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AEROMEDICAL REVIEW

AIRCRAFT ACCIDENT INVESTIGATION FOR FLIGHT SURGEONS

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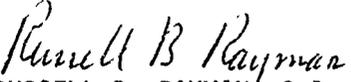
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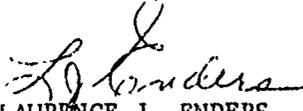
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This aeromedical review has been reviewed and is approved for publication.


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(1) to provide the flight surgeon with a practical guide to aircraft accident investigation; (2) to suggest a style of completing AF Form 711gA (Life Sciences Report of an Individual Involved in an AF Accident/Incident); and (3) to provide the flight surgeon with references relating to aircraft accident investigation.

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AIRCRAFT ACCIDENT INVESTIGATION FOR FLIGHT SURGEONS

INTRODUCTION

After Air Force physicians graduate from the Aerospace Medicine Primary Course at the USAF School of Aerospace Medicine (USAFSAM), Brooks AFB, Texas, they may be called upon at any time to participate in the investigation of an aircraft accident. The flight surgeon is obligated to provide the accident investigation board with an accurate and complete life sciences report including constructive recommendations. This is one reason why flight surgeons are on flying status--to provide a better understanding of aircraft operations and egress/life support systems, an understanding which is indispensable for successful investigation.

Aircraft accident investigation requires knowledge and skill. Knowledge of investigative techniques is imparted both at USAFSAM, and from reflective study of Air Force publications and professional journals. However, acquiring the skill (as well as style) of aircraft accident investigation is quite another matter--it must be developed and refined with experience; it simply cannot be instilled in a short course of instruction. What is expected of novice flight surgeons, however, is a thorough understanding of the basic principles of aircraft accident investigation as well as adequate preparation (before the accident occurs). This should provide the flight surgeon with adequate resources to complete a constructive and useful medical investigation.

This review was written primarily for the benefit of novice flight surgeons who have already received classroom instruction in the basic principles of aircraft accident investigation, but who have little or no practical experience. It has three primary purposes: (1) to provide the flight surgeon with a practical guide to aircraft accident investigation; (2) to suggest a style of completing AF Form 711gA (Life Sciences Report of an Individual Involved in an AF Accident/Incident); and (3) to provide the flight surgeon with references relating to aircraft accident investigation. If only a fraction of this material helps the flight surgeon in the field, aircraft accident investigation will be improved and the purposes of this review will have been fulfilled.

BACKGROUND

When one considers the nature of military flying, for example, aerial combat maneuvers, air-to-ground weapon delivery, air-to-air refueling, formation flying, and low level navigation, one cannot help

but be impressed by the USAF flying safety record, particularly during the last ten years. Certainly, the professionalism of our aviators and the increased command attention and support of flying safety have contributed to the excellent record of the U.S. Air Force. However, in spite of even the very best of flying safety programs, the nature of military flying is inherently risky and, as a result, aircraft losses and aircrew ejections will continue.

When accidents do occur, they must be investigated thoroughly in the hope that whatever information is revealed will help prevent a recurrence. As stated so well in AFM 127-1, Aircraft Accident Prevention and Investigation: "The purpose of an aircraft accident investigation is to determine all factors, human and material, which directly or indirectly contributed to the accident. This information can be used to . . . prevent recurrence of similar accidents. Each accident investigation adds to the overall USAF accident experience, providing a basis for corrective action. The proper use of accident experience results in elimination of accident potentials." (1, para 8-2).

ROLE OF THE FLIGHT SURGEON

Aircraft accidents are due to either human factors such as illness, disability, or errors of judgment; mechanical factors such as material failure; or environmental factors such as weather. Therefore, in order for an aircraft accident investigation board to have a full spectrum of expertise, its voting membership includes: a president who is a pilot or navigator; an investigating officer; a pilot current in the accident aircraft; a maintenance officer; and a flight surgeon.

The flight surgeon's role is to determine the cause of injury/death, to decide if egress/life support equipment functioned properly during the escape, survival, and rescue sequence, and to ascertain if there were medical or human factors which contributed to the accident. The importance of this role is underscored by the fact that personnel error accounts for 55% of aircraft accidents; material failure for 30-35%; and in 4-7% of accidents, the cause is undetermined (1, para 1-5). How the flight surgeon fulfills this role is the subject of the ensuing pages of this review.

