Docket No. SA-530

Exhibit No. 6J

NATIONAL TRANSPORTATION SAFETY BOARD

Washington, D.C.

Patient Transport Request
AMPA, Principles and Direction of Air Medical Transport
Chapter 7: Considerations in Vehicle Selection for Patient Transport

Blumen, I. J, Corbett, P. & Krost, W. (2006). Considerations in Vehicle Selection for Patient Transport. In I.J. Blumen & D. L. Lemkin (eds.) *Principles and Direction of Air Medical Transport* (pp. 43-56). Salt Lake City, UT:Air Medical Physicians Association.

(14 Pages)

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Considerations in Vehicle Selection for Patient Transport

Ira J. Blumen, MD
Patti Corbett, RN
William Krost, BS, NREMT-P

INTRODUCTION

The vast majority of readers of this chapter and this textbook are most likely involved with or interested in ***air*** transport. However, air medical transport represents only one aspect of an integrated transport system. Medical transport services will best serve patients when the appropriate utilization of available resources is assured. Vehicles, personnel, and equipment represent the transport resources that must be addressed. In the United States, the federal Emergency Medical Treatment and Active Labor Act (EMTALA, also referred to as COBRA) requires that all transfers be effected through qualified personnel and transportation equipment. Appropriate vehicle selection is no longer merely a patient care issue, but also a requirement for EMTALA compliance.

The most appropriate vehicle for patient transport may be influenced by several considerations. Vehicle availability, distance, time, weather, geography, patient status, and transport logistics are all important items to address. The selection process should include review of the potential disadvantages and advantages of each mode of transport.

Patient transport vehicles include air ambulances (i.e., rotor-wing/helicopter and fixed-wing/airplane) and ground ambulances. Patient transfer may require the use of one or more of these vehicle types. Generally speaking, critical care transport programs choose vehicles based upon their anticipated mission profile. A fully integrated transport system would include all three vehicle options. Triage decisions would then dictate the most appropriate vehicle for the particular mission.

It is essential for individuals who are knowledgeable about the transport environment and vehicle capabilities to participate in the patient triage process. Decision makers most often are the transport team professionals directly involved in these decisions on a routine basis. Referring physicians, receiving medical staff or other hospital personnel may not have the experience or the knowledge required to make optimal decisions.

The items presented in this chapter are generally considered when transport teams determine which vehicle will best fit the patient's needs and the program's goals. Non-transport personnel will find this information helpful as an introduction to this important topic.

TRANSPORT DECISIONS: A FOUR-STEP PROCESS

Selecting the most appropriate mode of transport requires four steps, which are summarized in Table 7-1. The first, and most crucial, step is patient evaluation. It is essential to make an accurate assessment of the patient's real and potential illnesses or injuries. It is also necessary to anticipate the most serious compli-

Step	Process	Consideration or Action
1	Patient evaluation	• Assess the patient's illnesses or injuries, both real and potential. • Anticipate the most serious complication that could occur during transport.
2	Evaluate the medical care required by the patient	• What care is available at the referring hospital or scene of an accident? • What care does the patient need prior to and during transport?
3	Is the transport time-critical?	• If "no," determine availability of an appropriate vehicle. • If "yes," consider: o How long will it take for a vehicle to arrive at the referring facility? o How long it will take to deliver the patient to the receiving hospital?
4	Consider the logistics of patient transport	• Available resources • Weather • Ground traffic and accessibility

Table 7-1: Four-Step Transport Decision Process

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cation that could occur during transport. If a patient's medical condition is unstable, even a minimal shortening of transport time may be lifesaving. In many cases, reducing out-of-hospital transport time has been shown to be beneficial to patient outcome.

Evaluating the medical care required by the patient is the second step of the decision tree. This step is often two-fold, evaluating both the medical care available at the referring hospital or accident scene and the care the patient may need prior to and during transport. The level of care needed during transport is the more common consideration when considering the transport personnel. However, there may also be an urgency to deliver a higher level of care and/or additional personnel to the scene of an accident or a referring health care facility to stabilize a patient prior to transport.

Step three determines if a transport is time-critical. If the transport is *not* time-critical, then the only real consideration is the availability of an appropriate vehicle for transport. However, if transport is time critical, it is important to consider how long it will take for a selected vehicle to arrive at the referral site *and* how long it will take to deliver the patient to the receiving hospital. These questions take into account the distance, speed, geographic limitations, and availability of the various vehicles. It also considers the scope of transport. A vehicle dispatched directly from the referring hospital to the receiving hospital constitutes a one-way transport. More commonly, the transfer will be two-way, with the vehicle and crew being sent from the receiving hospital to the referring hospital to pick up the patient. Transports can also be three-legged or three-way. In this case, the vehicle and team requested to do the transport are dispatched from a location other than the receiving or referring hospital. Hospital-sponsored flight programs and independent providers (air and ground ambulance companies) often do these third party transfers. In recent years, the dominant growth in helicopter EMS within the United States has been in the independent provider model.

The fourth step addresses the logistics of patient transport. This includes the availability of local resources, weather considerations, ground traffic, and accessibility of roads and landing areas.

General criteria for the appropriate use of air medical transport are summarized in Table 7-2. These criteria correspond to steps three and four of the decision tree.

Time and Distance Criteria	
Transport Time	The patient's clinical condition requires that the time spent out of the hospital environment be as short as possible.
Transport Delays	Potential transport delays associated with the use of ground transport are likely to worsen the patient's clinical condition. Delays might result from traffic congestion, construction, road obstacles, location of highway exits, floods, snowfall, or distance.
Timely Treatment	The patient's condition is time critical and the patient requires specific, timely treatment that is not available at the referring facility (or scene) in order to minimize morbidity and/or mortality.
Distance	The distance to the closest appropriate receiving facility is too great for a safe and timely transport by ground ambulance.
Logistical Criteria	
Critical Care	The patient requires critical care life support (monitoring, personnel, medication, or special equipment) during transport that is not available from the local ground ambulance service.
Local Ground Resources	Local ground units are not available for long distance transport, or the use of a local ground transport service would leave the local area without adequate EMS coverage.
Inaccessible Area	The patient is located in an area which is inaccessible to regular ground traffic, impeding ambulance access to or egress from the specific location. Lack of access may be due to traffic congestion, road obstacles or conditions, weather-related events (floods, snowfall), wilderness location, or other geographic considerations.

Table 7-2: Criteria for Air Medical Transpor

TIME-RELATED FACTORS

Many factors must be considered when evaluating the "time" necessary to undertake and complete a transport. This consideration of time goes beyond the speed of the vehicle and the distance between hospitals or transfer points. Time-related considerations for transport include response time; speed of transport; stabilization and preparation time; and out-of-hospital time.

