

CONSIDERATIONS IN INTERNATIONAL AIR MEDICAL TRANSPORT

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INTRODUCTION

International travel is a fact of modern life. Approximately 5% of the population of "first world" countries travel abroad each year on business or government service, for education or voluntary work, and increasingly for recreation/tourism. Inevitably, a proportion of these travelers will become ill or suffer an injury. The elderly, those from sedentary occupations, and those who participate in hazardous pursuits such as diving and skiing are all over represented among travelers. It has been estimated that 5% of those who travel have some form of chronic condition, often cardiorespiratory.¹ In addition, the proportion of travelers with chronic disease is increasing. There is also the risk of exposure to endemic conditions in the regions of travel – e.g., malaria or other tropical illness and parasitic disease. Furthermore, travel itself poses certain risks such as the well reported "economy class syndrome" (deep venous thrombosis).²

Most countries which are "exporters" of significant numbers of travelers have some form of agency which offers health information and recommendations on immunizations and prophylaxis, such as the U.S. Public Health Service Information for Travelers program and the Department of Foreign Affairs and Trade in Australia.^{3,4} However, some countries do not have such a service, some travelers may not avail themselves of the recommendations, and some unfortunates may succumb in spite of following all recommendations.

Most travelers who sustain illness or injury abroad will be able to be treated locally, and travel home unaided when recovered or in convalescence. However, some scenarios suggest or mandate the need for air medical transport. These are outlined in the next section.

International medical transports involve, by definition, a minimum of two countries. They may involve many more than this: the patient's nationality, referring location, destination and the origin of the air medical service may all be different countries. To use an actual case example, an American SCUBA diver with decompression sickness in one of the Pacific Islands, flown by an Australian air medical team to a hospital with hyperbaric facilities in New Zealand.

In closely spaced countries, especially with land borders (e.g., parts of Europe) some international medical transports may occur by road or by helicopter. Some heli-

copter emergency medical service (HEMS) operations, especially in parts of the European Union, even encompass cross border scene responses, usually conducted within a prearranged legislative framework and reimbursement agreement.⁵ These are best viewed as an expansion of the scope of some domestic HEMS operations, rather than as typical international medical transports, and will not be further considered here. Typically, international medical transportation involves the use of fixed wing aircraft – either dedicated air ambulances, or on board regular passenger transport (RPT) flights.

As long as people travel internationally, international air medical transport will continue to be required. While the majority of such patients are less ill than those carried by a typical domestic air medical transport operation, such as a HEMS program, the very nature of long distance air medical transport creates its own special problems.

INDICATIONS FOR INTERNATIONAL PATIENT TRANSPORT

The rationale for transport can be broadly divided into five categories: Lack of Appropriate Local Medical Facilities; Requirement for Ongoing Care; Regulatory Requirements; Financial Incentives; and Political Unrest.

Lack of Appropriate Local Medical Facilities

A patient may be in a country or region that lacks the medical facilities required for their illness or injury. This may include patients from this (their own) country who require specialized therapy not available locally. For example, the French Pacific territory of Nouvelle Calédonie (New Caledonia) has a contractual arrangement with an Australian hospital system and an air medical program to transport and treat nationals requiring cardiothoracic surgery and some other tertiary services. In an ideal world, such arrangements would be universally available – however, currently it is limited to a few jurisdictions, and occasional cases funded by philanthropy, community fundraising, or family wealth. More commonly, the patient is an overseas visitor. Many popular destinations for either traditional or "adventure" tourism do not have access to medical services of the

standard that those visiting would expect in their own country. A seriously ill or injured patient in such a location may represent a dire medical emergency requiring urgent response.

Requirement for Ongoing Care

Even where adequate acute care is provided, there may still be an indication for medical transport in the post acute phase. Travelers may sustain permanently debilitating conditions such as major cerebrovascular accidents or quadriplegia, or other conditions in which they face prolonged recovery, such as head injury or Guillane-Barre syndrome. Even if the debility is not permanent, language problems or separation from family and friends may provide strong social indications for relatively early transport.

Regulatory Requirements

Patients with medical conditions may be forbidden by airline regulations to travel without a medical escort. On some airlines, patients who have sustained an uncomplicated acute myocardial infarction may be prohibited from flying alone several weeks after the event. This is despite the fact that they may well have been discharged from hospital during the first week. With a medical escort, they may be permitted to fly much sooner.

Financial Incentives

Medical expenses in some countries are relatively higher than in others. Particularly for residents of countries with universal health coverage, it may be far more expensive to be hospitalized abroad than in one's own country. Despite the cost of air medical transport, it may be more cost effective to transport patients to their home countries early in their illness than to wait for complete recovery abroad. There are also payment limits on most travel medical insurance policies.

Political Unrest

Throughout the world there are many countries undergoing violent political upheaval. A traveler unfortunate enough to become ill in one of these countries faces the dual problem of uncertain medical care and uncertain personal security. Additionally, such situations may result in an influx of peacekeeping and aid personnel, who may not be welcomed in local medical facilities, and/or may be unable to access care due to scarce resources. Despite the possible risks involved for both the patient and escorts, early medical transport may be the best option.

ACTIVATION AND COMMUNICATIONS

As illustrated by the above scenarios, patients for whom international air medical transport is requested can vary from the stable and asymptomatic to the desperate. Before transport can be arranged, as much information as possible about the condition of the patient should be ascertained. Ideally this should be done by direct contact between the air medical service and the referring physician. The physician either performing or coordinating the transport should make the contact since their clinical and transport experience will help minimize communication problems and avoid the situation where the patient's condition turns out to be quite different from the initial description. A conference call including the referring, transporting, and accepting staff, plus interpreters as required, is ideal.

Once information is gathered on the patient's location, condition, care provided and destination hospital, the coordinating physician needs to determine:

- The urgency of the transport.
- The level of expertise (MD, RN, EMT-P, RT, etc.) and number of clinical staff required.
- The type of equipment and consumables/drugs required.
- Whether the destination facility is appropriate.