PREPARATION

One of the keys to successful aircraft accident investigation is preparation. The flight surgeon who makes an extra effort to be prepared will be better able to respond quickly and efficiently should an accident occur. This effort will, undoubtedly, contribute to a better final product. Preparation cannot be overemphasized since accidents always seem to occur at times least expected and at times of the greatest inconvenience. The following are suggestions to the flight surgeon which will help ensure readiness should the unexpected occur.

a. Designate a ready access area in a convenient location of the Flight Surgeon's Office for the paraphernalia that a flight surgeon might need for aircraft accident investigation. The accessibility of these supplies would then permit the flight surgeon to respond expeditiously to an accident whether it occurs during the day or in the middle of the night. Regardless of when an accident occurs, the flight surgeon must be ready to deploy immediately with supplies to the accident site. Groping for them, particularly in a deserted hospital at night or very early in the morning, is a poor way to begin.

b. In the designated ready access area, pertinent regulations and publications which will assist the medical officer must be maintained. These, at a minimum, include AFM 127-1, Aircraft Accident Prevention and Investigation, and AFR 127-4, Investigating and Reporting U.S. Air Force Mishaps (6). Articles germane to aircraft accident investigation such as are found in TIG Brief, Aerospace Safety, and Aviation, Space, and Environmental Medicine could also be kept on file. Other publications are suggested in the bibliography of this review. If this were done, the flight surgeon would have a ready-reference library from which he could extract useful information during the investigation.

c. Medical investigator kits should be prepacked, stored, and ready for immediate use. The number of kits and the extent of their contents must be determined by the flight surgeon based upon the wing mission, the nature of the surrounding area, and type of aircraft that most frequently takes off and lands at that particular base. For example, a base which accommodates high-performance single-seat aircraft and is located near a metropolitan area has potentially different investigation problems than a MAC base, situated near rugged hill country, where large aircraft are coming and going. Although flight surgeons are free to design their own investigation kits, the following is a suggested kit which can be modified accordingly.

Actually there should be two types of kits. One would contain minimum supplies most suitable for on-base accidents involving small aircraft or for physiological incidents. Waterproof plastic bags serve well as containers for the contents. Although the exact contents are at the discretion of the flight surgeon, the following minimum items are recommended: AF Form 711gA (Life Sciences Report of an Individual Involved in an AF Accident/Incident), vacu-containers, needles, tubes for collecting blood specimens, tourniquets, lab and x-ray request forms, paper, and pencils. More could be added, of course, but these items should be enough to begin the investigation of most USAF aircraft accidents. As many of these kits should be prepacked as might conceivably be needed: perhaps 6 to 10 on a fighter base and 20 to 30 on a cargo/transport/bomber base.

A second type of kit could be designed more suitable for deployment to off-base accident sites or for more serious accidents in which there are several or many casualties/fatalities. This kit could contain, in addition to the contents of the waterproof plastic bags described in the

preceding paragraph, such items as flashlights, scissors, pocket knife, metal stakes, twine, tape, and heavy leather gloves. Other items could be added at the discretion of the flight surgeon. Perhaps, only two or three such kits housed in flight surgeon crash bags would be sufficient for most bases.

For further suggestions as to the contents of the above kits, the reader is referred to report SAM-TR-74-43, Aircraft Accident Medical Investigators Kit (9), that lists every conceivable item for a medical investigator's use. This excellent publication provides many ideas. Each flight surgeon must make selections based upon preference and anticipated need.

Prepacked kits such as these are invaluable to a flight surgeon who must deploy quickly to an accident site. On hand would be the Form 711gA and the necessary supplies to begin the investigation on the shortest notice.

It is of questionable economy to buy expensive items such as cameras and tape recorders and then to store them, perhaps unused for years, risking breakage or loss by pilferage. Furthermore, the necessity is questionable since cameras and recorders are available to the flight surgeon from other sources. As for photography, the aircraft accident board has full support of the Base Photo Lab, whose personnel are immediately called to the accident site and are at the service of all the board members. These professional photographers will respond, therefore, to the needs of the flight surgeon and will take whatever photos, black and white or color, that are requested. Because Base Photo Lab personnel do fully support accident investigation and because of the superior quality of their product, it is recommended that the medical investigator fully rely on them, thus obviating the need to purchase and store expensive cameras. (A note of caution: as part of the preaccident investigation actions, the flight surgeon should insure by written agreement that the Photo Lab will take both color and black and white pictures.)

