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16. Abstract

The advantages of aircraft in providing military medical evacuation are well documented. Training and experience have resulted in a reliable and safe military medical evacuation system. Many studies have been done or are in process which pertain to civil emergency helicopter evacuation.

Fixed-wing secondary ambulance service is growing at a rapid rate without the benefit of studies such as those pertaining to helicopter primary ambulance service. Problems associated with this growth relate to equipment, crew training, and knowledge of the physiology of flight. Legislative and/or education efforts are needed to assure optimum general aviation patient transportation.

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AEROMEDICAL TRANSPORTATION AND GENERAL AVIATION

I. History.

The herald of today's helicopter and fixed-wing ambulance was the "flying ambulance" or "ambulance volante" introduced by Baron Dominique Jean Larrey, a French Army Surgeon serving under Napoleon.[21] By comparison, the "flying ambulances" of Larrey were heralds in deed as well as in name since, prior to that time, wounded were either carried to the rear by their comrades or were left lying unattended where they fell until the fighting ended. Larrey's "flying ambulances" were small horse-drawn carts for preliminary surgical treatment as well as transportation of the wounded.[21]

Some form of ambulance service existed as early as the 11th Century; the British Ambulance Association relates its founding to services provided in 1084 at the time of the crusades.[19] In spite of this early start and the marked progress by Baron Larrey around 1800, there was, in general, slow acceptance of the service. In 1862, when ambulance companies were put into use in the Army of the Potomac, the Surgeon General's recommendation that they be used in all armies was disapproved by General Halleck on the ground that they would be expensive, cumbersome, and apt to lead to panic.[24] However, some progress was made during the Civil War and at the Battle of Antietam, the wounded were collected by ambulance, were placed under shelter, and had treatment initiated within 24 hours.[24]

The first hospital-associated ambulance service was reportedly provided by Cincinnati General Hospital prior to 1865.[19] Motor-driven ambulances first appeared in Chicago in 1899 and were frequently used in World War I.[19] The evacuation of patients by air first occurred during the Russian siege of Paris in 1870 when 160 wounded were successfully airlifted by balloon.[30] Although air evacuation was limited during World War I, 1½ million patients were moved by air in World War II.[30] Helicopter ambulances first came into use in 1950, during the Korean Conflict.[19]

Helicopter Ambulance Service. Helicopter evacuation and transportation services are credited with contributing substantially to reduced mortality rates in the armed forces. The mortality rate of those reaching a medical facility was 8.1 per cent in World War I, 4.1 per cent in World War II, and 2.5 per cent in the Korean Conflict. It has remained at 2.5 per cent in the Vietnam War.[22] There is a paradoxical effect attributed to helicopter ambulance service which results in the erroneous impression that the mortality rate has not improved since the Korean Conflict. Actually, the marked increase in use of helicopter service has resulted in many casualties reaching a medical facility who, previously, would have died in the field. A comparison of the number of deaths with the number of wounded is a more meaningful indication of the success of evacuation and treatment. In World War II, 27 per cent of casualties were either killed in action or died after admission to a medical facility. In Korea, the rate was 22 per cent; it has been reduced to 17 per cent in Vietnam.[22]

Based on such success in the military, the use of helicopter ambulance service has been recommended for civilian use both to diminish the death rate among the approximately 10,000,000 disability-producing accidents per year in the United States, and to facilitate treatment in the innumerable acute illnesses requiring immediate medical care. It has been estimated (by a surgeon who was involved in military medical care in Vietnam) that almost one-half of the current highway toll could be saved if rapid evacuation services [32] were available. A similar allegation appeared in *Government Executive*, stating that a soldier wounded in Vietnam has a better chance of survival than a person receiving the same degree of injury on the streets and highways in most of the United States.[7] The major difference between the Vietnam battlefield and United States highways is the rapid evacuation of combat wounded by helicopter.