Particularly in emergency cases the medical assistance company or transport service may be the point of contact and in those cases will need to locate a bed in an appropriate acute care facility. There is little value in transporting a patient to a referral center lacking the capability to manage the acute condition and foreseeable complications. During the initial phases of coordinating a mission, confirming the transfer request and bed availability with the receiving facility and physician (if known) is critical.

LOGISTICS

"Amateurs talk tactics – professionals talk logistics"
– anonymous military maxim

Logistics take on great significance in international air medical transport and are often the major determinant of success or failure. The successful organization of most international medical retrievals requires the services of a large number of professionals apart from the medical team and controlling physician. Logistics planning depends on accurate information, as outlined above, including: location and (at least approximate, e.g., which city) destina-

Principles and Direction of Air Medical Transport

tion; and urgency of transport, based on the patient's condition and level of care available.

From this, the length/duration of flight can be determined for flight planning, refueling planning and aircraft selection. Duration of secondary ground transport at each end, which may be lengthy in some cases, will also need to be estimated, and factored into flight and medical crew duty times. Duration of transport will be used to estimate consumption of battery power, drugs/fluids and oxygen, as well as whether medical crew duty time limits will require extra team members. This may influence whether a larger aircraft is required.

For non-emergent transports, the opportunity exists to optimize timing of transport within a "window of opportunity" when the risks and workload of transport are least (e.g., when a ventilated patient is stable, but before development of secondary problems such as stress ulceration, deep venous thrombosis, nosocomial pneumonia, etc.).

Selection of medical escorts is more complicated than merely selecting the next name on the roster. While staff for international air medical transport are by definition expected to have passports, visas may be required depending on the referring country and the nationality of the escort. Some countries may bar entry to certain nationalities or prohibit their own citizens from visiting specified lands (e.g., the U.S. Department of State's proscribed list). In most situations, visas can be obtained through the appropriate Embassy, but for urgent transports an urgent visa exemption may need to be sought from the appropriate consulate, which will supply documentation to that effect.

Immunizations may be required to enter a particular country or to return to one's country of origin after traveling to regions with endemic infectious diseases. National agencies such as the U.S. Public Health Service dispense information for travelers, and the Centers for Disease Control and Prevention (CDC) Disease Information Hotline can provide additional data.⁶

Language barriers may exist between any combination of the patient, the referring country, the destination country and the air medical team. If none of the escorts can speak the language(s) concerned, consideration should be given to taking an additional designated translator, or organizing interpreters via the appropriate consulates.

Financial considerations must also be taken into account for the transport team going abroad. Appropriate credit cards and cash reserves may need to be organized and provided to the escorts.

An issue of concern is the transportation of narcotics or other dangerous drugs. All controlled drugs must be declared on entering a foreign country. It is valuable to have an official letter or certificate from one's government giving permission for the air medical team to be in posses-

sion of specified quantities of narcotics and other scheduled drugs. Ideally, this should be supported by a letter from a consulate of the country that the team is entering. The presence of a physician on the transport may make the transport of narcotics somewhat less problematic (see below).

For non-emergent long distance transports, transport of the escorts to the patient must be done safely and with comfort so that the crew can arrive rested. They will need to remain with the patient long enough to fully assess the patient's medical condition and to recover from the outward flight prior to the transport home. Twenty-four hours or longer may be required. Escorts will need to be accommodated within reasonable traveling distance to the patient, with adequate personal and equipment security.

Logistic problems may also occur on arrival in the country of destination, such as landing clearances and the need to book secondary road ambulance transport. Arrival documentation and clearances will need to be completed, and this should be arranged in advance. Customs and immigration services in most jurisdictions and circumstances are willing to board the aircraft on arrival and complete the formalities, provided adequate notice is given.

Legal requirements of the referring or receiving country may need to be complied with. The receiving hospital and the air medical service may also wish to seek a guarantee of reimbursement.

MEDICAL STAFFING

There is a misconception among medical and nursing staff not involved in air medical transport that any doctor or nurse can act as a medical escort for an international air medical transport. More worryingly, travel insurance companies who are the third party payers for most international air medical transports often share this assumption. This is erroneous. Just as for rotary wing and shorter distance fixed wing medical evacuations, the medical crew needs the training and skills to manage any complications likely to arise during transport; unlike the former, international medical transports may last for up to 30 hours and complications are more likely to occur.

There is probably a greater case for incorporating appropriate physicians into the clinical team for international transports than for the same class of patients transported domestically. Reasons for this include:

- Physician staff have far more uniform recognition accorded to them in different countries than do nursing staff.
- Physician-based teams are less likely to encounter problems in such areas as transport of narcotics.

Air Medical Physician Association

- The prolonged nature of the transport and the uncertain level of care at the point of referral make it more likely that treatments will need to be changed and not just continued.
- There may be resistance by referring staff to having their medical orders countermanded by non-physician staff.
- On-line medical control may not be possible for all phases of the transport.

Conversely, however, most physicians do not make good critical care nurses. If extensive nursing care is required, a nurse should be incorporated in the clinical team and not replaced by a physician. A composite physician/nurse team may be the best option in many cases.

Clinical teams for international transports need sufficient training, skills and authority to be able to alter treatment protocols, not just continue existing care. As a general rule, the level of patient care in transit should attempt at least to match the general level of care (e.g., coronary or intensive care) that the patient will require at the receiving hospital. The team should be trained in acute care medicine and aviation physiology and should have experience at resuscitating patients in confined spaces. Experience in domestic air medical transport is perhaps the ideal training ground. The team should have (or add) additional expertise in any specialist discipline (e.g., pediatrics, obstetrics, or hyperbaric and diving medicine, etc.) required for a particular patient.

Apart from medical training, several other factors should be borne in mind when organizing escorts: Numbers of Team Members; Logistic and Administrative Capabilities; Personality and Stress Issues; and Other Factors.

