on the adverse effects emotions can have on flight behavior. The use of an aircraft for expressing sexual frustrations, the acute mental shock following marital separation or divorce, and the use of dangerous flight acts as a form of "self-punishment" relative to guilt feelings, are documented.[1,2] The role such dangerous maneuvers can play in creating exhilaration as a counteractant to depressive feelings represents a concomitant factor. The synergizing effects of even a little amount of alcohol with other factors so as to impair judgment and mood has also been previously described. Such factors have recently been implicated in aggressive and dangerous automobile driving behavior and should be reemphasized in a continuing aviation safety program from which the evolving new crops of pilots will benefit as well as those old hands who may not have "gotten the message."[3] Office of Aviation Medicine FAA Report AM 66-8 covers certain of these topics.

III. Weather.

Weather accidents, especially when they represent deliberate pentration of known adverse circumstances, constitute examples of wilful activity which may be compared with "Russian Roulette". Our education activities are beamed at calling to the attention of potential victims the hazards of launching themselves into temporary atmospheric extremes which hold promise of exceeding the structural strength of their aircraft. Freudian disciples have attributed a significant number of these accidents to such factors as "tempting the Gods", thus suggesting immortality, pressing the weather to demonstrate masculinity, and other psychic mechanisms.[1] Since the majority of general aviation weather accidents occur after the pilot has had ample warning that a critical circumstance was developing (either from the Weather Bureau, a Flight Service Station or the obvious appearance of the elements), we are disseminating case history information so that airmen may be forewarned of proclivities on the part of some to penetrate known adverse weather.

IV. Carbon Monoxide.

No matter how often facts of carbon monoxide poisoning have been disseminated, apparently a certain percent of general aviation pilots have failed to comprehend the significance of this potential hazard. This past spring a pilot highly experienced in flying could not account for one hour of a two hour flight in his Piper Apache while flying over Minnesota at night after midnight. The pilot later recounted that all three of the radios became inoperative and he made a perfect gear-up landing at an airport. When observers approached the aircraft, all of the electrical equipment was on as the power controls had not been turned off. The pilot was in place mumbling incoherently over and over, "so tired". The radios, when tested, were in perfect condition. It developed that the gasoline heater in the fuselage was in the "on" position, the heater can had three one-inch cracks and the exhause pipe from the heater was broken. The investigators felt that carbon monoxide had escaped into the cabin and partially incapacited the pilot. This near tragedy further emphasizes our continuing efforts regarding the dissemination of information bearing upon the potential hazards of carbon monoxide, with guidance as to the periodic checks for defective heaters.

V. Hypoxia.

Hypoxia is a condition known to competent airmen since World War I, yet, even today, general aviation pilots climb to altitudes in excess of twelve thousand feet for extended periods of time and become impaired due to hypoxic changes.

In February of 1967, a Cessna 401 obtained an altitude of 23,000 feet over South Carolina on an instrument flight plan while climbing to 25,000 feet. The aircraft was lost to air traffic radar and a ground witness (a flight instructor) heard a high pitched whine which was accelerating in nature followed by a dull thud. The accident investigators found scattered debris and evidence that the wings had separated in flight. The evidence indicated that although the aircraft was equipped with oxygen, the pilot had no access to his oxygen mask (which was stowed in the back out of reach). On some previous occasions the pilot had boasted of having been capable of operating at 25,000 feet without oxygen.

Continued education of all pilots regarding the adverse effects of hypoxia on performance, an expanded physiological training program through-

out the U. S., and the pending issuance of a regulation requiring use of oxygen where cabin altitudes exceed 12,000 feet (NPRM–67–30) are remedial actions we have underway. Further information is provided in FAA Report AM *66–28*.

VI. Alcohol.

In spite of protests by various groups to the contrary, ethyl alcohol continues to play a significant role in U.S. general aviation accidents. Ethyl alcohol produces euphoria, and even in small amounts changes the mood and judgment of individuals. In driving, a two-dimensional task, not involving roll and pitch parameters as is so with three-dimensional flight (and involving neither stall speeds nor wind drift), alcohol has been a concomitant for decades of homeward trips after evening cocktail parties. In flight, even small amounts of alcohol can incapacitate an airman from the judgment standpoint. The toxicological evidence indicates that a significant number of general aviation pilots have attempted flights under circumstances which exceed the pilot qualifications or the aircraft limitations (instrumentation), resulting in serious accidents.