The same can be said for tape recorders. They will be made available by the host base for use by the board members. In case a flight surgeon needs a recorder before the board has one in its possession, arrangements can be made for temporary loan from the base medical facility.

d. To be an effective and efficient investigator, the flight surgeon must do far more than have neatly tucked-away publications and a complete investigator's kit. The sine qua non of being prepared is training that can be obtained in several ways; for example, flight surgeons should be required to review periodically aircraft accident investigation procedures. This training can be done, in part, by reviewing AFM 127-1 and AFR 127-4, particularly those chapters and paragraphs dealing with the medical portion of the investigation. Furthermore, AF Form 711gA should also be reviewed periodically block by block. It is recommended that flight surgeons accomplish these reviews quarterly,

as a group, at the Aerospace Medicine Council Meeting. Only in this way can flight surgeons maintain familiarity with aircraft accident investigation procedures, with their role as investigators, and with the proper accomplishment of AF Form 711gA.

e. Flight surgeons must be familiar with the structural features of the aircraft, the egress system, and life support equipment utilized by the squadron to which they are assigned. Additionally, the flight surgeon must know the nature of the squadron missions and the portions of the missions which are especially demanding on both the pilot and the aircraft. This knowledge is gained not only by flying, but also by visiting periodically the egress and life support shops, by talking to shop personnel, and by reading appropriate publications such as the aircraft dash one and various technical orders dealing with the egress/life support systems of squadron aircraft. Only in this way can the flight surgeon understand this equipment and its operation, and be able to identify deficiencies. When suddenly called to the field following a crash, the flight surgeon must already be very familiar with those systems.

f. The flight surgeon must become acquainted with flying safety and life support personnel and should attend their meetings, both with the wing and squadron. This is another way that the flight surgeon can learn more about the mission, safety, and life support problems and can also establish good rapport with those officers with whom he would be working in the event of an aircraft accident.

g. And finally, novice flight surgeons should read over old aircraft accident reports which are usually on file in the wing flying safety office. These reports can be very instructive in that they represent examples of completed formats of previous investigations.

h. Ensure that 901X0 aeromedical technicians remain current in aircraft accident investigation procedures. Although they receive training during the Aeromedical Specialist Course, the material may be forgotten unless it is periodically reviewed. These technicians frequently provide invaluable assistance to flight surgeons particularly in those accidents involving large numbers of personnel. Although technicians are not voting members of the board, they may participate with the flight surgeon in the investigation.

THE AIRCRAFT ACCIDENT INVESTIGATION BOARD

When an accident occurs, the flight surgeon will be immediately appointed as a voting member of the aircraft accident investigation board. In some cases, he may be the squadron flight surgeon; in other cases, he may be sent from another base. This very much depends upon the location of the accident and the major command policy. In any event,

the medical member must be fully dedicated to the investigation. The flight surgeon must be relieved of all hospital duties, permitting a full-time commitment to the accident investigation. AFM 161-33, The Aerospace Medicine Program, states: "While an investigation is going on, it must be regarded as the investigating flight surgeon's primary duty" (5). If the flight surgeon is permitted to spend only a portion of his time with the board in order for him to continue with his hospital duties, in most cases, the accident investigation duties will suffer. For the very best product, total immersion in the accident board proceedings is mandatory. And this is achieved only by full-time presence with the other board members. In general, most investigations last two to five weeks.

Exactly how a board functions depends very much upon the board president. Usually, the board is given a work area, secretarial support, and whatever other administrative support is required. Each investigator goes about his business accomplishing his portion of the investigation by visiting the crash site, interviewing survivors and witnesses, and consulting with other experts and board members. Most board presidents have a meeting twice a day for cross talk, discussion, resolution of problems, and updating progress. These meetings are extremely important in that the investigators can not only discuss and resolve problems, but also can provide information to one another. It provides a forum for the integration of all available information which is so necessary in constructing the sequence of events leading to the accident as well as an analysis of its cause. This lends further credence to the requirement for the flight surgeon to be 100% dedicated to the accident board proceedings.

Although the flight surgeon is the only medical member of the investigation board, he may solicit assistance and consultation as he deems necessary. In fact, this is very much encouraged. For example, he may want to consult with egress specialists or life support personnel. (In some commands, a life support officer is routinely assigned to work directly with the flight surgeon as a nonvoting member of the board.) Other consultations may be with the pathologist in order to ascertain cause of death or cause of injuries. The autopsy findings of the pathologist and the operational knowledge of the flight surgeon must be integrated in order to understand various injury patterns. Therefore, the young, inexperienced flight surgeon should never feel alone since he may call upon any number of available consultants.

The flight surgeon member of the board should conduct his investigation without any pre-conceived ideas. It is of utmost importance that he keep an open mind and not prematurely draw conclusions based upon what he has heard or upon what seems obvious at first glance. A good investigator approaches an accident as a detective approaches a murder mystery-- everyone and everything is suspect. The flight surgeon must seek answers to many questions: Did any human factors cause or contribute to the accident? Did the egress and life support systems function properly?

What caused death or injury? Were there any survival problems? What can be recommended to prevent a recurrence? The flight surgeon then must gather evidence in order to answer these questions. It can come from the wreckage, autopsy, survivor testimony, lab and x-ray studies, witnesses, and findings of other members of the board.