Numbers of Team Members

The numbers of team members may need to be increased for prolonged transports. One would not expect a single team to care for a ventilated patient in an intensive care unit for more than 12 hours without relief. Given the additional strains of transport, staff should certainly be on duty no longer than this. Regardless of how organized, escorts must have time away from patient responsibility every few hours. The timing of these breaks will depend on the level of care required by the patient.

Logistic and Administrative Capabilities

As the principle problems encountered are often logistic rather than medical, for unusual or potentially problematic cases, senior staff experienced in international transport should be sent and/or consideration given to incorporating an additional designated "red

tape cutter" in the team. If there is a language barrier, at least one team member with appropriate linguistic fluency will obviate the need to add an interpreter.

Personality and Stress Issues

International air medical evacuation is often a stressful experience for the escorts. They are often working with very sick or unstable patients in unfamiliar surroundings, sometimes compounded by language barriers. In addition, they are subject to the stresses and fatigue of prolonged flight. This may be exacerbated by the difficulty, in emergency situations, of ensuring that all team members are ideally rested and refreshed beforehand. Ideally, the team should have experience working together and have compatible and mutually supportive personalities.

Other Factors

A single physically small escort may be adequate for ground or short duration air transport of a large immobile patient, but will find it difficult managing the care of such a patient alone on a prolonged international transport. For certain national and cultural groups, as well as some clinical situations (such as a sexual assault victim), the gender of the escort may also be an issue (see below).

Selection of medical staff for international air medical missions can be complex. Each case must be handled on its individual merits and the worst-case scenario should always be kept in mind.

MEDICAL EQUIPMENT

International air medical transport may create equipment difficulties that can be anticipated and should be planned for. With adequate preparation, unnecessary delays will be avoided and patient care will not be compromised.

The international environment and the differing levels of health care between nations mean that equipment aspects of international transport are often complex. Anecdotal reports occasionally circulate about medical escorts flying to a hospital (either in a chartered jet or by regular passenger transport), borrowing medical equipment from the hospital for the transport then "Fed-Ex"ing the equipment back to the referring hospital. This approach is unlikely to be successful outside the realm of the apocryphal. The referring hospital or ambulance may not have equipment or medical supplies to lend in support of the patient. This is in contrast to most domestic transports, during which the referring hospital's pipeline oxygen supply and consumables can be utilized during assessment and stabilization, and in some cases (e.g., drug infusions)

Principles and Direction of Air Medical Transport

continued in transit. Foreign hospitals and vehicles may have incompatible connectors for oxygen tubing, suction and electricity. Oxygen pressure may be inadequate to activate a pneumatically powered ventilator. When coordinating international air medical transport, the ideal situation is for the transport team to provide all medical equipment and supplies that may be required for routine patient care and any possible deterioration. As described above, this approach has logistic and flight payload and planning consequences.

NURSING AND MEDICAL STORES

The prolonged nature of many international medical transports means that nursing procedures not normally performed during domestic transports (i.e., eye, mouth and pressure area care) may be required. The additional volume of equipment needed may prove difficult to accommodate in smaller air ambulance craft and may even create stowage problems aboard regular passenger transport aircraft. Positioning and securing medical equipment within useful reach may be a problem aboard regular passenger transport or other aircraft not fully dedicated to the air ambulance role.

ELECTRICAL POWER

Most monitors and therapeutic equipment have internal batteries, but these have relatively limited capacity. International transports often take up to thirty hours and utilize multiple vehicles. Even if using a dedicated air ambulance, much patient care will take place before or after flight, beyond the reach of aircraft power. In addition to the transport time itself, it is also important to account for the transport to and from the airport and the time required to clear customs. This process will be time-consuming and external power may not be available during this time. Equipment with prolonged battery life or the ability to use multiple external power sources, or ideally both, is a major asset.

Five major types of external electrical power may be available:

1. 100 - 120 volt 50 Hz AC, as used in North and South America, and parts of Asia
2. 200 - 250 volt 50 Hz AC, as used in Europe, Japan, Australia, Africa, parts of Asia, and the Middle East
3. 28 volt DC -- the standard cabin power in aircraft of business/light commercial class aircraft (i.e., air ambulances)
4. 115 volt 400 Hz AC -- International Airline Transport Association (IATA) standard for cabin power for airlines
5. 12 volt DC -- the near universal standard for road vehicle power

Medical equipment that can utilize all power sources likely to be encountered is obviously advantageous. Alternatively, a separate universal power source for all devices can be used. This can be a battery supply; like computers, nearly all monitors and infusion pumps utilize internal batteries supplying a 7.5 to 12 volt DC current. Even those devices which appear to run on 110 or 240 volt AC almost always have internal transformers. It is a simple task for an experienced biomedical engineer to wire most medical devices for external 12 volt DC. Bypassing the AC supply may have the additional benefit of reducing the electromagnetic "signature" of the device and its potential effect on aircraft navigation systems. This effect has been demonstrated for one popular transport monitor.⁷ Vehicle batteries are an obvious example of a large capacity 12 volt supply. However, airlines will not carry these due to the potential for acid spillage causing airframe corrosion. An alternative is a large gel cell type sealed battery. Another more complex but more versatile alternative is a universal power adaptor unit, which may also incorporate additional batteries.⁸ A third alternative is to use only medical devices utilizing replaceable batteries. These may be "off the shelf" devices intended for home or small medical clinic use; alternatively, devices may be customized by replacing rechargeable batteries with replaceable ones. Ideally, all devices should allow battery changes with no interruption of function, a feature found in some infusion pumps marketed for patient controlled analgesia and/or home use.