RESPONSE TIME

The period of time from the initial call for transport until the transport team arrives at a referring facility or accident scene is referred to as the response time. Transport services that respond directly to the scene generally require a rapid response time. Similarly, if a transferring facility cannot stabilize a patient, the response time to the bedside of the critical care transport team may

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be more crucial than the time it takes to transport the patient to the receiving facility.

Many variables enter into the final response time. When a transport team is based at the referring hospital, no travel time is required and response time may be almost immediate. While the team assesses the patient and prepares the patient for transport, the referring physician could be contacting the receiving facility and physician.

More commonly, a transport team will not be on-site at the referring facility. Following the initial contact between the referring and receiving facility, time is required to accept the patient, mobilize resources, and dispatch the critical care transport team. Dedicated helicopter and ground teams are often on their way within 10 to 15 minutes or less. A medical airplane usually takes longer to coordinate and depart, with time to takeoff ranging from 15 minutes to an hour or more. This delay is often due to the fact that the pilot and medical crew may not be "on-site" at the airport, but rather "on-call." In addition, the pilot is required to file a flight plan prior to departure. Takeoff delays may be even greater if the aircraft is not dedicated for medical missions and must be reconfigured for patient transport. Taking into consideration all of these variables, it is not uncommon for the preparation time to equal to one hour.

Considering response times and logistics of vehicle options may at times make choices difficult. A ground ambulance that may be immediately available at a referring hospital could be enroute to the receiving hospital long before a distant helicopter could arrive to the referring facility. However, the ground ambulance may have to contend with traffic, construction, irregular terrain and other ground-related delays which pose no impediment to aircraft. In the U.S. many programs are strategically placing air and ground critical care transport vehicles in remote areas to improve the response times to the patient.

Response times for helicopter services should consider the availability of a safe helipad or landing zone (LZ) near the patient's location. For interfacility transports, it is always preferred to have an on-site helipad or landing area close to the referring facility. A distant LZ may eliminate the advantage of the helicopter's speed by requiring additional "ground-time" to travel back and forth between the landing area and the hospital. Typically, a ground ambulance will pick up the medical team at the LZ and take them to the patient. The patient should *not* be brought directly to a distant landing zone to meet the aircraft and crew. Whenever possible, it is preferable for the transfer of care to occur directly from the referring physician to the critical care transport team for both medico-legal and continuum of care purposes. Unfortunately, this is not always possible or practical. Following the flight crew's assessment, stabilization, and preparation of the patient for transport, the ambulance will take the patient and team back to the helicopter.

For helicopter scene response, the availability of an on-site or nearby LZ is also an important consideration. Distant LZs will require an initial ground transport – by vehicle or by foot if in a wilderness or mountain setting – to rendezvous with the helicopter, which may add considerable time in the pre-hospital setting.

If use of a helicopter or airplane is considered, *total* response times must take into account the available landing sites. The helicopter has the capability to arrive directly at the hospital or nearby LZ, while the airplane must land at a more distant airport and requires a ground ambulance to transport the flight team a greater distance to and from the hospital. Depending on the distance to travel between the referring and receiving facilities, ground transport to and from the airport to a "fast" airplane may offset the advantage of a slower helicopter that can go directly hospital-to-hospital.

Finally, vehicle availability and weather conditions may impact response times of any mode of transport. For example, a medical helicopter may be unable to fly because of inadequate weather conditions, maintenance requirements, or prior transport commitments. Significant delays in response times may mandate the selection of a different vehicle for transport. Ground ambulance availability may also be restricted in certain weather conditions. During severe flooding, freezing rain, ice and heavy snow conditions, ground ambulances may not be able to safely reach a destination hospital. While some ambulances are equipped with retractable chains to help maneuver in the snow, it does not guarantee a timely response for ground transport in those conditions.

It is important for referring physicians to understand the factors that impact response times and to recognize what a "normal" response time should be. Considerable confusion may occur when referring physicians expect the response times from dedicated transport services or specialty teams to be comparable to those of local ground ambulance services.

SPEED OF TRANSPORT

When a critical care or specialty care team is urgently needed at the bedside, or when out-of-hospital time must be kept to a minimum, speed of transport becomes an important consideration. This is especially true as distances increase between referring and receiving facilities. In comparing actual speed of travel, airplanes typically provide the fastest mode of transport and ground ambulances the slowest. However, as previously stated, when utilizing an airplane, ground trans-

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port must also be utilized to get the patient to and from the airport.

In a time-critical transport or in remote geographic areas, the reduced travel time offered by air transport may be essential. In an urban setting where much shorter distances may be traveled, the ground ambulance may provide the best option.

STABILIZATION AND PREPARATION TIME

The amount of time that will be spent by the transport team to stabilize and prepare the patient for transport may also be related to the selected mode of transport. Critical and specialty care transport teams that arrive by air or ground often take more time to assess and stabilize a patient prior to transport than do local ground ambulance services. This is especially true of neonatal and pediatric transport teams who may spend a considerable amount of time at the referring hospital managing and stabilizing a patient *before* transport. A busy helicopter transport service may not be able to accommodate prolonged "out-of-service" times at the referring hospitals. Extended time "out-of-service" may result in other missed transports.

As part of a program's mission and routine practices, it is important to determine what is "appropriate" prior to transport. For some programs time will be considered most critical, and as such, transport teams always work as quickly as possible to expedite transports. For these programs, only interventions necessary to sustain the patient would be performed prior to initiating transport.

Other programs, however, will routinely do more to stabilize a patient prior to transport. The philosophy of these transport teams is that taking the time to perform stabilizing interventions prior to departing the referring unit provides optimal patient care. Patients with airway problems or profound respiratory failure may benefit when stabilized prior to transport.

Airway management decisions are critical when it comes to stabilization and preparation time. While patients can be intubated in the various transport vehicles – sometimes with extreme difficulty – it may be preferable to intubate in the more controlled environment of the referring unit. In preparing a patient for transport, other anticipated therapeutic changes may also be best handled first in the referring unit in order to evaluate the patient's response. Changing to a portable ventilator or to manual ventilation within the controlled intensive care unit, emergency department or operating room setting will enable the transport team to identify any ventilation or oxygenation complications that arise and to correct them before leaving the unit. A change in any medication to support the patient's blood pressure or cardiac rhythm is also best handled first in the referring unit.