Much has been written recently about the advantages of helicopter ambulance services, particularly on congested highways, on the ski slope, and in other hard-to-reach areas.[1 3 8 15 20 28 29 35] Also, numerous studies are being conducted by Federal agencies to evaluate various aspects of helicopter evacuation.[26]

The federal studies mentioned above cover a gamut of areas such as: comparison of small and large helicopter effectiveness; validation of cost effectiveness of utilizing helicopters for single purpose missions; comparison of ground versus air-ambulance effectiveness; effectiveness of combined helicopter and ground ambulance service; design and operation of a helicopter medical evacuation system in a widely variable rural environment; development of data to validate new training, equipment, and techniques for patient handling; feasibility of employment of ex-military corpsmen; and utilization of helicopters to determine effects on reducing response time and improving evacuation capability.[26]

State air ambulance programs are in process in California, Arizona, and Mississippi, and metropolitan studies are being conducted in Detroit and Minneapolis-St. Paul.[7 26] One county in Texas is currently using a joint military-civilian helicopter service to evacuate automobile-accident victims to San Antonio Hospitals; an experienced corpsman accompanies the helicopters which are on 24-hour alert.[8 17]

Early in 1968, in Southgate, Michigan, the nation's first private helicopter ambulance service was begun.[14] Other private programs or studies have been undertaken in Pennsylvania, North Carolina, Maryland, Montana and other areas.[15] The Health Foundation of the District of Columbia Medical Society has offered to provide matching funds to provide helicopter ambulance service.[23] The Missouri State Highway Patrol has ordered a STOL fixed-wing aircraft for evacuation of highway-accident victims.[10]

Although a recent paper opined that the cost of helicopter equipment and crews may prevent extensive civilian utilization,[33] there are other indications that considerable growth in helicopter ambulance use is expected. A recent advertisement of an engine manufacturer stressed the advantages of helicopter ambulances.[5] There is also a recent report that, in the Washington, D.C. area, insurance companies have offered to provide coverage for helicopter ambulance service through regular health insurance programs.[23] This coverage would be based on $30 per helicopter pickup plus $3 per operating minute. The authors assume that this cost is based on the anticipated reduction of mortality which has been predicted.[6] Various publications have pointed out the availability of equipment and trained personnel (both air crew and medical attendants) for civilian programs should hostilities in the Far East cease, e.g.[16] Surplus or obsolete military equipment is presently being utilized in a program conducted by a state National Guard and the state university hospitals. In fact, there are some who believe the only limiting factor to widespread helicopter usage is the availability of heliports since, unless the patient can be transported directly into the emergency room from the helicopter without use of an intervening ambulance, advantages are significantly reduced.

Fixed-Wing Ambulance Service. The use of air-taxi transportation of patients has experienced remarkable growth. There was a fivefold increase in the number of trips and miles flown from 1958 to 1966[18] without the benefit of extensive research such as is presently being performed in helicopter evacuation.

The fixed-wing operation differs from the helicopter flight in that it usually involves transportation of patients from one city to another either for the convenience of the patient or the family, or for prolonged intensive or special medical treatment. This function is usually designated as secondary ambulance service. Whereas helicopter flights are usually of short distance, the average fixed-wing flight for medical transportation averages about 800 miles.[18]

II. Present Status.

There are many well-equipped air ambulances with well-trained crews including aeromedical technicians. Certainly most medical transportation flights are performed without difficulty, but incidents have occurred which suggest that certain educational and legislative efforts should be directed to air ambulance services both to remedy the existing deficiencies and to prevent multiplication of problems if continued growth in air ambulance services occurs.

Case Histories.