SUPPLY OF OXYGEN

Potential problems with oxygen during international air medical transport include the requirement for a larger supply for prolonged flights, the lack of standardization of supply and fittings between countries, and the problems of oxygen supply and utilization aboard regular passenger transport aircraft. The first is principally a concern when smaller aircraft are used for long transports. A large adult ventilated on a FiO_2 of 1.0 will require up to 750 liters of oxygen per hour. This volume may need to be supplied for eight to twelve hours or longer. Carriage and changover of additional cylinders within the cabin may pose safety hazards or violate local aviation policies. It may be possible to carry additional cylinders in the cargo hold, but these will then only be accessible during refueling stops. Liquid oxygen systems are an obvious advantage for air ambulance aircraft involved in prolonged transports. Another potential future development is the oxygen concentrator. However, most current devices do not produce oxygen under pressure as is required to power

Air Medical Physician Association

many transport ventilators. They also require an external power source.

Lack of international standardization of oxygen systems is another area that may prove problematic. It is most likely to affect the air medical team attempting to stabilize a patient at a foreign referring hospital. Ventilator supply fittings may be incompatible with the local intermediate pressure (410 kPa, 60 psi) outlets. Currently, there are over twenty designs of outlets in use worldwide. Some countries have more than one standard fitting (e.g., the United Kingdom has both Schrader type and indexed screw systems).⁹ It is a relatively simple engineering project to construct adapters for the outlets in use in the area of operations. The difficulty lies in defining this area and obtaining details or samples of the outlet fittings in advance of being tasked.

A potential point of confusion is the different color-coding of oxygen outlets, cylinders and fittings in different countries.⁹ The International Standards Organization (ISO) standard (used in British Commonwealth and a number of other countries) color for oxygen outlets is white, but in the U.S.A. it is green, while Germany and some other European Union countries use blue. Similarly, while a yellow wall outlet supplies medical air in the U.S.A., in countries with ISO coding yellow signifies vacuum (suction) outlets.

Utilization of oxygen aboard regular passenger transport aircraft can also be problematic. Some airlines will supply, and mount in the aircraft, large oxygen cylinders for patient supply at a cost equal to that of the seat spaces occupied by the cylinders. These cylinders will be from the carrier's country of origin and will typically be fitted with regulators terminating in one of that country's standard intermediate pressure outlets.

The majority of airlines will not carry additional oxygen. While International Civil Aviation Organization (ICAO) regulations require all passenger airlines to carry oxygen sufficient for 1% of passengers for the duration of flight at all times,¹⁰ this supply may not be practical for patient use. Onboard oxygen is typically supplied in small cylinders with combined regulator/flow meters capable of delivering either 2 or 4 liters per minute. This rate is insufficient for the patient already requiring supplemental O₂ at sea level. For the patient on high flow O₂ by mask, it is possible to rig a high flow system with 'Y' connectors and additional tubing -- but persuading the airline crew that one patient needs more than one cylinder at a time may be difficult.

As this standard airline system will not supply oxygen at standard pipeline pressure (350 - 410 kPa, 50 - 60 psi), it cannot be used to drive pneumatically powered transport ventilators. Consequently, the ideal international transport ventilator for use on RPT aircraft is an electrically powered model that utilizes ambient air. Air can easily be

enriched at the inlet point with oxygen at ambient pressure from airline cylinders or other sources. The problem then becomes one of supplying power for the ventilator, as identified above.

An additional problem is ensuring the supply of oxygen from the hospital to the aircraft, as well as on the ground during refueling or other stopovers. This may be a problem in some countries where oxygen is not readily available and hence ambulances may carry little or even none. Enough oxygen must be supplied not only to get to and from the airport, but also to clear customs and immigration. If in doubt, the transport team should take their own portable oxygen supply for the secondary transportation leg and even for use at the hospital. This then has to be factored into logistic planning, including, for airline transport, obtaining a clearance for the cylinders to be carried on board.

EFFECTS OF ALTITUDE

These are similar to those encountered in domestic air medical transport but greater in degree. Commercial airliners fly between 30,000 and 42,000 feet while maintaining an interior cabin altitude equivalence of 5,000 to 8,000 feet. The cabin altitude obviously affects PaO₂ delivered to the patient. Even with use of dedicated air ambulances, the higher cruising altitudes that may be required for inter-continental flight may preclude pressurization of the cabin right down to sea level; however, lower cabin altitudes than those experienced during RPT may well be possible. Altitude effects may interfere with the function and accuracy of monitoring devices, such as capnographs and spirometers, while volume cycled ventilators will typically deliver higher tidal volumes than indicated at cabin altitudes above sea level.¹¹

HUMIDIFICATION

A pressurized aircraft can provide a cabin altitude equivalent to a lower altitude, but it cannot duplicate the typical water vapor content of air at these lower levels. Reduced humidity becomes of considerable significance in the patient undergoing prolonged transport where the normal humidifying mechanisms for inspired air have been bypassed, such as intubated patients or those with tracheostomies. Passive heat and moisture exchange ("HME", "Swedish nose"), or active humidification are two means to resolve this problem. Advantages of the former include simplicity, light weight, no electrical power requirements and a positive contribution to infection control. Advantages of the latter include better performance and the ability to actively warm the patient. As a general rule, longer transports, those involving pediatric or elderly patients and patient conditions which compro-

Principles and Direction of Air Medical Transport

mise temperature homeostasis (burns, sepsis, use of paralytics¹²) are relative indications for active humidification. If active humidification is not employed, additional insensible losses during prolonged transport may significantly impact fluid balance and should be considered in calculation of baseline fluid requirements.