Certainly every accident is different; none ever follows a script. They may occur on or off base; fighters, transports, bombers, or helicopters can be involved; some cause as many as 100-150 fatalities; others result in various injuries but no fatalities; other accidents will involve successful or unsuccessful ejections. Therefore, because of the wide range of circumstances surrounding aircraft accidents, the investigator must be flexible in his approach to the investigation. What is written in this paper, therefore, may not apply to every situation. Suggestions by this author have been kept intentionally rather general in order to serve as a framework. Flexibility and improvisation within this given framework are essential.

THE INVESTIGATION

Survivors

The flight surgeon who first arrives at the scene of an aircraft accident has, as his primary responsibility, the medical care of any survivors. Once this is done, however, and the responsibility for patient care has been assumed by other physicians, attention should then be focused upon starting the medical portion of the accident investigation. Even if the on-site flight surgeon is uncertain as to whether or not he will be appointed to the board, he must still begin at once. This collected preliminary data can always be given to any other medical officer that might subsequently be appointed to the board.

Many experienced flight surgeons feel that the investigation, particularly interviewing the crew, should be started as soon as possible. Although a natural and well meant inclination is to wait until the next day to allow the crew to settle down physically and emotionally, it is advisable, if at all possible, to forego this temptation. If the crew interviews are postponed, it is possible that the survivors might forget some small, but extremely important details of the accident sequence.

Assuming that the aircrewmembers have survived the accident (or ejection), the flight surgeon should take them immediately to the hospital for a complete physical examination (using SF88, Report of Medical Examination and SF93, Report of Medical History) to include lab and x-ray studies-- even those aircrewmembers who have no apparent injury. There are several cogent reasons for taking the survivors immediately to the medical facility: to determine extent of injuries and to begin treatment; to extricate the crew from a chaotic crash site; and to begin the interviews.

Aircrewmembers who think they are not hurt are often found to have injuries. Therefore, an examination as soon as possible is mandatory. For example, many pilots who have ejected from high-performance aircraft and have experienced no back pain have been found to have compression fractures of the thoracic-lumbar vertebra. One study indicated that 10% of airmen who eject will sustain such an injury (8). In any event, the flight surgeon must then initiate whatever treatment is necessary and must also decide whether or not there are medical reasons for temporary (or possibly permanent) removal from flying status.

Another reason for taking the crewmembers quickly to the hospital is to remove them from the tumult and excitement at the crash site which very quickly will attract a multitude of people, unofficial as well as official. Well meaning commanders, life support and flying safety personnel, maintenance personnel, and others, in their haste to learn the circumstances of the accident, will frequently deluge the aircrewmembers with questions. This is not good practice since it not only delays medical care of the survivors, but also subjects them to answering very important questions in an atmosphere of excitement and tension. Suggestions made by these people may lead to distortion of the memories of the aircrew as to what actually happened. The flight surgeon is in a position to extricate politely and legitimately the aircrewmembers in order to take them to the hospital. Once the medical examination is complete and treatment rendered, other officials can be given access to the crews in a much more controlled and comfortable hospital environment.

Although the flight surgeon has the crewmembers in the hospital primarily for medical evaluation and treatment, he incidentally has the luxury of beginning his portion of the investigation in the quietness and privacy of his office or ward. Once the medical needs of the crew have been addressed and the situation has somewhat settled, the best technique is to have each crewmember dictate (using a tape recorder) the history of flight and the events leading up to the crash (or ejection). In this way, with the details fresh in mind the aircrew can give statements which the flight surgeon will have available for the board. This can be invaluable, not only for the flight surgeon, but also for the other members of the board. The crewmembers can provide a much better history of flight if it is recorded in the quietness of the flight surgeon's office as soon as reasonably possible after the accident.

Because the flight surgeon is very concerned with human factors, he should fully investigate the preaccident behavior and environment of the aircrew. In order to do this, the crew must provide a detailed 72-hour preaccident history of their activities. Of particular relevance during that time is the eating, drinking, and sleeping history. A variety of questions come to mind. Did the pilot have a good night's sleep the night before the accident? Was he under any particular stress because of family or financial problems? Had he been drinking excessively during the past few days? For example, it is quite possible that the crewmember had a serious family problem and was feeling depressed and unable

to sleep well for several days. Perhaps he had taken several sleeping tablets borrowed from a friend the night before the accident and was not in very good condition to fly the following day. Such information can only be ascertained by an aggressive flight surgeon who investigates in detail the environment of the crew. Not only must this 72-hour history be taken from the crewman, but also from his family, friends, and squadron mates who were with him during that three-day period. And it should be investigated for aircrew fatalities as well as for survivors.