1. A 22-year-old female was a passenger in an automobile which was struck from the rear by a large truck. She was diagnosed as having a dislocation of two cervical vertebrae with incomplete flaccid paralysis of both arms and the right side of the body. While in the hospital, she regained partial function of the arms. She had "received a collar" following reduction of dislocation. Approximately five weeks later, while still in the hospital, a cast was applied following a second reduction. The elevation of the city of hospitalization was 6,800 feet msl. One week later, the patient was placed on a bed board, taken by ambulance to the airport, and placed in a reclining position in a twin-engine aircraft. The flight elevation was 8,500 feet at first and later rose to a maximum of 9,200 feet. The patient was discussing the flight with the nurse and crew, and was not observed initially to have any difficulty in breathing. Later, however, the attending nurse noticed the patient's head droop. The nurse administered oxygen, attempted to cut off the cast, and requested the pilot to land because she was having difficulty with the patient. The nurse could detect no vital signs prior to the landing; and after the landing, the patient was pronounced dead. At autopsy, both lungs were edematous and congested, and the right lower lobe manifested pneumonia with coalescing patches. The cause of death was reported to be bronchial pneumonia, secondary to fractured cervical vertebra. The hospital records revealed a spike in temperature the day before departure and a pulse rate of 120. The patient, on atropine because of complaints of frequent swallowing of saliva, had also received one and a half grains of codeine before the flight. Prior to the accident, she had been living at sea level. The air-taxi operator was told that the patient was fine for the flight and that there should be no problem with the planned maximum flight altitude of 9,200 feet.

2. A twin-engine aircraft was used to transport a middle-aged man who had been hospitalized with a diagnosis of leaking aortic aneurysm. At the request of the patient's family, the man was to be flown to a well-known medical center for surgical correction. The patient's doctor was reluctant to release him but, at the insistence of the family, a release was effected. The patient, in a marginal medical condition, was transported to the airport by ambulance. He was loaded on board the aircraft with no attendant available and with only one pilot on board. The flight covered a distance of approximately 1,100 miles. At the time of landing, the pilot first observed that the patient seemed to be in shock. There had been no effort made to detect pulse or respiratory rate, or to observe the patient's general condition during the flight.

3. A twin-engine aircraft was used to transport a patient, previously hospitalized in a southern city for cardiovascular disease, to her home in the northern United States. There were no inquiries made by the patient's physician regarding altitude or the use of oxygen during flight. There was no oxygen available, no medical attendant on board, and only one pilot was present. When the aircraft reached the city, the patient was dead. The pilot stated that he was responsible to provide transportation and was not responsible for the patient's care.

4. A child was admitted to a southeastern hospital with second and third degree burns over the trunk. Because of business and personal pressures, the parents urged the physician to release the child for travel home. The physician finally consented and left instructions with the parents concerning necessary care, but no effort was made to secure medical assistance in flight. The child was placed on a single-engine aircraft with no medical attendant present and, apparently, with no space for the parents. The copilot was given instructions from the parents regarding medication and other instructions which had been received from the physician.

5. An elderly patient was being transported from a southeastern city to a northern city for prolonged nursing-home care. At the time of transfer, the patient was considered to be in marginal condition following a CVA which resulted in partial paralysis. The aircraft was equipped with suction, oxygen, and a nurse familiar with aeromedical evacuation problems. The patient was sedated during the flight. A physician was available at the point of dispatch for consultation with the nurse via telephone each time the aircraft stopped for refueling. The eventual altitude flown was higher than that planned and, during the flight, the patient became cyanotic and showed evidence of respiratory distress. Oxygen was employed and the nurse requested that the pilot descend to a lower alti-

tude. The pilot at first refused, but following persistent urging by the copilot and the nurse, finally did descend to a lower altitude.

6. An air-evacuation flight, with a nurse attendant on board, transported an elderly nursing-home patient with cardiovascular disease from a northern city to a southeastern city. During the flight, the aircraft was vectored by ATC from its proposed path of flight with some increase in the enroute flight time. Also, the aircraft was required to enter a holding pattern at several points, resulting in an unplanned fuel stop. While the aircraft was on the ground, there were delays in obtaining fuel; the patient reported being extremely uncomfortable due to the high temperature at ground level. The pilot was apparently either unaware of any method of expediting the flight, or could see no need to do so. (During preparation of this paper, the FAA announced that air-ambulance flights can now use "LIFEGUARD" on the flight plan if the pilot requests air-ambulance priority status;[2] such flights have previously been given priority on request, but, until "LIFEGUARD," there was no standard procedure for requesting priority handling.)