EFFECTS OF THE AVIATION ENVIRONMENT ON EQUIPMENT

The effects of noise, vibration and acceleration on medical equipment are similar to those faced in domestic air medical transport or ground ambulance operations. They have been well discussed elsewhere in this text.¹³

EFFECTS OF MEDICAL EQUIPMENT ON AIRCRAFT

This is particularly relevant to the use of regular passenger transport aircraft or other non-medically dedicated craft on which any combination of aircraft, monitors and other electromedical devices are not in regular use. Certain items of medical equipment such as external cardiac pacers, defibrillators, and monitors may emit electromagnetic radiation in the microwave and radiofrequency areas of the spectrum. As a result, these devices have the potential to interfere with the aircraft's navigational and communications systems. As a general rule, for transports involving regular passenger aircraft or the use of one service's equipment aboard another's aircraft, it may be advisable to use older equipment with an established record of safety (e.g., a Lifepak 5 defibrillator) providing that updated features are not required for patient care. Another advisable step for use of your own equipment on a RPT is to clear the equipment used with the airline's engineering division ahead time. Most international carriers have a permitted list of medical equipment. Items not on this list are generally proscribed. Some airlines may allow equipment on board that has documented approval by other airlines. Independent testing to military specifications may also be acceptable.¹⁴

AIRCRAFT SELECTION

The decision regarding which type of aircraft to use for air medical transport must be made on an individual basis. Numerous factors must be considered and carefully taken into account in order to make the proper decision. Either dedicated air ambulances or regular passenger transport aircraft (commercial airlines) may be used for international air medical transport.

The ideal remains a dedicated international/long range jet ambulance with a large cabin, combined with

good short field performance and capability to operate from unsealed strips; but few, if any, available aircraft meet all these specifications. Also, in the absence of a significant workload, such an aircraft may not be economically justifiable.

All modern wide bodied, pressurized, commercial passenger jet aircraft are potentially suitable for international air medical transport, provided that an adequate patient care area with stretcher fit, oxygen supply, seating and storage are made available. A modular capsule that can be mounted in a range of RPT jets has been described,¹⁵ but its use is not yet widespread.

Alternatively, some aircraft used for dedicated domestic air ambulance operations may have the range and performance to be appropriately seconded for international operations. A business or light commercial aircraft (normally a jet) that is normally used in general aviation operations may be fitted out with an optional medical interior that can be rapidly installed.

MINIMUM STANDARDS

Air Ambulances

All air ambulances involved in international air medical transports should meet minimum requirements in a number of areas, as identified below.

Pressurization

Aircraft flying internationally are likely to fly at considerable altitude to achieve optimal performance and range. As a result, unpressurized aircraft are medically unsuitable.

Stretcher

A stretcher fitment which provides full body access and allows turning for posturing and pressure area care is necessary. A method for loading the patient while still on the stretcher, which is independent of any specific ground facilities, is essential.

Oxygen

An oxygen system with the capacity to supply the maximum conceivable oxygen flow for the endurance time of the aircraft plus a margin for loading, startup, shutdown, unloading, ground delays and unforeseen problems. There should also be a separate reserve oxygen supply, and a portable supply for loading and unloading (the latter two can usefully be combined).

Storage

Capacity to hold all medical equipment and consumables consistent with the level of care and the organization's mission statement, plus reserves of all vital

Air Medical Physician Association

items. Medical equipment should be readily detachable (ideally in a modular configuration) to enable constant and consistent treatment and monitoring by the medical team throughout the air transport *and* necessary ground legs.

Seating

There should be seating capacity for at least two and preferably three medical crew. If prolonged flights are being undertaken, this should increase to a minimum of three preferably four, although not all these seats need to be adjacent to the stretcher. Indeed, for medical teams working in shifts, seating away from the stretcher is superior for resting.

Facilities

These should include simple toilet and hand washing facilities featuring maximum possible privacy. Basic galley facilities for hot and cold drinks and at least simple snack foods should be available.

Regular Passenger Transport Flight

The medical fit for a patient transport mission aboard a regular passenger transport flight should also comply with the above. The relative merits of air ambulances and RPT include:

Availability

There is a wide variation between the policies of different airlines with regard to transport of patients. As a general rule, airlines that are national or flagship carriers tend to be the most accommodating, particularly for cases involving repatriation of their fellow nationals. In certain countries, most or all RPT operators are extremely reluctant to carry critically ill patients. This situation obviously needs to be factored into any decision-making process. Conversely, the services of a suitable air ambulance for some missions may be difficult to obtain, e.g., limited local availability, or for very long distance transports.

Cost

It is clearly less expensive to use regular passenger transport than air ambulances. The total cost of international air ambulance transport is typically three to four times the cost of regular passenger transport.¹⁶ This factor is not lost on insurance companies and other payers who will advocate the use of regular passenger transport whenever possible.

Space

Air ambulances tend to be lacking in overall space in comparison to commercial airliners. However, the more

careful planning of the cabin layout for the medical role in air ambulances tends to counteract this restriction. Overall, space and storage capability are, to all practical intent, nearly unlimited in regular passenger transport aircraft; and performing procedures such as intubation are likely to be far easier. Washing, toilet, and catering facilities aboard RPT aircraft are clearly superior for long transports. However, ergonomic factors (such as the proximity of attendant seats to the stretcher) are, as a rule, poorer aboard regular passenger transport aircraft fitted with stretcher kits. In both classes of aircraft, stretchers are usually mounted against the cabin wall, meaning access to one side of the patient is limited. This may make some medical procedures, such as tube thoracostomy on the "wrong" side, extremely difficult.

Equipment

Many specific equipment concerns have already been discussed. There is no doubt that using dedicated air ambulances is an easier option by far. With regular passenger transport aircraft, or when converting a business jet to the air ambulance role, one must be sure to provide all the equipment that could possibly be required during the transport. On the outward leg of a mission conducted by regular passenger transport, equipment and supplies will need to be sent as checked baggage. There is hence the potential for it to be lost or transported to a destination different from the staff. The risk of this is low but certainly not inconceivable; and on a tight time schedule (which is the rule rather than the exception) it is likely to result in the return leg being disrupted.