Five years of toxicological data relative to fatal general aviation accidents lend strong evidence that alcohol continues to play an adverse role in air safety. While some of these cases may be "false" positives, due to putrefaction, contamination, or other factors, many are substantiated by a history of pilot consumption of alcohol immediately prior to the fatal flight. In a number of cases, unequivocal evidence that the alcohol played a role in the accidents was not obtained, hence, the official probable cause for these does not reflect the presence of alcohol. On the other hand, the data are firm enough in the aggregate to warrant an aggressive safety education program. The following data is instructive:

	1963	*1964*	*1965*	*1966*	*1967**
Total Fatalities	900	980	1,020	1,123	1,016
Fatal Accidents	477	510	543	564	508
Pilot Toxicology Performed	29%	42%	54%	62%	74%
Pilot Positive Alcohol	59(43%)	82(39%)	105(36%)	94(27%)	91(24%)
Less Than 50 mg%	19	23	45	44	43
50–99 mg%	12	18	20	18	11
100–149 mg%	9	22	16	16	16
Over 150 mg%	19	19	24	16	21

*Data available as of February 1968.

FAA Report AM *66–29* provides detailed information on this data.

VII. Suicides (Volitional Acts).

Suicides encompass a certain percentage of "accidents", and in our view, since such deliberate acts are volitional, should not be categorized as accidents (the latter being "unplanned events"). Several suicides occur each year through the instrumentailty of an aircraft, possibly about a dozen in number. It is our feeling that since suicides are not accidents, the latter defined as unintended happenings, accident investigators should be alert in each investigation to clues suggesting a wilful act. If the latter proves to be the case, perhaps suicides should be provided a separate category in safety statistics, distinct from the accident data which are accordingly reduced in magnitude. A report on aviation suicides was made by the FAA in Vol. 38, No. 10, *Aerospace Medicine*, October 1967, pp. 1058–1059.

VIII. Aerial Application.

In July of 1965 a pilot lost control of his Piper Supercub while spraying with insecticides of the organophosphorous type. Laboratory blood tests revealed that the cholinesterase level was low enough to produce significant physiologic impairment. It was felt by the investigators that in some way excessive exposure to the insecticide was experienced by the pilot during loading or handling procedures. The FAA is continuing studies of the extent to which toxic substances contribute to flight accidents and has established a special laboratory activity at the Civil Aeromedical Institute to receive samples forwarded by investigators of agricultural flying accidents. A concurrent safety education program is underway. Report AM *66–30* gives a detailed analysis of aerial application accidents.

IX. Appendicitis.

A May 1967 fatal Cessna 172 accident in Montana occurred when the pilot apparently got into rising terrain in mountainous conditions and could not climb out of a ravine. The post mortem revealed that the pilot exhibited acute suppurative appendicitis with periappendicitis and abscess formation. The Regional Flight Surgeon felt that the attempted gain of altitude and concomintant gas expansion in the appendix and abscess could have caused enough pain to impair the pilot's performance. Certainly the presence of such a serious medical condition in which wives or children with no, or minimum, (recognizing that it may have been totally asymptomatic) would potentially be adverse to a pilot's well being. We are continuously publishing *Medical Facts for Pilots* (in the *Airmans' Information Manual*) and other medical safety educational material and have prepared several motion pictures for loan by the FAA to pilot groups concerning the importance of physical state to safe flight.

X. Cardiovascular Disease.

Pilot inflight incapacitation due to experiencing a coronary occlusion or a cerebrovascular accident occurs about six times each year as documented by the reports of the National Transportation Safety Board (formerly produced by the Civil Aeronautics Board). Without doubt, were it not for the physical standards regarding repetitive medical certification for airmen, the inflight incapacitation and accident rate would be considerably higher. However, spectacular episodes continue to occur several times each year flight ability, manage to land an aircraft after cardiovascular incapacitation of the pilot. Continued educational programs aimed at identifying for pilots the symptoms of cardiovascular disease and the need for thorough physical examinations, together with the desirability of physical fitness activities, are current preventive measures of aviation medicine discussed and discussed in *Aerospace Medicine*, vol. 38, No. 10, October 1967, pp. 1057–1059.

XI. Age.

Although age is considered significant in air carrier operations (in the U. S. the retirement age for air carrier pilots is 60 years) no mandatory upper limit is set for general aviation pilots. The accident statistics relative to age in general aviation flight activities bear out the present philosophy. For example, the following figures describe the accidents per 10,000 pilots for the certificated and age categories shown:

	16–29 years	*30–44 years*	*45–59 years*	*60 & over*	Total *Total*
Student	60	94	111	82	77
Private	126	118	120	113	120
Commercial	254	146	109	123	152
Air Transport	298	118	59	104	93
Total Accident Rate	106	121	109	110	114

The above data reveal that the older pilots do not experience a higher accident rate than their younger colleagues. The table does not contain "exposure" data such as the number of hours flown per year, which may be less for pilots over sixty. On the other hand, perhaps older pilots are more cautious (thus achieving an older age) and "expose" themselves to such things as adverse weather or unwarranted low level maneuvers less often. Detailed information is provided in FAA Report AM *67–22*.