7. A single-engine aircraft was transporting an automobile accident victim with serious injury to a larger hospital in the state in which the accident had occurred. The flight was during hours of darkness. The patient apparently died shortly after takeoff, and the aircraft was returning to the originating airport. Probably due to mismanagement of mixture control, the aircraft lost power and made a crash landing. The 30-year-old female nurse accompanying the patient was in a rear seat of the four-seat aircraft and was not wearing a seat belt. The right front seat had been removed to accommodate the canvas stretcher which was neither secured nor restrained in any fashion, nor was the patient secured to the litter. At impact, both litter and patient were thrown out of the aircraft, the nurse received a concussion requiring hospitalization, and the 30-year-old male pilot experienced serious injury including multiple fractures.

Scope of Services Currently Available.

To gain more information on the scope of services available to the physician who might request air-ambulance service, 30 firms providing such services were contacted. They were selected in convenient cities from the yellow pages of the telephone directory. The authors do not maintain that the sampling was complete for cities surveyed (although completeness was attempted), nor that the city selection was at random. The approach was that of a physician requesting information on air-ambulance service with the following information needed:

1. Type and cost of aircraft.
2. Litters. (Do you furnish them or does the patient?)
3. Availability of litter restraints. (How do you fasten the patient in the aircraft?)
4. Availability of an attendant knowledgeable in aeromedical evacuation.
5. Availability of oxygen.
6. Availability of suction.
7. Availability of a physician for consultation regarding aeromedical problems. (Is it all right for the patient to fly?)

Results of the contacts with air-ambulance operators appear in Table 1. Not all questions were answered since some operators declined to respond to detailed questions unless service was actually being requested.

Cost. Based on our survey, the cost of air-ambulance transportation (a range from single-engine fixed gear at 26 cents per mile to jet aircraft at rates over $1.00 per mile) appears to be comparable to that of surface ambulances. The cost of surface transportation per mile is about the same or higher than the cost quote for twin-engine, propeller-driven aircraft. This finding is consistent with conclusions made at a VA hospital that it is both easier and more economical to transport its patients by air.[4] Although it has been suggested that pressurized aircraft be required for air-ambulance flights, at least for secondary service, this is not economically feasible (nor is the implied assumption accurate that all pressure-change problems would be eradicated).

Litters and Restraint. With the degrees of freedom of movement which can occur in flight, the problem of helicopter patients vibrating out from under restraints is only one of many restraint problems encountered with patients in the reclining position. A USAF report mentions the problem of aggravation of wounds by litter straps and suggests experimentation both with movable

TABLE 1.—Availability of Specified Medical Items and Services Reported in a Survey of 30 Secondary Air-Ambulance Operations

	Total Number of Respondents	Availability of Items and Services			
		Readily Available	Can Obtain	Not Available	Inadequate or No Information Obtained
Litters	30	22	0	5 (Patient must furnish if desired)	3
Litter Restraints	30	14	7 (Use seat belts)	7 (See text)	2
Medical Attendants	30	6 (with aeromedical experience)	5	15 (Patient must furnish if desired)	4
Oxygen	30	14	5	7 (Patient must furnish if desired)	4
Suction	30	6	5	17	2
Aeromedical Consultation	30	8	0	19	3

straps, and with greater distribution of pressure by the use of wider securing devices.[13] The report notes that presently-used litters are too narrow for nearly five per cent, and too short for over five per cent, of Air Force personnel.[18] Since casts and other appliances may require additional accommodation, the need for different or larger litters becomes evident. One air-ambulance firm which we contacted has constructed a vest with straps attached to assist in restraint (we have a verbal report of an apparently similar device being marketed by a West German firm), but seven firms reported no litter restraint at all. We assume that the negative answer was in reference to litter restraints and that at least seat belts are available.

Attendants and Crew. The National Research Council has urged that the 30,000 medical corpsmen (many with aeromedical experience) who leave the service annually be appropriately utilized.[16] Air Force reserve units have well-trained, experienced personnel,[11] many of whom might well prefer air-ambulance work to their present occupation (which in most cases, in our experience, is already medically related). However, only 20 per cent of the operations contacted by us have technicians available with aeromedical experience.