Convenience

The principal advantage of air ambulance transport is superior flexibility in going when and where they are wanted. For many international air medical transports they are the only choice, as no regular passenger transport is available to the patient's location. There are minimal needs to change flights on air ambulances, and one does not have to worry about delays resulting in missed connections when using dedicated ambulance vehicles. To transport a stretcher patient from Eastern Europe to Australia or the United States on regular passenger transport aircraft will require a number of different flights and involve several airlines. To organize an inter-airline flight can be little short of a nightmare. Not only must seats be booked, but the patient must be cleared with each individual airline's medical department. Provisions must be made for the patient at the airport medical center during each layover. Each airline is likely to have different stretchers and different oxygen cylinders and fittings.

Principles and Direction of Air Medical Transport

With air ambulances there are none of these problems. However, the difficulties are often merely exchanged for others, such as obtaining landing clearances and refueling rights at strange airports in foreign countries. Teams may require the services of a customs agent and/or assistance from the relevant consulate(s). Local currency or U.S. dollars may be required to pay the (sometimes apparently exorbitant) landing charges and sometimes other "unofficial" payments.

Acceptability and Privacy

All international airlines have regulations describing which medical situations will preclude patients from flying. They usually involve "antisocial" medical conditions but may also include the presence of indwelling nasogastric tubes or urinary catheters. Each airline medical department will provide specific advice on what is allowed on that particular airline.

Reliability

A large number of people are involved in a "regular" passenger transport retrieval. Most of these people are unaware of their importance in this task or even that a medical retrieval is taking place. This group includes baggage handlers, ground engineers, porters and airline booking staff. If any one person fails in his or her task, the stretcher, oxygen, or baggage may not be in the correct place at the correct time and the retrieval will be delayed. Using air ambulances reduces such personnel issues to a minimum.

Response Time

This is the primary advantage of air ambulances over regular passenger transport aircraft for international air medical transport. Most airlines require a minimum of 48 hours notice for stretcher bookings and up to 5 days for large volumes of oxygen. If the patient requires emergent transport, the air ambulance may be the only option.

In summary, regular passenger transport aircraft are superior in terms of range, space for medical equipment and personnel, and prearranged landing clearances (vital in certain countries). It also has a major cost advantage. Air ambulances are superior in most other aspects. However, even when all else favors the use of air ambulance, those paying may still refuse to countenance anything other than the use of regular passenger transport. Such a refusal, though, may itself be nullified on occasions if none of the available airlines are prepared to offer transport.

When urgency obviously overrides all else, the air ambulance is usually accepted. It is often not the medical condition itself that will allow a patient to be transported safely by one particular aircraft type, but factors related to urgency, cost or other concerns. The authors have safely

transported patients internationally who required major cardiovascular and respiratory support using both types of aircraft.

EVALUATION AND STABILIZATION

It is always best for the clinical team to assume patient care at the referring hospital by direct contact with the referring physician and not at the airport. The written or verbal report can be supplemented by one's own evaluation of the patient's clinical status, a process far better performed at the hospital than the airport. Privacy and quietness for physical examination are far superior in the hospital setting; radiographs can be posted and the clinical record reviewed. Additional investigations may be obtained as required prior to flight. One should meet the patient and family in an unhurried setting. Consent for both patient care and the flight should be obtained, crucial issues (i.e., resuscitation status) reviewed, and the procedures and logistics of transport explained to patient and family.

All relevant or potentially needed monitoring and support equipment should accompany the team to the hospital. The greatest risk of deterioration in the transport of critically ill patients occurs with the initial movement within the hospital.¹⁷ Secondary road transport may also be of considerable duration. Equipment actually or potentially required for the patient during the flight should also be deployed for secondary phases of transport. Mobile intensive care modules that move as a unit with the patient are a good system to overcome this problem.^{18,19}

Frequently the patient is in a different clinical state than expected, requiring additional stabilization, care or monitoring. The hospital is the ideal place for insertion or replacement of vascular cannulae, endotracheal tubes, chest drains, gastric tubes and urinary catheters. The hospital setting also allows access to radiography to confirm placement (usually).

Any changes in the patient's diagnostic, physiological, or treatment status from that expected or alterations in the care plan instituted by the air medical team should be communicated to the receiving hospital and physician. This contact should be made routinely, but is mandatory if the patient's condition changes. The implications of this for the referring hospital are obviously that a different treatment regime or even a different ward/unit may be required, occasionally even a different hospital. Forewarning the receiving institution, preferably involving or via the mission's medical control physician, will avoid a bed availability crisis on arrival.

SPECIAL CONSIDERATIONS

A number of special problems, or special considerations regarding common problems, may arise in international air medical transport.

COMMUNICATION

Language barriers are commonly encountered in international air medical transport. While verbal communication between the patient and clinical team is not essential for care in many cases, it yields optimal care for others. A family member may be considered to accompany the patient as a translator. Even if the same language is spoken by all participants in a transport operation, cultural differences make it likely that verbal or non-verbal messages from the patient, family, or air medical crew may be misread by one another.

CULTURAL ASPECTS

These are obviously more common in international than domestic air medical transport and may cause considerable difficulty. In certain cultures, it is intolerable for a strange male to touch a female or vice versa. Other common caring behaviors may have unforeseen consequences; e.g., in some cultures, to touch the head is to violate a major taboo. The air medical crew must be sensitive to cross cultural perspectives, while being assertive enough to make the patient's family aware of the imperatives of care.

TRANSPORT OF RELATIVES

With international air medical transport, the expectation of family or friends is likely to be that they can accompany the patient. This tends not to be a problem with regular passenger transport retrievals, as seating for accompanying persons can be easily arranged (albeit at extra cost). Seating for accompanying persons should be remote from the patient care area. Appropriate visiting should be encouraged. With air ambulance missions this is not easy. Space will be limited and seating likely to be in close proximity to the patient. The air medical crew must communicate with the flight crew as to whether or not additional people can be carried and still remain within the payload envelope for the return flight before discussing this with the patient and family. The issue of what is best for the patient should be paramount. When the patient is a conscious sick child, the presence of the mother may be highly desirable; conversely, the presence of a near hysterical relative of an unstable ventilated patient may be deleterious to the patients' care. Unlike its stationary counterpart, the flying intensive care unit does not have

an adjacent room into which visitors can be ushered and counseled by ancillary staff in the event of a crisis or death. There are no easy answers and each case must be dealt with on its merits.