XII. Accident Repeaters.

The observation that some people are accident prone takes on real implications when the following statistics are viewed.[4] During the period 1965–66, a survey of 15,977 general aviation accidents revealed that 79 pilots experienced two or more accidents. Six hundred and sixty had two accidents, sixty-two had three and seven had four. Dr. Bedell found that within the repeater population, twelve percent were fatal (87 out of 729 repeaters). This segment of the airman population represents another area for safety education activity.

XIII. Physician Pilots.

Occupational studies relative to accidents have revealed interesting statistics. For example, physician pilots in the U. S. appeared in the annual fatal aircraft accident rosters an estimated four times in excess of their representation within the general aviation pilot population. After an intensive educational program launched by the FAA, the separate number of M.D. fatal accidents dropped slightly, but not enough to give

a clear cut effect. The M.D. flight accident circumstances revealed that the majority of physician accidents resulted from fatigued M.D. pilots undertaking long planned and highly anticipated trips for recreational purposes. The victims happened to draw departure or return times which coincided with adverse weather, and, in view of the "therapeutic" nature of the flights, elected to risk adverse weather rather than scrub the anticipated flight. When the above personal human frailty pitfall was grought to the attention of the pilots, some appear to have developed the capacity to avoid future similar emergincies. Details are given in FAA Report AM *66–25*.

XIV. Gyrocopters.

In the United States a considerable home-built amateur "experimental" movement is active and tens of thousands of aircraft resulting from this activity are in various stages of construction and flying. The safety experience of the group appears quite good, and through their national organization, the Experimental Aircraft Association, the dissemination of safety information is quite extensive. In following the program, one type, the separate small self-powered single seat "gyrocopter" segment, seems to experience a relatively high accident rate.

Selected examples of fatal accidents involving powered gyrocopters are shown in Table I. From the table, it is apparent that some enthusiasts are pursuing flight in the new gyrocopters in a fashion reminiscent of the way early aviators pursued flight in their fragile aircraft, the result being a high accident rate due either to pilot limitations or aircraft frailties. In view of the popularity of this new segment of aviation, we hope to encourage steps which effect a reduction in gyrocopter accidents.

XV. Commentary and Conclusion.

Each year a new crop of student pilots emerges and many move into the private pilot category. From this, a significant number go on to higher certification. Air safety information programs, therefore, must be continuing and repetitive. Accident case histories are object lessons and the dissemination of the factors leading to specific accidents have important educational value for all airmen, but especially the new airman. Of critical significance are the Aviation Medical Examiner (who is the only legally designated individual periodically seen by each airman) and the flight instructor (probably the most important single person in the airman's flight career). Accordingly, our safety programs and literature for distribution will continue to be directed to

TABLE I

Date	*Location*	*Circumstances*
9/25/66	Benton, Pennsylvania	Waiting details.
10/22/66	Raleigh, North Carolina	Waiting details.
10/26/66	North Kingsville, Ohio	Waiting details.
12/12/66	Dowagiac, Michigan	Waiting details.
1/28/67	Chino, California	Waiting details.
4/6/67	Scottsbluff, Nebraska	After owner started engine, propeller blades inflicted fatal injury—strong surface winds.
5/14/67	Westland, Michigan	Three descents then fatal, out of control, impact.
7/10/67	El Mirage, California	Waiting details.
9/2/67	New Orleans, Louisiana	Flying low over road, pulled up and nosed over, followed by crash.
9/16/67	Palmyra, New York	On base leg, pieces came from gyrocopter at about 40 feet altitude.
10/10/67	Cimarron Field, Oklahoma	After circling airport at 100 feet, gyrocopter went into a steep dive with rotor blades coming off in air.
10/22/67	Lockport, Illinois	Pilot carried "medi-alert" card referencing a previous heart attack. Pilot may have had another while inflight.
11/5/67	Brown Field, San Diego	Disintegrated at 200 feet.
1/21/68	El Mirage Lake, California	Waiting details.
2/13/68	Chula Vista, California	Waiting details.
2/19/68	West Liberty, Iowa	Crashed near highway.
3/24/68	Upshur County, West Va.	In strong winds, pilot thrown from aircraft, fractured skull in blade contact.
6/20/68	West Point, Virginia	Turned upside down shortly after take-off. Physician pilot.
7/14/68	El Mirage, California	Waiting details.

these two groups as well as all airman. Motion pictures illustrating the relationship of various medical factors to accidents are being made by the FAA. The latest of these is just completed and describes the psychological factors which underlie unsafe flight.

In conclusion, we recognize that many factors conspire to cause accidents, and probably there is an irreducible number of accidents which result from "unreachable" closed-minded individuals. We intend to continue our investigations and research into the medical and emotional factors underlying general aviation accidents with the appropriate follow-up by educational activities, including pamphlets, reports, talks to pilot groups, and movies for loan.

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