The practice of some helicopter programs is to "drop off" specialty teams, most commonly neonatal teams, if they anticipate extended ground times. The focus in these situations is to deliver a highly skilled specialty team as quickly as possible to the referring facility to begin patient assessment and stabilization before patient transport is initiated. Preparation time can take one to three hours, depending on the clinical needs of the infant. A ground ambulance may be dispatched to transport the crew and patient to the receiving neonatal facility or the helicopter may return to complete the transport.

OUT-OF-HOSPITAL TIME

For stable patients, out-of-hospital time may not be critical. However, out-of-hospital time may be the most important factor in transport vehicle selection when dealing with time-critical transports or unstable patients. The total time spent in the transport environment will be dependent upon the logistics required to get to and from the vehicle, as well as the vehicle's speed. Out-of-hospital time will be affected by off-site helicopter landing zones and travel to and from airports.

The transfer of a patient from one vehicle to another is not only time consuming, but has been recognized as one of the most problematical and potentially dangerous times in transport of the critically ill or injured. Equipment is most likely to become disconnected or fail and monitoring of the patient is more difficult during these intervals. The ability to intervene will also be limited. Transfers between vehicles should be kept to a minimum to reduce transport times and patient risk.

GENERAL CONSIDERATIONS IN VEHICLE SELECTION

Patient transports can be conducted in various makes and models of helicopters, airplanes and ground vehicles. When evaluating a transport vehicle, specific capabilities should be investigated to assure that the program utilizes the vehicles which best serve their specific mission profile.

Vehicles should be assessed for usable cabin space and available options for medical configuration. The speed of travel and vehicle range may be important considerations for some programs, but less of a consideration for others. Noise and vibration are inherent to all transport vehicles and the transport environment. If aircraft are under consideration, additional specifications to evaluate include the number of engines, type of

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engines, useful load (the amount of weight that can be lifted), and capabilities for cabin pressurization (fixed-wing only). The costs related to vehicle selection must be carefully evaluated. Transport programs must strive to be cost effective regardless of the type of vehicle(s) selected.

The ideal transport vehicle should be safe, cost efficient, quiet, comfortable, medically configured and equipped, and fast enough to meet the program's needs. It should be large enough to transport one to two patients with two to four medical crewmembers. The vehicle must provide adequate patient access and be easy to load and unload. It should be inexpensive to purchase (or lease), inexpensive to operate, and require little maintenance. Given these parameters, many question if the ideal vehicle actually exists. Vehicle maintenance requirements are additional considerations. Vehicles with excessive maintenance may result in increased out-of-service time. An aggressive preventative maintenance program will help to reduce the number of missed missions or delays from vehicle downtime. In general, larger air and ground ambulances have increased maintenance needs and costs. This should be factored into the decision when comparing makes and models of vehicles.

SAFETY

Safety must be the first priority in patient transport. Everyone involved in the transport process must be responsible for the overall safety in and around any transport vehicle. The training and experience of the pilots, drivers, and mechanics responsible for vehicle operations are as important (if not more important) as the selection of the vehicles themselves. When evaluating different helicopters, airplanes or ground ambulances for your transport program, the vehicle's safety record should play a significant role. In addition, requesting hospital or pre-hospital agencies, when determining which critical care transport services to utilize should choose one that has demonstrated a significant commitment to safety.

Accidents have occurred with all modes of patient transport. In the United States, the National Transportation Safety Board (NTSB) collects data on aviation-related accidents. Ground ambulance accident data is very difficult to collect. Generally speaking, ground ambulances have a higher probability of being involved in an accident, but offer a better chance of survival than aircraft mishaps.

Before any patient transfer, the risks and benefits of different modes of transport should be carefully considered. This is also a requirement of the referring physician under EMTALA.

RANGE

The range of a vehicle is commonly defined as the total distance it can travel without refueling. Ground ambulances and helicopters may have a range between 150 and 400 miles, while airplanes may cover up to 2,000 miles.

SERVICE AREA

There is a direct correlation between vehicle range and the service area of a transport program. A ground ambulance may become inefficient, costly, and time consuming at distances greater than 100 miles. Fixed-wing transport programs may choose to be regional, cross-country, or international in scope. Helicopters will generally operate within a 100 to 150 miles radius from their base of operations. The National Association of EMS Physicians guidelines for air medical dispatch advocates that a rotor-wing aircraft, in general, provides a decreased response time to the patient up to approximately a 100 miles distance, depending on logistics such as duration of ground transfer leg. In comparison, fixed-wing aircraft provide a decreased response time to patients when transport distances exceed approximately 100 miles.

SPEED

As previously mentioned, the speed of the transport vehicle is important during a time-critical transport or when out-of-hospital time must be minimized. There is little variation between the different types of ground ambulances with regard to the speed of transport. In addition, ground ambulances are limited to the legal speed limit. The speed of helicopters and airplanes, however, will vary by make and model. The typical civilian air medical helicopter flies at speeds of between 115 to over 170 miles per hour, while airplanes may attain speeds between 120 to 450 miles per hour.

CABIN SPACE

Regardless of the vehicle selected, the patient care area during transport will be significantly smaller than in the hospital setting. Several space considerations should be assessed when choosing a vehicle to perform a particular mission. It is important to determine the number of patients, number of medical crewmembers, and the amount and type of medical equipment that will need to be carried at one time. Whether of not your mission profile includes the transport of specialty care teams should be taken into consideration, as their equipment needs are usually significantly greater. Many vehicles, especially certain helicopters, will be capable of transporting only one patient in comfort and safety. Others may accommodate two or more. At times, limited cabin space may not accommodate the number of personnel desired and procedures may become difficult or impossible. The transport distance may also be a cabin space consideration. Larger aircraft and ground ambulances with extended cabins offer crewmembers added comfort on long missions—when a patient is on-board or when there is no patient.

When dealing with pediatric transports, an important space issue is the consideration for family members accompanying the patient. Some programs feel that it may be beneficial for the anxious child to have a parent present in the transport vehicle. In tight confines, however, this may not be possible or appropriate. Many programs by policy will not take family members on air transport, but may allow this in a ground ambulance. During ground transport, if family members are regularly allowed to accompany the patient, use of the front cab may be an option. In helicopters and airplanes, it would not be appropriate for family members to be in the co-pilot's seat.

MEDICAL CONFIGURATION

The medical configuration of the air or ground ambulance is critical to the success of any critical care transport service. Most states establish the minimum medical equipment required onboard patient transport vehicles. State regulations may also address medical configuration. In the United States, the Federal Aviation Administration (FAA) regulates how built-in equipment must be installed and secured in aircraft. The Commission on Accreditation of Medical Transport Systems (CAMTS) provides voluntary accreditation standards that address medical configuration. While local and federal regulations must be adhered to, the actual design of the medical interior is usually left up to the owners and/or operators of the vehicles.