It is anticipated that the considerable recent efforts directed toward the formation of a national registry of attendants for surface ambulances [25] will eventually be extended to include the aeromedical technician. Certainly much of the training provided for surface emergency medical technicians would be applicable to aeromedical technicians, especially for primary air-ambulance service. Altitude physiology would have to be added since it is of particular importance for secondary air-ambulance service. The stabilized, low-risk patient can have considerable discomfort or experience a life-threatening exposure if hypoxia or hypobaric problems either are not prevented or are mismanaged. Programs in physiological training are conducted at the FAA's Civil Aeromedical Institute (Oklahoma City, Oklahoma) and at a number of USAF bases. Although only 1,000 or so applicants per year have previously taken advantage of this opportunity, over 8,000 general aviation pilots applied in 1970,[13] as a result of increased awareness of availability of the training.

Without assurance that air-ambulance workers are well represented among participants in physiological training programs, consideration should be given to requiring them to take such training. Since it should not be necessary for an

indoctrinated technician to explain or to justify to an uninformed pilot the need for flight-profile changes, flight crews should also be required to receive this training.

Aeromedical indoctrination of flight crews would provide other benefits; although not directly related to flight safety, they would at least tend to prevent crew distraction. Two recent incidents demonstrate the value of knowledge of the gas laws obtained through physiological training. A commercial pilot was transporting the remains of a traffic fatality. Near midnight, as the unpressurized, super-charged, twin-engine aircraft climbed through 14,000 feet, vocalization sounds came from the body for a matter of seconds. The lone pilot was shaken, but continued the flight. The pilot's greatest concern was that, were he to discuss his experience, his FAA medical certificate might be in danger due to suspected psychiatric problems. Four months later, while taking physiological training, a presentation of Boyle's Law brought him to the realization that gas expansion in the lungs of the cadaver had reached a point where the gas escaped and vibrated the vocal cord.

In another case, a commercial pilot was leveling off at altitude when the cadaver he was transporting seemed to emit a prolonged sigh. The pilot had helped load the body on the plane and was convinced that it contained no life, but he experienced some consternation and could not bring himself to turn around and look. He subsequently became aware of what had probably occurred during a discussion of aeromedical principles and gas laws in a physiological training course.

Oxygen. Seven of the operators surveyed reported no oxygen available; five others could obtain it on request. However, a long-standing NPRM applicable to general aviation recently went into effect as a regulation which will require oxygen use for flights over 30 minutes above 12,500 feet and for all flights above 14,000 feet.[9] As part of the intensive educational campaign by the FAA to acquaint pilots with the need for an oxygen source, pilots have been urged to use aviators' breathing oxygen with its very low humidity to prevent freezing of the regulator. Most physicians would anticipate that the oxygen provided by an ambulance (surface or air) would at least be medical oxygen, and preferably humidified oxygen for some patients. Air ambulance operators should, therefore, be aware both of the need for humidification beyond the regulator if the aircraft oxygen is used, and of the increased likelihood of regulator freezing (due to added cooling during expansion of oxygen to greater-than-sea level volume) if medical oxygen is used.

Some physicians feel strongly that low-level flight in unpressurized aircraft will obviate the risk of depressurization one faces in high altitude pressurized aircraft. A handbook from the American College of Surgeons,[27] in discussing the air ambulance, makes no mention of hypoxic problems, apparently assuming all flights are either low level or pressurized.

Suction. Although suction equipment will certainly be needed on some air-ambulance flights and should probably be a requirement for all secondary and primary air-ambulance aircraft, 17 of the operators surveyed indicated that they had no such equipment.