X-ray and Laboratory Studies of Survivors

Special studies are an integral part of the investigation. This includes x-rays and clinical laboratory/toxicological determinations on the survivors and decedents (this section discusses survivors only; see page 14 for decedents). X-rays of the spine are mandatory on all aircrew members who had ejected from or bailed out of an aircraft. As already stated, approximately 10% of crewmen who eject sustain compression fractures usually of the lower thoracic and lumbar vertebra. Frequently these fractures cause little or no pain and cannot be detected clinically.

In addition to x-ray studies, blood and urine specimens should also be obtained and sent to the laboratory. The purpose of these tests is not only for investigation, but also, for detection of possible underlying disease that may have contributed to the accident. Laboratory tests recommended include CBC, carboxyhemoglobin, blood alcohol, blood glucose, urinalysis, and a drug screen. These tests may detect conditions of potential significance such as anemia, infection, carbon monoxide inhalation, hypoglycemia, and diabetes. Blood alcohol and drug screening tests are also ordered as a routine, although positive tests for alcohol-illicit drugs are practically unheard of in military aviation accidents. There have been, however, accidents possibly caused by the unauthorized use of medication for unreported illness.

It is very strongly recommended that laboratory request forms be marked MAJOR AIRCRAFT ACCIDENT in bold print to be sure that they are not lost and that the laboratory is aware of the importance of these studies. For these reasons, the medical investigator should have a personal conference with the laboratory OIC and NCOIC regarding the critical importance of their role in the situation. It is also most wise to retain in appropriate storage second aliquot specimens in case of loss of the original. All lab studies should be reported as soon as possible and the results entered on AF Form 711gA. The investigation cannot be properly closed until all lab data are reported; stating that a lab result is "pending" is not acceptable. Of course, if a lab result is abnormal, the flight surgeon must determine why and whether or not the abnormality was a causal or contributory factor to the accident.

THE CRASH SITE

At the crash site, the flight surgeon may well discover invaluable evidence in his investigation. For this reason, nothing should be moved or removed at the accident site until the accident board members have had ample time to fully comb the area and to photograph the entire site as well as any portion of the wreckage which may be germane to the investigation. Of particular interest to the flight surgeon are: the extent and cause of injury/death; and the employment and function of the egress system and life support equipment. Because many types of aircraft are in the USAF inventory, each with its own systems, the flight surgeon must tailor his investigation accordingly.

Escape from aircraft can be by ground egress, bailout, ejection, or by capsule. In general, most USAF accidents involve aircraft with ejection seats. However, regardless of the escape system or the type of aircraft, there are established procedures for emergency escape with which the crew must be intimately familiar. Therefore, the flight surgeon must fully investigate every detail of the escape sequence, paying particular attention to its function and to crew discipline, i.e., did the crew follow established procedures during the escape?

Flight surgeons will be challenged to determine causes of injury/death. Factors to be considered are decelerative forces, use of restraints, injury by fixed or flying objects, and the escape method and sequence. Useful information in the analysis is the position of bodies or parts thereof in reference to the wreckage and the ejection seat. Distances and directions should be noted and recorded on a small scale map. By meticulous attention to detail, injury patterns and causes of death can often be ascertained.

To give a few examples, if a pilot with multiple injuries was found one mile from the crash site with a fully deployed but partially burned parachute, it then becomes a distinct possibility that the aircraft was on fire prior to the crash and that the pilot's parachute was burned sometime during the ejection sequence ultimately causing his death. This information not only helps the flight surgeon explain the cause of injury/death, but it may also be important to other board members who are trying to determine what type of malfunction occurred in flight.

Or, if a pilot was found with a severe skull fracture and his helmet was located a half-mile from the crash site, it would be reasonable to assume that fatal injuries were incurred because of helmet loss sometime during the escape sequence. But why was the helmet lost? Was it due to high Q forces? Or because the pilot had not fastened his chin strap? Perhaps other squadron members may relate that the deceased frequently flew with his chin strap unfastened. Was this carelessness the cause of death and, if so, what could the flight surgeon do to prevent recurrences?

For ejection-seat aircraft, the flight surgeon must analyze in detail the ejection sequence from the time the decision was made to eject until the pilot reached the ground. However, because of the complexity of ejection-seat firing and sequencing, egress specialists should be consulted. Questions to be addressed are: Did the aircrewman properly utilize the egress system? Did it function as it was supposed to? Are there recommendations for improvement? As examples, if the flight surgeon finds that the D-ring had not been pulled on the ejection seat, this is good evidence that either the pilot did not attempt ejection or that he was incapacitated prior to ground impact. Or, if the D-ring had been pulled, but there was no ejection, a faulty egress system is suspect. These are only a few examples of an infinite variety of circumstances with which the flight surgeon might be confronted. By consultation with an egress specialist, these and other such problems can often be solved.