Medical configuration goes beyond the location of equipment, the number of patient litters and crew seats. The vehicle must be configured in such a way to allow the medical team to provide quality patient care consistent with their mission statement and scope of care. Easy access into and out of the vehicle's patient care area is critical. Doors must be wide enough to accommodate a transport isolette (assuming that the service offers neonatal services) or patient litter with all attached medical equipment. Two individuals should be able to maneuver the equipment easily into and out of the vehicle without excessive rotation or tilt from the horizontal plane. It is essential that the transport crew have adequate access to the patient's airway and be able to visualize the patient's upper torso at all times.

The cabin's medical configuration must be designed with the safety of the patient and crew in mind. Operational controls must be physically protected from accidental interference. Equipment should never be installed in close proximity to a person's head. The head-strike area must remain clear to avoid head injury in the event of accident or turbulence. This is true for both air and ground ambulances. In addition, all equipment must be secured during any vehicle movement. With sudden or extreme vehicle motion, unsecured equipment may become projectiles, resulting in injury to the patient, medical crew, pilot, or driver. It is essential that all personnel be properly instructed in vehicle and equipment tie-down procedures.

Further evaluation of the medical configuration of a transport vehicle should include examination of built-in or portable medical equipment, medication and supply cabinets, medical oxygen, suction, electrical power, cabin lighting, climate control, and communications gear. Additional consideration should be given to backup equipment and storage needs, depending on the mission profile.

Medical Equipment

The majority of the medical equipment used during transport should be portable. This allows the equipment to go "bedside-to-bedside" with the patient, and eliminates the need for monitors, ventilators, infusion pumps, and other devices to be built into the vehicle. Use of portable equipment requires a means for appropriate stowage and security of medical gear. Hard mounts for equipment offer the greatest protection against sudden unexpected movement in the ambulance.

Medication and Supply Cabinets

Adequate cabinet space for the storage of medications and supplies is mandatory. On-board drugs and supplies must be easily accessible to crewmembers from a seat belted position. Cabinets must be closed and secured during transport. Many designs have cabinets that slide open and flip up, which provide the best access for patient care and restocking the vehicle. Controlled substances must be kept locked and stored in a manner consistent with law, rule, and regulation.

Oxygen and Air

Portable and built-in oxygen should be available in all patient transport vehicles. The portable oxygen and air tanks back-up the built-in system and are used to promote safe transfer of the patient from the vehicle to the hospital or from one vehicle to another. Separate built-in oxygen systems should be available for each patient in vehicles that may transport more than one patient at a time. Oxygen sources and devices should have the ability to provide oxygen in concentrations between 21% and 100%. Sufficient oxygen and air must be carried to meet the estimated duration of the longest anticipated trip. A reserve equal to the length of the trip is recommended.

Gas outlets must be clearly marked for identification. Flow meters and outlets must be padded, flush mounted and located to prevent injury. A display showing the amount of oxygen remaining in the system should be visible to the crew from inside the cabin, which provides a safety check for oxygen depletion in transport. In case of on-board fire, there should be a means to terminate the flow of oxygen from inside the vehicle.

Many programs utilize liquid oxygen to conserve space and weight. This option also offers the ability to carry increased amounts of oxygen. If traditional tanks are used, a lift should be installed to assist in the loading and unloading of the oxygen tanks and reduce the risk of injury.

Suction

There should be two suction devices in the transport vehicle. Built-in suction is recommended, as is a portable system for back-up. A handheld suction unit is generally acceptable as a secondary suction device. Suction should be controllable to a maximum value of -300 mmHg. Vehicles that transport more than one patient should have discrete suction capabilities.

Electrical Power

Electrical outlets, power invertors and demand invertors are all important in the transport vehicle. The vehicle should have an alternating current invertor and a sufficient number of electrical outlets for the equipment that will be utilized. While portable medical equipment is usually supported by battery reserves, it is usually preferable to conserve battery life while in the vehicle. Many vehicles will also be equipped with a "shoreline," allowing portable equipment to be plugged into outlets in the vehicle so the batteries can charge while the air or ground ambulance is stationary between transports. The shoreline should include two main receptacles: one 120VAC to power the HVAC (heating, ventilating, and air conditioning) and a second 120VAC to power the other needs. Also a battery conditioner/charger with a battery saver is a useful addition to any ambulance. It can be powered off the shoreline and generator.

Cabin Lighting

Adequate cabin lighting in transport vehicles allows continuous assessment of the patient and performance of any necessary procedure. Lighting should be adjustable to meet the needs of each transport situation. Barriers should be available to protect the pilot or driver from bright patient cabin lights that may interfere with night vision. In the ground ambulance a light should be installed in the center of the doorsteps as well. Step well lights should light whenever an entry door is opened or the bench lights are turned to low intensity. This provides added safety during night transports, both by reducing falls and offering the ability to watch all equipment for potential disconnection. Another creative safety feature is the installation of lights over the back doors in the inside cabin that illuminate when the ambulance operator uses the turn signals and brake lights. This will alert the onboard crews of anticipated turns, change in speed and stops.

Climate Control

Clinical and operational complications may develop during patient transport when the vehicle, patient, or crew is exposed to significant temperature variation. This is true for both ground and air transport as regards seasonal and geographic considerations. Flight at higher altitudes will also result in significant temperature changes.

It is essential that the microenvironment of the patient cabin be monitored and controlled. Marked deviation from the normal comfort zone may result in impaired performance of the transport crew. Neonatal and pediatric patients are at special risk of both hypothermia and hyperthermia due to their large body surface-to-mass ratios.

Communications Equipment

Adequate communications equipment is essential for every transport vehicle. At a minimum, the vehicle should have the capability to contact its base of operations or communications center, as well as "on-line" medical control. Airplanes and helicopters must be able to talk to controlling agencies and other aircraft. Vehicles that respond to the pre-hospital setting should carry the equipment needed for communications with "on-scene" emergency personnel. Many state EMS agencies require a cell phone be installed in all ground ambulances.

Recent communications advancements have placed GPS (global positioning system) devices in many air and ground ambulances. Utilizing satellite communi-

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cations, integrated mapping and software, automated flight following is possible for aircraft and the location of ground vehicle can be tracked. Satellite telephones are also available for installation that will enable direct voice communication when a vehicle is outside of routine radio or cellular telephone range.