An Air Force study outlined the range of pressures needed for various types of suction (oral-nasopharyngeal versus closed cavity situations) and mentioned a need for at least 25 inches Hg pressure for hospital use, and a minimum of 10 inches Hg for emergency field use. Following the Air Force evaluation of three different suction units, a general purpose respirator and a chest suction unit were suggested.[31] None of the general purpose aspirators now in use meet all of the desired criteria noted above. The availability of a 110-volt power source in air-ambulance aircraft would permit presently available equipment to meet the recommended requirements for thoracic suction. With an increase in air-ambulance service, it is anticipated that equipment designed specifically for general aviation aircraft use will be available.

Aeromedical Consultation. The major deficiency in the services offered by air ambulance operators is the lack of contact with a physician knowledgeable in aeromedical evacuation (19 of the firms reported none). The use of such a physician would reduce all of the previously mentioned problems. His absence is a manifestation of the unjustified confidence on the part of the ambulance operator, or the customer, or the patient's physician, that the other party meets certain standards. The physician and/or the family assumes that an air ambulance is as well

equipped and staffed as a ground ambulance. The air-ambulance operator frequently appears to assume that no one would be referred for aeromedical transportation who is not in adequate condition to be so transported. The operator also assumes that the physician will prescribe any supportive regimen required to provide safe transporation, but many physicians are not aware of of the special problems associated with flight and may not give proper consideration to patient welfare in the potentially hostile environment of reduced barometric pressure and reduced partial pressure of oxygen.

Proper administrative involvement of physicians would be expected to aid patient transfer by the establishment of uniform documentation of patient status including among others, diagnosis, condition, and type and time for administration of medication (preferably on a Greenwich mean time basis). It would be of particular advantage to have the necessary forms available at all hospitals.

In fact, a specified procedure is necessary to avoid the previously mentioned problems of unjustified confidence or avoiding responsibility in either the dispatching physician or the air-ambulance operator. Only two of the firms which we contacted mentioned that they require a written release from a physician prior to accepting a patient for transportation. It is the opinion of many of the experienced personnel in the Military Airlift Command that proper preparation of patients and document standardization would be a significant aid to convenient and safe patient transportation.

Additional Service Considerations.

In addition to the topics covered above, there are other considerations which require attention in air-ambulance service.

Choice of Patients. Patients with heart disease should be excellent candidates for aeromedical transportation providing supplementary oxygen is available. However, a patient with pneumothorax, post traumatic emphysema, intestinal obstruction, or penetrating eye injuries would, of course, constitute a risk regardless of oxygen administration if exposed to sufficiently decreased barometric pressure. These and other conditions require pressurized aircraft.

Pressurization. Although pressurization would eliminate hypoxic and hypobaric difficulties, it can also cause problems, as manifested by a case in which an air ambulance retained sea level pressurization until landing at an airport of 3,000 feet elevation. The sudden pressure reduction upon opening the door caused a bottle of intravenous fluids to surge out through the vent, and probably forced fluid through the IV tube at an increased rate. Moreover, sudden increases in pressure, such as would occur in a rapid descent, could cause increased rates of flow of blood from plastic donor bags, with the associated hazards of cardiovascular overload. Although the air splint is desirable for aviation transportation since it is lightweight, changes associated with gas expansion at altitude could conceivably impair a patient's circulation by pressure from the splint. One air splint now manufactured has a safety valve. An attendant could restore vented pressure either as the ambient pressure increased at the end of a flight, or at the time of any reduction in altitude. Physiological indoctrination would give pilots and technicians the background to handle or prevent such problems. Any internally used balloon or pressure device would be less easily managed.

Turbulence. Frequently flights remain below 5,000 feet over level terrain without encountering too much turbulence, but over hilly or mountainous terrain, turbulence may be difficult to avoid at even moderate altitudes. Besides the discomfort so generated, especially for a sick or injured person, the possibility of air sickness is always present, and thus every air-ambulance operator should follow the practice of the Military Airlift Command and refuse to carry a patient with maxillofacial or dental surgery which has necessitated wiring of the jaws. The military will transport such patients only with elastic tie bands or an emergency release mechanism which can be activated by the patient or attendant.[34]

g Forces. Although short term forces of turbulence or maneuvering will not usually constitute a problem for the properly restrained patients, the person with some form of traction could be subject to marked changes in traction forces. These changes in g forces are prevented in USAF Military Airlift Command flights by the use of spring tension devices in place of weights. The concomitant reduction in weight would be of particular benefit to general aviation.