The flight surgeon with life support personnel as consultants must also investigate the employment and function of all life support equipment. Although this equipment varies considerably from aircraft to aircraft, it generally includes parachutes, life preservers and rafts, and survival kits with such items as radios, beacons, flares, and first-aid kit. Much of this equipment is vital not only for escape, but also for survival and rescue. Did the crew use any of this equipment and did they use it properly? Did everything function as advertised? And if not, why not? What can be recommended for improvement? These questions clearly show why flight surgeons must be familiar with all life support equipment utilized by their squadrons.

Noncrew Members

The medical investigation is not necessarily confined to the aircrew itself. There have been accidents in which other support personnel have either contributed to or caused the mishap. For example, an accident could occur because of an error by air traffic controllers, maintenance personnel, or supervisors. This possibility must be considered and, if necessary, suspect noncrew members are then interviewed. As a hypothetical example, an air traffic controller may have given an aircrew faulty or erroneous information which resulted in a crash. Possibly, the controller had taken antihistamines for a URI or had not slept properly for the last several days and was not alert during duty. Or, perhaps maintenance personnel had worked long hours because of operational necessity and left a tool in the engine resulting in damage and serious malfunction. Again, an infinite variety of scenarios are possible and should always be suspect by the flight surgeon.

On occasion, the flight surgeon may need to interview witnesses. For example, it is possible that somebody had seen the crash or had seen the ejection sequence. Such an on-site observer can provide the investigation board with very valuable information. Most often, such

witnesses are called before the entire board so all its members may have the opportunity to ask questions. This procedure is usually done formally since the testimony is official and does have legal implications.

Survival and Rescue

The accident sequence includes survival and rescue events which the flight surgeon must also investigate. Although most downed airmen are rescued within hours, there is always the possibility that crews would have to survive, perhaps in a hostile environment, for days. Pertinent questions would include: Was the appropriate survival equipment available? Did it function? Was it used properly by the crewmen? Did rescue teams respond appropriately? What problems were encountered during the rescue operation? All of these factors must be analyzed in depth by interviewing all concerned parties in addition to the survivors and by examining the life support equipment used by the crews. Any discrepancies should be included in the final report with recommendations for their correction.

Fatalities

An autopsy must be done on each aircrew member fatally injured. This autopsy is essential since gross and microscopic examinations often give clues not only of causes of death/injury, but also of pre-existing disease heretofore undetected, e.g., coronary artery disease, which may have contributed to or caused the accident.

However, the requirement for autopsy has legal implications regarding jurisdiction and laws regarding jurisdiction of aircraft fatalities vary from state to state. In some states, jurisdiction is waived, thus allowing the autopsy to be performed in Air Force medical facilities; other states may have stricter laws whereby the coroner has jurisdiction. In any event, it is extremely important that flight surgeons become familiar with the laws of the state in which their Air Force base is located.

It is also recommended that the flight surgeon establish contact with the coroner or medical examiner and that procedures for the disposition of aircraft fatalities be worked out in advance. In this way, in the event of an aircraft accident with fatalities, there will be no breach of state law nor confusion as to jurisdiction for moving bodies and performing autopsies. (Flight surgeons should be aware that just moving the body from an accident site is illegal in many states unless permission has been granted by the coroner or medical examiner.)

It is in the best interests of the investigation board if an Air Force pathologist performed the autopsy since he is familiar with Air

force autopsy procedures and requirements. Furthermore, it facilitates consultation with the investigating flight surgeon, which is necessary since injury patterns can be best determined by integrating the pathologist's knowledge and the flight surgeon's knowledge of the aircraft and its escape systems.

In some cases, identification of bodies may be very difficult because of severe trauma or because of a large number of fatalities. If such a problem exists, the flight surgeon has several recourses. Because teeth are usually not destroyed in even severe accidents, dental surgeons can determine identity by comparing the deceased's dental records with the teeth found. Also, fingerprints and footprints can be used for identification. Even in accidents in which the hands and fingers are destroyed, the feet remain intact because of protective flying boots--and every Air Force crewmember has a footprint in his medical records. If there are so many fatalities that the base pathologists are inundated, assistance should be requested from the Surgeon's Office, Air Force Logistics Command (2. 7).

Autopsy studies must be done as soon as possible after an accident since decomposition results in the formation of ethanol and aldehydes which invalidate toxicological studies of which more will be said below. Embalming procedures, if done prior to toxicological studies, will also invalidate them.