PRIVACY ISSUES

The prolonged nature of most international air medical transports means that tasks not often required in domestic air medical transports may need to be performed. These include pressure area, bladder and bowel care. It may be difficult to provide this care while ensuring the patient's modesty, especially with flight crew and family members in close proximity. This may be less of a problem in commercial aircraft, as the presence of large numbers of people is usually offset by the provision of curtaining for the stretcher area, albeit that some such curtaining systems are inadequate. Privacy concerns should be discussed with the patient, family and flight crew before transport. It should be emphasized that air ambulance flight crew, though not directly involved in patient care, are still air medical professionals and bound by a similar code of conduct and ethics as the clinical team.

DEATH DURING TRANSPORT

The possibility of the death of the patient should be considered during all international air medical transports. This issue, and that of resuscitation, should be discussed when culturally appropriate with the patient and family before transport. It is most convenient and appropriate (and considered almost imperative in some cultures) that the patient be pronounced dead in their own country. If the patient should die in flight, the clinical team may be able to elect to defer pronouncing death for some hours -- until after arrival in the appropriate place. Even if pronouncement of death is made in flight, there is the option of continuing to the destination if this is in accordance with the patient's and family's wishes and the laws pertaining to the carrier and airspace concerned. Family members accompanying the patient will be unable to do anything other than remain with the patient until the next landing in the event of death.

However, in the event of a death in flight, in some jurisdictions the aircraft is obliged to land at the nearest suitable airport and submit to coronial requirements. These may in some circumstances be quite onerous, such as material witnesses being prohibited from leaving until at least the preliminary investigation is completed.

The air medical team must notify their coordination center, the accepting hospital and the receiving physician of the patient's demise. The coordination center can then arrange for a hearse to pick up the patient and expedite completion of legal requirements. The accept-

Principles and Direction of Air Medical Transport

ing physician should notify any family members already at the destination of the death of the patient. The air medical team should also speak to the family as soon as possible after completion of the transport.

INFECTION CONTROL

There was a time when the medical escort could reasonably expect to reach the destination in better condition than the patient. This expectation changed dramatically several years ago with the first cases of Severe Acute Respiratory Syndrome (SARS). The reality was that escorts and other cabin occupants have probably been at risk for many years from such infectious diseases as tuberculosis and meningococcal disease. SARS, however, appears to be a far more contagious and virulent disease, with many of the deaths from the epidemic occurring in the medical care givers of early cases. Although SARS appears to be currently dormant, there are few who would be brave enough to say that it won't be back. On the contrary, it would seem that not only will there be future epidemics of SARS, there will almost certainly also be epidemics of other new respiratory viruses which will be as or more virulent than SARS.

What does this mean for the air medical transport community? There are several changes that will need to be made in the way many of us work. The following advice comes directly from the CDC Guidance on Air Medical Transport of SARS Patients:²⁰

- Highly infectious patients will need to be transported in dedicated Air Ambulances with crew members kept to an absolute minimum. The crew will need to wear personal protective equipment (PPE) (see Table 1).
- This will need to be worn for all patient contacts. All except the respirators should be removed between patients or, if soiled, disposed of in a designated bin. The respirator must be worn continuously until staff is in a designated safe area.
- Hands are to be washed with soap and water or an alcohol-based hand rub immediately after removal of the PPE.
- Oxygen delivery can be with a simple non-rebreather mask if appropriate. Assisted ventilation should be with a dedicated mask-valve-bag device with a HEPA expired air filter. If the patient is intubated and ventilated, the ventilator will have to have a HEPA filter on its expiratory limb.
- All cough-inducing procedures should be limited during flight.
- There will be times during most flights lasting longer than a few hours when the escort will need to remove

- | |
|--|
| <ul style="list-style-type: none">• Non sterile disposable gloves• Disposable Isolation Gowns• Goggles or face shield (not normal glasses)• Fit-tested disposable respirators (N-95 respirators)• Alcohol-based hand wash. |
|--|

Table 9-1: Personal Protective Equipment (PPE) for Air Medical Transport of Infectious Patients

their PPE, e.g., during toilet or meal breaks. In order to facilitate this being done safely, if the aircraft is large enough, there should be designated clean and dirty areas. The location of these areas will depend on direction of cabin air flow. If the aircraft is not large enough for safe clean and dirty areas, one should consider a portable isolation pod being used, in which the patient is isolated from the aircraft environment.

The Aircraft

The feature of most relevance here is the cabin airflow characteristics. Ideally the cockpit and cabin should have separate airflows with the cockpit environment at positive pressure compared with the cabin. This is not possible for the average air ambulance. The next best arrangement is to have the airflow from fore to aft with no recirculation of cabin air at all. If recirculation is unavoidable, then one must ensure that HEPA filters are fitted to the recirculation valves. As already mentioned, for flights greater than four hours, there should be a crew rest area where there is no mixing of air with that of the cabin.

If there is any possibility of unfiltered cabin air being recirculated to the rest of the aircraft, then all on board must wear N-95 masks for the duration of the journey. This includes the flight crew, whose members will then have issues relating to the compatibility of their N-95 masks and the quick fit aircrew oxygen masks. An alternative for the flight crew is to wear quick fit oxygen masks for the duration of the flight.

Patient Placement

The patient should be placed as far "downwind" of the aircrew as possible. If they are spontaneously breathing they should wear N-95 masks to reduce pollution.

Post Transport

The aircraft cabin should be thoroughly cleaned and the air conditioning turned to maximum for as long as recommended by the manufacturer for at least one complete air exchange. Cleaning personnel should wear PPE whilst in the cabin. Post mission, all crew who could have possibly come in contact with the patient must be monitored for an appropriate period of time.