III. Need for Organization.

There is a clear need for unity among operators, such as can occur through a national organization. Such unity could not only elevate standards but could also do much to stimulate production of appropriate equipment for the general aviation air-ambulance operator. Costs could possibly be pared by coordination of to-and-from flights to reduce one-way revenue flights. Since there will be unscheduled, overnight stops, hospitalization when required could be facilitated through interaction with members of an organization such as the Flying Physicians Association, a presently constituted, aeromedically-oriented association with members throughout the country.

A group of persons from government and industry with interests in air-ambulance service met recently in Oklahoma City under the chairmanship of the senior author to initiate a national air-ambulance organization. Their recommendations, which are listed below, give some indication of the high standards that could be promoted through such an organization.

1. There should be provisions for environmental controls for adequate heating and cooling of the area occupied by the patient.

2. There should be provisions for an AC power source aboard aircraft so that necessary medical devices can be utilized in flight.

3. There should be provision for emergency airway management, laryngoscopy, suction equipment, various size suction catheters, and a hand-operated ventilator with associated airways. There should be on-board provision for peripherally humidified oxygen with a flow meter for the patient.

4. Drugs, instruments, trauma control equipment (such as splints and bandages), and any other indicated device or equipment should be placed on board when appropriate to the illness or the mission.

5. Litters should be so constructed that they may be anchored to the aircraft with the patient secured to the litter. They should be stressed to the same "g" requirements as that of the aircraft. The restraints securing the patient to the litter should be such that they distribute their forces uniformly and avoid pressure points. Further, access to the aircraft should be through a door constructed in such a way that it provides a minimum of movement of the litter and the patient while the latter is being placed in the aircraft.

6. Communications should be provided between pilot and attendant, and it is desirable to have communications between the attendant and the ground. The communications should allow the attendant to remain in the immediate vicinity of the patient.

7. Attendants should be on every ambulance flight and they should be briefed medically on the interhospital transfers. Further, it should be required that the attendant and the pilot-in-command have knowledge of basic resuscitative techniques and basic aviation physiology.

8. Illumination in the aircraft should be available in the area of the litter. Portable lighting facilities should also be available so that areas around the patient can be highlighted.

Some topics not covered in this paper, but which require consideration in air-ambulance operations, include the following: transportation of premature and other infants; transplant donor, or organ, transportation and the effect of their support devices on navigation equipment; importance of noise protection for the patient; and medicolegal responsibilities, such as insurance.

IV. Summary.

The Military Airlift Command has developed an excellent international system with outstanding features of safety and convenience. Although some of these features are not applicable to the general aviation air-ambulance network, many MAC standards set goals for the general aviation air-ambulance operator to strive toward. A great deal could be accomplished by a national organization of air-ambulance operators which could set standards, encourage joint efforts to provide equipment modernization, and possibly reduce costs by coordination among members to decrease the number of one-way revenue flights.

At the present time, some states are considering laws pertaining to air-ambulance operations. It is the opinion of the authors that if any national regulations governing patient transportation by air are written, many government agencies including the FAA could be involved. Recent changes in Federal Aviation Regulations, Part 135, provide much higher operational standards for the air-taxi operation than previously existed. These changes affect any air-ambulance

operator, but at present there are no regulations which mention the specialty of air-ambulance operation.

Efforts are necessary (be they legislative and/or educational) to bring the care of the patient being transported by air to the same level provided by surface transportation in those states and cities with regulations. The fact that a patient is being transported does not alter his patient status. This is best summed up in the words of Brigadier General Harold F. Funsch, a pioneer and a present leader in the movement to provide modern, safe, and convenient patient transportation: "Patients are not cargo, patients are not passengers, patients are patients." This motto of the Military Airlift Command should be the dictum of all general aviation air-ambulance operators.

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