As part of the autopsy, the pathologist must secure tissue and biological specimens for toxicological analysis since these may reveal very important information for the medical investigator. Such specimens are submitted for analysis to the Armed Forces Institute of Pathology (AFIP) (3. 4). Tissue specimens should include, if possible, 150-250 grams of liver, brain, kidney, lung, and marrow, each of which should be placed in a labeled plastic bag and mailed in dry ice to AFIP. Do not use chemical preservatives since they can invalidate various studies. Properly packed, this permits a transit time of 24 to a maximum of 72 hours. If available, blood, urine, and stomach contents should be packed in the same manner and shipped to AFIP. Toxicological studies done by AFIP on tissue and biological specimens include carboxyhemoglobin, alcohol, lactic acid, and a drug screen (approximately 75 drugs are included).

In the event of fatalities, it is also recommended to x-ray the entire body. Sometimes important clues and unexpected injuries are revealed, such as the presence of foreign bodies or projectiles which otherwise would have remained undetected.

AF FORM 711gA

The medical portion of the aircraft accident investigation report is completed on AF Form 711gA. Life Sciences Report of an Individual

Involved in an Air Force Accident/Incident. The form is very complete and addresses the entire accident sequence including egress/ejection, survival, and rescue. It serves as an excellent format for the investigating flight surgeon whose task it is to gather, to sort out, and to analyze a considerable amount of data. Therefore, it cannot be over-emphasized that flight surgeons must periodically review the 711gA, block by block (instructions for its completion can be found in Chapter 11 of AFR 127-4), in order to ensure familiarity with its content and format. Then, suddenly confronted with an accident investigation, the flight surgeon will at least have a preconceived notion of how to proceed.

A word of caution: flight surgeons frequently feel compelled to "fill in" all of the blocks of the 711gA as quickly as possible. This compulsion should be resisted lest the investigation be an unthinking pursuit of unrelated details. Rather, view the accident from the heights, integrating and correlating all of the available evidence, and use the Form 711gA only as a vehicle for recording information. It should not be forgotten that, although the flight surgeon can ask for assistance (for example, a life support officer or a physiological training officer), the ultimate responsibility for its accurate completion is his.

Although modified over the years, the basic format of the 711gA has remained about the same. Therefore, in anticipation of further changes, the form will not be discussed block by block. Rather, generalizations will be made that may be applied regardless of how it may be structured in future years.

1. Flight Data

This section addresses weather and environmental conditions, the information of which could be provided by survivors or from secondary sources.

2. Medical Information

Medical information required by the form is of particular interest to the flight surgeon. All injuries must be identified, their cause determined, and an estimation of when they occurred during the accident sequence. Only by such an analysis can recommendations be made to prevent similar injuries in the future. Diseases or defects present at the time of the mishap must also be noted since they very well may have contributed to the accident. This requires that the medical records of all aircrewmembers be reviewed in detail. It is also important to know whether or not the aircrew member was flying with a medical waiver since it must be determined if the waived medical condition contributed to the accident. (This information may help determine if USAF waiver policy is too liberal or too conservative.) All lab, x-ray, and autopsy results are also included in this section.

3. Psychophysiological and Environmental Factors

This section is extremely important in that these factors have been and continue to be contributory to a significant number of accidents annually. Each of the factors must be considered in relation to the accident, escape, landing, survival, and rescue. This is a particularly tedious portion of the flight surgeon's investigation because causal relationships of some of the factors, e.g., boredom, inattention, and overconfidence, are difficult to prove. Therefore, the investigation of psychophysiological and environmental factors will put the flight surgeon to the test. Any of the factors which contributed to the accident or which were suspect must be explained fully in the narrative portion of the flight surgeon's comments and analysis. Furthermore, appropriate recommendations for corrective action should be made.

4. Personal Data

Information in the crewman's flight and personnel records concerning flying experience, schools attended, and training is included in this section. These data may be useful if the flight surgeon feels inadequate flying experience or training were contributory factors. Also included in this section are anthropometric measurements, which can be a factor in ejections from small cockpit aircraft by crewmen who are unusually tall or with excess sitting height.

5. Personal, Survival, and Escape Equipment

The medical investigator should have assistance from life support personnel in completing this section. All life support equipment which the aircraft and crew carry must be identified and must be discussed regarding its availability, its use, and its proper function during all phases of the accident sequence, i.e., accident, escape, landing, survival, and rescue. In the event there were any discrepancies in the use or function of this equipment, an explanation with recommendations should be included in the flight surgeon's comments and analysis.

6. Egress, Survival, Ejection, Bailout

The escape sequence whether by ground egress, ejection, or bailout must be investigated in detail. This portion of the 711gA provides an excellent guide for this purpose since it addresses practically every conceivable difficulty that an aircrewman might encounter. Conscientious completion of these sections will help identify escape problems and will permit constructive recommendations.

7. Survival and Rescue

Survival and rescue are part of the accident sequence and, therefore, must be fully investigated. This section addresses all aspects of survival and rescue: environmental conditions, appropriate use of equipment by the crew, and rescue operations. Any problems or difficulties must be identified with appropriate comments and recommendations included in the remarks portion of this section.