Vibration

Vibration is inherent to the transport environment and can have detrimental effects on the patient, crew, and equipment. In helicopter transport, vibration is most severe during turbulent weather conditions and during transition to a hover. In airplanes, vibration increases during cloud penetration in turbulent weather and during high-speed, low-level flight. On the ground, the amount of vibration will be dependent on vehicle weight, wheelbase, suspension characteristics, vehicle maintenance, and road conditions.

The effects of vibration can be minimized in nearly all transport vehicles. Contact with the vehicle frame may be reduced or avoided by placing padding (stretcher pads and cushioned seats) on any part of the vehicle that may come in contact with individuals. In the ground ambulance, adding felt-lined aluminum tracks to make them rattle free is a worthwhile effort. Something as simple as the use of full-length stainless steel hinges for the cabinet framework can go a long way in vibration reduction.

In addition, proper patient and crew restraints will minimize the effects of vibration. The effects of vibration may compromise the ability to perform patient care procedures. Vibration may also loosen equipment, cause machine settings to change or produce artifact in patient assessment devices. Decreased vascular tone manifested by unexpected decreases in blood pressure may also result from vibratory forces.

Noise

Noise is also inherent to all transport vehicles. The most common sources of noise related to EMS activities are the engines. Noise not only interferes with communications, but will also interfere with patient evaluation (e.g., auscultation). Noise can have detrimental effects on the physiologic responses of both the patient and the medical team. Long-term ill effects on hearing in pediatric and newborn patients have been suggested but no data has documented clear association.

COSTS

The cost of a critical care air or ground ambulance will vary greatly depending upon the type of vehicle used and whether the vehicle is dedicated (i.e., sole-use) to patient transport and to only one transport team. There is little doubt that helicopters are the most expensive vehicles for medical transportation -- both from the operational standpoint and also with regard to patient charges. Airplane transport may also be costly but becomes more economical for greater distances.

A dedicated transport vehicle will likely be more expensive than a vehicle that can be used on an "as needed basis." A dedicated vehicle, however, may or may not be feasible for every transport service. If a transport team cannot have their own vehicle, it may be necessary for other transport teams to share the vehicle and the high costs involved in its operation and upkeep. If a dedicated vehicle cannot be justified, it is recommended that the team select one or more vehicle operators who can provide the appropriate vehicle(s) for use within an established timeframe.

VEHICLE OPTIONS FOR MEDICAL TRANSPORT

Increasing numbers of traditional (hospital-based) rotor-wing transport programs are expanding their services to provide integrated medical transport systems including fixed-wing or ground support. As the world becomes more "mobile," long-distance fixed-wing transport has become an integral part of the medical *and* transport industries.

Physicians involved in air medical transport are expected to be aware of the capabilities, advantages and disadvantages of their particular aircraft. However, it is becoming more and more important for physicians and allied healthcare providers involved in transport decisions to recognize the advantages and limitations of various modes of transport.

ROTOR-WING AIR AMBULANCE

When a healthcare or public safety provider thinks of a medical helicopter, the aircraft is considered synonymous with an experienced medical crew providing advanced medical skills and specialized equipment. However, the vehicle itself may provide significant advantages over other modes of patient travel. While helicopters have a definite role in patient transport, they are not the sole solution for all transport teams. Like other vehicle options, their strengths and weaknesses must be carefully considered when selecting a vehicle for a particular patient transport.

Speed of travel is an important consideration for helicopter transport. Depending upon the type of air-

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craft, weather conditions, flight altitude, and total load (weight of aircraft, fuel, patient, crew, and equipment), helicopters may travel at speeds of 115 to over 170 miles per hour. This speed and the fact that helicopters do not need to "follow roads" but travel "as the crow flies," often equate to a transport time one-third to one-fourth of that required by ground transport over an equivalent distance. The helicopter becomes very beneficial when time is critical. The service area for helicopter programs is greater than that of ground ambulances, but less than the service area of airplanes. Service areas of helicopter programs range from 100 miles up to 150 miles. Most helicopters are able to cover this distance in 1 to 1 1/2 hours. Some programs may go as far as 200 miles from their respective bases.

The speed of travel is only one unique capability of the helicopter. Like the ground ambulance, the helicopter has the ability to go "door-to-door" when on-site helipads or landing areas are available at both the sending and receiving facilities. Rotor-wing aircraft need only a small, flat area that is clear of obstructions to take off and land. The helicopter also has the ability to fly into locations inaccessible to other modes of travel, and avoid ground obstacles and traffic delays. This capability is of most benefit when roads are impassable after snowstorms, floods, tornadoes, and other disasters, or when patient care occurs in rural or wilderness areas.

While helicopters have many distinct advantages as patient transfer vehicles, they also have inherent disadvantages. Limitations of helicopter transport vary with the type of helicopter considered for use. It is important for the transport team, referring physicians, and receiving clinicians to be familiar with the limitations of an aircraft.

Landing requirements for helicopters are a disadvantage compared to ground ambulances, but offer more flexibility than the airport requirements of fixed-wing aircraft. If an appropriate landing area is not readily available, the time needed to identify and secure a landing zone may diminish the helicopter's advantage of speed.

Confined patient compartments and weight limitations may offer significant obstacles to optimal patient care. Even in larger helicopters, patient access may be limited. In most helicopters, the patient cabin is considerably smaller than in ground ambulances.

No matter the size of the helicopter, weight and balance limitations are important considerations in each and every flight. Every rotor-wing aircraft has a maximum lift capability, from which useful payload can be calculated. The combined weight of the crew, patients, and equipment must all be taken into consideration. High humidity, high ambient temperature, and high elevation will reduce the useful load a helicopter can carry. A heavy load may also limit an aircraft's ability to hover and transition to forward flight on take-off. In specific flight scenarios, pilots may opt to carry less fuel to maintain an adequate payload for each medical mission. In addition, when departing from an airport or a large open area, a pilot may choose to do a rolling or running takeoff, allowing the aircraft to lift off with more fuel onboard. Larger helicopters may have fewer restrictions, but these same principles apply.

It is critical to provide pilots with patient(s) weights in advance of all flights. A weight and balance calculation is done for each mission. In addition, patient girth measurements may affect the ability to utilize a helicopter and/or airplane, depending on the model used.

In addition to impacting the aircraft's payload, weather considerations also significantly limit the utility of helicopter transport. Fog, sleet, heavy snowfall or rain, low lying clouds (decreased ceiling), high winds, and lightning are important weather considerations for air transport programs. Most helicopter programs operate under visual flight rules (VFR), but travel under instrument flight rules (IFR) is becoming more common. The majority of IFR flights are conducted "airport-to-airport," but newer Global Positioning System (GPS) technology makes it possible for IFR missions direct to GPS-approach hospital helipads. Annual pilot training and specialized aviation equipment are necessary for IFR missions. In areas where poor visibility and low ceilings cause a significant number of missed flights, IFR and GPS capabilities may be an important consideration.

It is important to note that there are occasions when flights may initially be accepted and due to the inadvertent rise of inclement weather, the flight needs to be aborted. In this case, it may be necessary to have a ground unit dispatched to assume the transport. If a transport service has its own ground units, it can facilitate transition from air to ground transport much quicker than if it has to contact an additional provider to facilitate the critical care transport.

Flight physiology can also affect helicopter transport. It is often thought that only altitudes above 8,000 feet impact the patient or crew. This is not always the case. Crewmembers flying with sinus problems, ear problems, or upper respiratory infections may feel the effects of barometric pressure changes with as little as a 1,000 or 2,000 foot change in altitude. Helicopters that must quickly climb to higher elevations to fly over mountain peaks may experience operational and mechanical effects of altitude change.

Medical crewmembers, pilots, and patients may all be impacted by the stresses of flight. Noise, vibration, and turbulence are generally more severe in helicopters than in other forms of transportation. Helmets and

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headsets should be worn by the flight crew and a headset should be given to awake patients to facilitate communications in flight. This equipment also provides hearing protection. Some type of hearing protection should be worn by the crew and patient at all times when the helicopter is running

Some effects of flight physiology on air medical transport are more specifically related to pilots. Night vision is a critical factor. Night flight may result in a loss of spatial references (ground lights, horizon). This can adversely affect the pilot's visual, vestibular, and proprioceptive systems. A pilot's perception of aircraft position, direction, altitude, angular motion, and level of flight may be temporarily compromised. This sensory mismatch may have serious consequences.

Another sensory system complication that may be experienced in helicopter transport is motion sickness. The problem may be most severe in turbulent weather conditions. Aviation authorities also impose significant restrictions on the medications a pilot may take while on-duty. Medical team members who work in and around aircraft should observe the same precautions.

Many transport services may find the costs related to purchasing or operating a dedicated helicopter to be prohibitive. Simple analysis shows that transport by rotor-wing aircraft is significantly more expensive than travel by ground and, in most cases, more expensive than fixed-wing carriage. In terms of isolated vehicle costs, a new medically equipped single engine helicopter will have an average purchase price of approximately $2.4 million US (2006 USD). Light twin-engine helicopters may cost twice as much and a new medium twin-engine helicopter will cost between $5.5 to 6 million US (2006 USD). If an aircraft is not purchased by the sponsoring agency, annual operating expenses for a leased medical helicopter (aircraft lease, pilots, mechanics, flight time, fuel, insurance, etc.) may exceed $400,000 US for a single-engine helicopter and top $1.5 million US for a medium twin-engine vehicle. Many hospital-sponsored programs form consortiums to share costs, or utilize an independent provider model to avoid expense and risk.

FIXED-WING AIR AMBULANCE (AIRPLANE)

Fixed-wing aircraft offer both advantages and disadvantages compared to ground ambulances and helicopter. They generally travel at greater speeds and cover greater service areas than other modes of transport. The cost of operating a fixed-wing aircraft is substantially higher than a ground ambulance, but the cost-per-mile over long distances is much less in an airplane than a helicopter. For transports over 150 to 200 miles, programs often consider the use of fixed-wing aircraft. Airplanes are generally not practical for transports of less than 150 miles.

Airplane cabins are often larger than those in helicopters, enabling many airplanes to transport two patients and two or more medical crewmembers or family. Weight restrictions, weather, noise, vibration, and turbulence are less of a factor with fixed-wing travel than with helicopters. Airplanes have the ability to fly above or around various inclement weather conditions. However, specific aviation factors such as high humidity, high ambient temperatures, and higher elevation may nonetheless impact fixed-wing operations. As with the helicopter, pilots may choose to carry less fuel to maintain an adequate payload. Fully loaded aircraft require longer runways for take-off and landing.

Smaller fixed-wing aircraft may not be able to create a pressurized environment. Flight in these vehicles is limited to lower altitudes. Cabin pressurization combats the negative effects of the physiologic gas laws and provides for safer and more comfortable transport. At flight altitudes of 30,000 to 40,000 feet, pressurized aircraft can often create an internal cabin altitude of 7,000 to 8,000 feet. When altitude-related hypoxia is of concern, flight at lower altitudes allows the artificial cabin pressure to approach sea level.

The greatest limitation to the use of fixed-wing aircraft is the necessity to land at an airport. The length of runway needed will depend on the type of aircraft used. Generally speaking, jets require longer runways than propeller airplanes. Fixed-wing transports also dictate that patients will require multiple transfers, from hospital to ground ambulance (or helicopter) and ambulance/helicopter to airplane. Another consideration is the operating hours of the airports, as refueling requirements may necessitate the use of an alternate site.

Medical flight crew must be aware of the various stresses of flight when traveling at high altitudes in pressurized environments. Stresses of flight are most significant when flying at altitudes greater than 8,000 feet and are especially important with flight at 30,000 to 40,000 feet. While a pressurized cabin is extremely beneficial, loss of cabin pressure at altitude can be catastrophic.

A major concern in fixed-wing transport is the appropriateness and safety of the aircraft's internal medical configuration. While the vast majority of ground and helicopter ambulances are designed and dedicated to patient care, the same is not always true with airplanes. Some fixed-wing "ambulance" providers may provide patient transport services in what others might consider an unsatisfactory and unsafe transport environment. The patient litter, oxygen tanks, and onboard medical equipment may not be appropriate to flight or might not be properly secured. The oxygen and electrical systems may be inadequate for long transports. Before con-

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tracting with any fixed-wing agents, the transport team should carefully inspect the airplane when it is in the medical configuration.

GROUND AMBULANCES

The ground ambulance represents the most common vehicle used for interfacility transport and the primary means of prehospital patient transport. In selecting ground vehicles for patient transport, the advantages and disadvantages of this mode of transport must be considered.

Advantages

Ground vehicles may offer advantages over air ambulances. Availability is a primary consideration. Parts and maintenance are readily available for ground vehicles, and diesel fuel or gasoline is more commonly found than aviation fuel.