8. Flight Surgeon's and Life Support Officer's Analysis and Recommendations

This section is the single most important part of the Form 711gA. It is in this section that the flight surgeon and life support officer summarize their findings, their analyses, and recommendations regarding the accident, egress, survival, and rescue sequence. All pertinent findings in the preceding sections of the 711gA should be discussed in detail. The flight surgeon should make thoughtful, constructive recommendations to correct deficiencies, to prevent recurrences, and to enhance flying safety.

It is in this section that the crewman's 72-hour preaccident history is included. Remember, relevant information can be obtained not only from crewmembers, but also from their families, friends, and squadron mates. The flight surgeon should make extra efforts to probe into all precrash activities with particular attention to eating, sleeping, and drinking during that three-day interval. It may be found that poor diet, inadequate rest, or unreported illness are significant factors.

Because the circumstances of aircraft accidents can vary infinitely and the number of aircrewmembers vary from aircraft to aircraft, the flight surgeon is not held to a rigid format in completing this section. Therefore, he must tailor this section according to the circumstances of the accident. With experience, most flight surgeons develop a style. However, any reasonable format and style are acceptable as long as the information is clear, complete, and accurate. One suggested format follows.

- a. A short description of the events leading up to the accident.
- b. A short description of the crew to include such information as crew position and prior flying experience.
- c. A chronological account of activities of each crewmember for the previous 72 hours.
- d. A complete analysis of the accident, egress, survival, and rescue. Pertinent information included in the previous portions of the 711gA should be discussed in detail with particular attention to problems encountered, malfunction, etc.

e. Describe all medical considerations, i.e., presence of disease, waivers, lab and x-ray studies, and, if applicable, relevant portions of the autopsy report.

f. Conclusions based upon the aforementioned narrative.

g. Recommendations for correction of any deficiencies.

The flight surgeon's very last entry on the 711gA is recommendations for correction of deficiencies. As the completed accident report passes upward through appropriate channels, attention is given to the recommendations of each board member. If the recommendation is considered sound, action agencies are then assigned in order to implement it. For example, if a defective part which may have contributed to the accident was found in the accident aircraft, e.g., an F-15, it is quite possible that messages would be sent to every Air Force base with F-15's informing them of the defect and requiring that the particular part in question be fully inspected. Or, if a flight surgeon finds over-the-counter medications in the flight suit of a deceased crewman, it may be recommended by higher headquarters that the subject of flying and medication be reviewed by squadron flight surgeons at the next wing flying safety meeting.

In some cases, deficiencies are discovered which require immediate attention and which cannot wait for the accident report to reach higher levels. For example, the flight surgeon and life support officer might find serious parachute malfunctions that would require a full inspection and correction of similar parachutes worldwide. In such cases, immediate action messages are dispatched through channels to warn commanders of an existing situation which could lead to death or injury of personnel and loss or damage to aircraft and property.

Once in final form, the 711gA is incorporated into the entire aircraft accident investigation board's final report. The report is subsequently routed through major command channels to the Air Force Inspection and Safety Center (AFISC) at Norton AFB. In the Life Sciences Division of AFISC, the AF Form 711gA is reviewed by flight surgeons and life support officers. Then the data is entered into computer-maintained records. By reviewing the 711gA's of all accidents occurring worldwide, the Life Sciences Division is then able to discern various trends in Air Force accidents. With this information, appropriate action can be taken to remedy problems, to modify life support/egress systems, and to improve flying safety.

Furthermore, personnel of the Division have been able to retrieve data from the computer for aircraft accident epidemiological studies and to publish professional journal articles of great use to investigators in the field. Examples of such articles include "Human Factors in Air Force Aircraft Accidents," "Myocardial Infarction: An In-Flight Problem?," "Spinal Injuries in Nonfatal USAF Aircraft Accidents," and "Helmets and

Head Protection in USAF Ejections." Therefore, in the interest of flying safety, it is apparent that the flight surgeon must accomplish the 711gA very thoroughly, completely, and accurately.

PHYSIOLOGICAL INCIDENTS

AFR 127-4 states: "A physiological episode is a physiological reaction, near accident, or hazard in flight due to medical or physiological reasons" (6, para 6-3g(2)). Examples include hypoxia, presence of toxic substances, decompression sickness, hyperventilation, spatial disorientation, loss of consciousness, and rapid decompression above 25,000 feet. Although such incidents usually do not require convening a full aircraft accident investigation board, the flight surgeon is required to investigate the incident and to complete only those parts of the 711gA which are relevant. General guidelines can be found in AFR 127-4, para 6-3g(2) and 11-4c. The purpose of the medical investigation of a physiological incident is the same as for an accident.

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