In most geographic areas, ground ambulances are likely to be more accessible than other modes of transport. The number of available vehicles is often affected by population density. Rural areas may be served by only one or two ambulances, while larger communities will have more ground vehicles in their service area. In the event that an ambulance is taken out of service for scheduled or unscheduled maintenance, other ambulances are more likely to be available for back-up in urban/suburban areas. In areas where there are a limited number of ground ambulances, the dispatch of one unit on a long distant transport may leave an area to be temporarily underserved. In many rural communities, the only ambulance(s) available are likely used for prehospital response as well.

Ground ambulances provide door-to-door service, with no need for a runway, helipad, or landing zone. Once placed on the stretcher and secured in the ambulance, the patient can be transported directly to the receiving facility without movement from one vehicle to another. As previously mentioned, one of the most problematical and potentially dangerous times in transport of a critical patient is during transfer from one vehicle to another.

Medical crews may find transport by ground ambulance to be more user-friendly and functional than work in other vehicles. In addition, it may be easier to train personnel for the ground transport environment than for the aviation setting. Medical personnel can be more quickly oriented to ground safety procedures, the location of equipment, and the proper use of supplies. However, medical personnel unfamiliar with the world of "mobile medicine" may still find this a most challenging environment.

In general, the patient compartment of ground ambulances is larger than in helicopters and airplanes. Depending on the vehicle selected and the configuration of the ambulance, vehicles may be able to accommodate two to four medical crewmembers and one to two patients. Fewer restrictions apply to the size, weight, and amount of equipment that can be taken on a ground transport. Unlike aircraft, there are generally no weight and balance limitations on ground transport with regard to the amount of equipment that can be carried or the location of the equipment in the vehicle. However, equipment and personnel must still be properly secured. Another advantage of the ground vehicle is that the medical team can easily interrupt a transport and "pull over" if an emergency arises to facilitate patient assessment and intervention. If necessary, ground ambulances can also be easily diverted to alternate destinations as dictated by patient condition or the exhaustion of supplies. Ground ambulances may operate in certain weather conditions that often restrict safe air operations, providing transport decision-makers with a reliable mode of transport for a wide range of weather scenarios.

Limitations

While there are many advantages to the ground ambulance, there are also limitations to this mode of transport. Ground ambulances have significant time, distance, and access constraints. The speed of ground vehicles is limited, and inclement weather, traffic congestion, construction zones, detours, and terrain effects may delay or even halt ground transport. Ground vehicles may not be able to gain entry into remote or restricted areas. During long transports with prolonged out-of-hospital times, there are greater risks of patient complications and crew fatigue. Tight vehicle suspensions, narrow wheel-bases, and high centers of gravity predispose ground vehicles to rough and turbulent rides. Excess and irregular movement may be painful or detrimental for certain patients, especially those with vertebral fractures and other orthopedic injuries. If the patient care module is over the recommended weight it will affect the operation and performance of the ambulance, adding strain on the engine, make starting and stopping a more challenging event and cause excessive and unusual wear patterns on the tires.

Another common problem is motion sickness. This is usually a result of various factors, including limited cabin space, poor ventilation, sideways seating, poor road conditions, lack of visual references (the "horizon"), and loss of orientation to the direction of travel. The smell of gasoline or diesel fuel may be an aggravating factor. Individuals may benefit from medication, acupressure bands, or other remedies to prevent or allevi-

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ate motion sickness. Crewmembers must be concerned about the potential side effects of medication. Improved cabin ventilation and external visual fixation on a distant object may also be helpful in alleviating symptoms.

To improve the air quality inside an ambulance, a high capacity fresh air vent exhaust fan can be installed at the rear of the ambulance. The intake vent should be located at the front of the module. This takes into consideration the high potential for entry of dust and noxious fumes into the patient compartment. Hood mounted ventilators that can alter the integrity of the ambulance should be avoided due to the propensity to allow water into the patient compartment. The module should be equipped with a dual air conditioning and heating single unit system, utilizing a separate engine driven compressor and auxiliary condenser to cool the patient compartment. The system should be able to run from the shoreline when the vehicle is parked. Electronic thermostats with digital temperature displays to control the system are a feature that can be installed in the patient action area to alert the caregivers if changes have occurred. The cabinet in which the air conditioning and heating unit is located should be fully insulated to provide maximum cooling and heating performance.

Despite their limitations, ground ambulances remain the dominant vehicle in patient transport.

Ambulance Classification

In the United States, the General Services Administration (GSA) has established Federal Specification for the Star-of-Life Ambulance, which reflects the minimum requirements for ambulances purchased by the federal government. These specifications, which are found in the GSA document KKK-A-1822E, are widely accepted as a standard for ambulance design in the U.S. This federal document provides detailed requirements for the design and performance of ambulance chassis, bodies, and related systems and components

The first consideration as to how ambulances are designated is by the gross vehicle weight rating (GVWR) of the vehicle chassis. There are eight "classes," Class 1 to Class 8, with the higher classification corresponding to greater weight, as shown in Table 7-3.

In addition, these eight classes are often combined into three "duty" classifications: light-, medium- and heavy-duty vehicles. These chassis classifications, however, are less precise, as different listings may vary according to which weight classes are considered part of which chassis classification. However, the GSA Federal Standards identify the light-duty commercial truck to have a gross vehicle weight rating between 1,800 to 9,000 kg or 4,000 to 19,999 lbs. A medium-duty vehicle has a gross vehicle weight rating of 9,500 to 16,000 kg or 21,000 to 35,000 lbs.

Class	Weight
Class 1:	0 - 6,000 lbs.
Class 2:	6,001 - 10,000 lbs.
Class 3:	10,001 - 14,000 lbs.
Class 4:	14,001 - 16,000 lbs.
Class 5:	16,001 - 19,500 lbs.
Class 6:	19,501 - 26,000 lbs.
Class 7:	26,001 - 33,000 lbs
Class 8:	33,001 lbs. and over

Table 7-3: Vehicle weight classification

The second consideration in the classification of ground ambulances is contingent upon the vehicle's body. There are three basic types of ground ambulance configurations.

A Type I ambulance is a modular or box-type unit mounted on a conventional light- or medium-duty truck chassis with the engine mounted in front of the cab. The front of the ambulance resembles that of a pickup truck, while the patient-care compartment is in the box-like module which is built separately and mounted behind the cab. Unless specifically modified, the crew cab and patient compartments are not connected by a passageway. The connection between the cab and body, if any, may be a sliding window or a limited-height walk-through opening. These ambulances offer a large patient compartment with room for storage inside the cabin, as well as exterior compartments. Compared to Type III, these have a higher height, a longer wheelbase and improved engine access. Type I ambulances are a good choice for transport teams and EMS agencies that desire a larger cabin and increased storage capacity.

Type II is a standard full-sized van in which the body and cab are continuous. The patient care compartment is contained within the van body. These are built into a light-duty commercial chassis van with a raised roof for additional headroom. The floor is low in height and the vehicle has a short wheelbase. Disadvantages of a Type II are its small patient compartment, little (if any) storage, and difficult engine access. Many private ambulance companies and EMS agencies with low volume and no requirement to carry extra equipment will opt for this class ambulance as it is the least expensive to meet the GSA standards—as much as $40,000 less than a Type I or Type III vehicle. In addition, these smaller and more maneuverable vehicles may be favored in areas with congested streets or areas with limited access.

The Type III ground ambulance is the most popular ambulance configuration. This ambulance is a modular

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vehicle with a "walk-through" between the cab and the patient compartment. These are built on a light-duty or medium-duty cutaway-cab commercial chassis similar to those used to build smaller recreational vehicles and school buses. The front of the ambulance is similar to a van, with the engine mounted partway into the cab, making engine access more difficult compared to the Type I. The patient-care compartment is in the box-like module which is built separately and mounted behind the cab. Because of the cab's raised roof, low floor height and cutaway back, these vehicles have a large patient compartment, a full-height walk-through opening to the body and room to store equipment. Like the Type I, the Type III body usually has several exterior storage compartments. Type III ambulances are popular with transport teams, private companies and fire departments that desire a shorter wheelbase and lower frame height than a Type I vehicle, but still want the larger, modular body with exterior storage capabilities.

A decision as to which type of ground ambulance will best serve a transport system should be based upon numerous factors. It is important to consider the amount, type and size of medical equipment that will be taken on transport. The decision should also take into account the maximum number of patients and team members to be transported at one time.

Earlier versions of the GSA's KKK-A-1822 designated ambulances as Type I, II or III, while further breaking down each of these configurations into A (ALS ambulances) and B (BLS ambulances). The latest Specification for Ambulances that was published in June 2002 (KKK-A-1822E) added an "additional duty" designation for Type I and Type III. This new specification addresses the trend toward larger ambulances and the escalating requirement to carry additional equipment and personnel.

Additional-duty ambulances usually are built on a medium-duty chassis and can be very beneficial to the critical care transport team due to the potential to carry more personnel and considerably more medical equipment. A transport program can custom build a larger patient compartment for complex critical care transport and specialty care transport; some can be configured for two patient transports, which can be accomplished easier and more efficiently; vehicles have improved handling and a smoother ride; there can be additional storage capacity inside the cabin and in external compartments. Some medium-duty chassis ambulances will have adequate space to carry a generator that could be used if the ambulance were to break down with a patient onboard. This is especially important in the critical care transport of a patient on a ventilator, or other specialized equipment. If well maintained, a medium-duty ambulance will generally provide a longer road life (in some cases double) compared to a light-duty ambulance.

There are numerous options for medium-duty chassis to build and configure a critical care ambulance. Depending on the payload requirements, some options include the following:

- Class 4-5: Ford F-450, Ford F-550, GMC C4500 and C5500
- Class 6-7: Freightliner M2, International 4200 and 4300

In addition to offering a variety of larger chassis and configurations, manufactures are offering more vehicle and engine options, enhanced safety features (additional occupant restraints, more rounded interior corners, better securing of sharps container and other potentially dangerous items) and high efficiency air filtration systems.

Regardless of type, ground ambulances remain the most affordable vehicle to operate in times when cost, utilization, and reimbursement are important issues. The approximate cost of a medically configured ground ambulance ranges from $70,000 to 350,000 USD. Annual maintenance and fuel cost may fall between $15,000 and 30,000 USD. In comparison with helicopters and airplanes, ground ambulances clearly cost less to operate, purchase, maintain, and insure.

ADMINISTRATIVE CONSIDERATIONS

Many administrative models may govern the management of transport vehicles. A hospital or other entity may decide to enter the ambulance "business" and operate a transport service. Vehicles can be leased or purchased, and non-medical personnel (pilots, drivers, mechanics) can work directly for the business enterprise. The business assumes responsibility for compliance with all state and federal regulations. This option places all the financial risk on the fiscal entity. If well managed, a significant amount of money may be earned; if poorly managed, a great deal of money can be lost.

An option favored by many hospitals is to enter into a contractual relationship with an outside company for the entire air or ground operation. The operator assists the hospital with vehicle selection and medical configuration. The entire operation (non-medical personnel, vehicle maintenance, back-up vehicle and regulatory compliance) becomes the responsibility of the operator and all costs are determined by contract. This option often costs the hospital the most money but places the risk fully upon the operator. Annual expenses to the hospital are much more predictable within this fiscal structure. Hospitals may also choose to buy the vehicle and have an outside agent manage the operation. The hospital gets the benefit of owning a valuable asset, and retains the vehicle if they opt to change operators.

The previously noted administrative structures assume that there will be a dedicated vehicle for medical transport. Another alternative is the use of multifunction air or ground units. This option is often used by specialty transport teams and fixed-wing operations. Depending on the volume of transports, this option may be the most cost effective. Use of multifunction vehicles is common in air medical transport. Many helicopter and airplane programs routinely make their aircraft available to other transport teams. The practice is also seen most clearly in the use of multi-tasked public service aircraft fulfilling fire, EMS, and law enforcement roles.

Independent fixed-wing air ambulance operators may also use this option to avoid the expense of owning and maintaining their own aircraft. At the time of a request, they may contact aircraft owners and "broker" the transport.

Any agreement between a transport team and an outside transport service, or any contract between a hospital and an operator, must address several key issues. A commitment to safety must be evident, and the safety record should be carefully reviewed. Vehicle specifications and capabilities should be clearly identified, and there should be a plan for coverage when vehicles are "out-of-service" for any reason. The qualifications, experience, and training of pilots, drivers, and mechanics must be reviewed. Response time expectations must be specifically defined, and hours of availability should be firmly established. Finally, the operator's liability insurance must be verified.

SUMMARY

Transport medicine is becoming a specialized entity. Dedication, knowledge, and planning are essential to the provision of appropriate personnel, medical equipment, and mode of transport for each patient. No single vehicle is the ideal selection for all patient transports or all transport teams. It is essential to evaluate the needs of the medical team and the patient to determine the appropriate air or ground vehicle for transport. An ongoing study of appropriate utilization is key to predicting future needs and identifying issues and trends. As patient advocates, medical directors of transport systems must strive to provide optimal patient care in a safe environment, and assure the most appropriate utilization of transport resources.

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