Logistics

There should be enough infection control supplies for the expected duration of the flight, plus additional time for unexpected delays. Experience suggests a 30% time margin should be allowed for these contingencies.

All airports where the plane is scheduled to land for refueling, etc. need to be contacted and informed of the nature of the patient's illness. This may also be necessary for emergency diversion airfields. On international flights, local medical authorities will need to be contacted. It may also be necessary to gain approval to fly over some countries when carrying such infected patients.

Personnel Issues

There should be a consideration of staff being unwilling to participate in such high risk transports. Company policy should incorporate policies and guidelines for this situation.

Clearly a policy and contingency plans for the transport of highly infectious patients must be organized and then practiced many times before the safe transport of an infected patient is even considered.

FINANCIAL AND REIMBURSEMENT ISSUES

The majority of air medical transports in most areas of operation are funded under the provisions of travel insurance of one form or another. The remainder are reimbursed by a variety of other payers: governments, aid agencies, large companies (such as oil exploration operators) and occasionally by patients themselves or their relatives. Some insurers or other payers will have contractual arrangements with particular international air medical services (some insurers even provide in-house air ambulance services²¹). However, more often the insurer will "auction" each mission among available air ambulance providers and take the cheapest appropriate bid.

The difficulties in dealing with third party payers, such as health maintenance organizations (HMOs) and similar health insurers, will be familiar to those working in the United States health industry, but are likely to be an unpleasant novelty to those from countries with some form of universal health system, such as the United Kingdom (UK), much of Europe, and Australia. Where contracts are awarded on price only, this will create pressure to use the least expensive aircraft (e.g., a turboprop in place of a jet, with consequent slower response time) and perhaps a less expensive clinical crew as well (fewer personnel and/or more cheaply reimbursed individuals, e.g., emergency medical technician in place of a nurse or doctor).

In some cases, there may even be financial pressure to undertake treatment at local facilities as an alternative to air medical evacuation, although this usually takes place before the air medical service becomes involved/aware, and only those cases in which this strategy fails to come to the attention of providers. This may be concurrent with similar pressure to utilize RPT rather than the more expensive air ambulance medevac. The definition of air medical transport or equivalent terms may also be the subject of some dispute – the authors have experience of a case in which a travel insurance provider, asked to fund an air medical evacuation for a tourist with peritonitis in a developing country, argued that their definition of, and reimbursement liability for "medical evacuation" was limited to the provision of a single (i.e., unescorted) seat home on the first available flight. This is obviously an extreme example; but those accustomed to dealing with HMOs in the U.S. can attest that there is frequently an insurmountable difference between what the payer and health care providers consider a reasonable level of care. To the authors' knowledge, there has been no legal test case of this specifically related to international medical transport to date; however, a recent case in the U.S. makes sobering reading.²² A patient sued her HMO for denial of treatment after sustaining a complication; however, the court ruled in favor of the HMO, to wit, that denial of reimbursement for treatment did not equate to refusal to treat. This precedent may prove to have profound future implications for international air medical transport that falls under U.S. jurisdiction.

Ironically, increasing pressure from insurance payers not to use air ambulances may be matched by increasing reluctance from airlines to sanction medical transports by RPT for a range of reasons, likely including decreased profitability and liability issues, especially relating to infectious diseases. International air medical services and their potential patients may find themselves occupying an increasingly difficult middle ground between these two parties. One potential consequence of this is that patients with significant illness may attempt to board RPT flights incognito, most likely with assistance from relatives or companions, and then seek medical assistance after takeoff. This was certainly observed amongst casualties from the recent Bali bombing.²³ To date this has been a relatively rare phenomenon, although some anecdotal reports circulate; however, only 20% of in-flight deaths identified in one review occurred in patients with known medical conditions.²⁴ However, the developments outlined above suggest that such undeclared quasi-medical transports may increase, and become a more common cause of in-flight medical emergencies.

One possible avenue of response to the above developments is a greater degree of cooperation between international air medical providers and agreed adherence to a

Principles and Direction of Air Medical Transport

common set of minimal standards. This would provide a united front against clinically or operationally hazardous cost containment measures; however, unless the standards are well recognized and preferably external (e.g., Association of Air Medical Services, AAMS), there is the risk of allegations by payers of cartel formation and price fixing by providers.

DECISION MAKING IN AIR MEDICAL TRANSPORT

Air medical services may become involved with the patient at a variety of points along the course of their illness. In the simplest case, the air medical service may be contacted purely to perform the air ambulance role, with all else being already arranged. At the other end of the spectrum is the urgent contact, typically by a relative or traveling companion of a patient who is critically ill in a foreign country where even basic life support measures may not be available. Air medical services involved in international transport must develop the capability to accommodate routine requests for transport and have contingency procedures to deal with less typical requests. As a general rule, the earlier the service becomes involved, the more involvement will be required from the medical director or other air medical physician in advising on interim treatment and preparation for transport, locating a receiving facility and accepting physician and determining the urgency of transport. Alternatively, this medical decision

making may be outsourced to another agency (hospital, travelers' medical service, etc.) by prior agreement.

The air medical service must also delineate its capabilities with respect to: types of transport (urgent, routine, regular passenger transport); type of patients (BLS, ALS, critical care, specialty transport); and number of requests or patients that can be handled simultaneously. There must be a willingness to refer those requests for which the service is not available or suited.

The accompanying diagram (Figure 9-1) shows a decision making process applicable from the first contact with the patient potentially requiring international air medical transport. The actual air medical service may become involved at a variety of points along this flow chart. The decision tree attempts to outline the full range of response options. Obviously it will require modification for services and areas that do not have access to this range of options (i.e., where no regular passenger transport, or no air ambulance capability exists).

If an individual case fits a category the transport agency does not service, consideration should be given to referring the case to another service with the appropriate capability. Perhaps more than in any other area of air medical practice, international air medical transport benefits from cooperation and not competition between services.

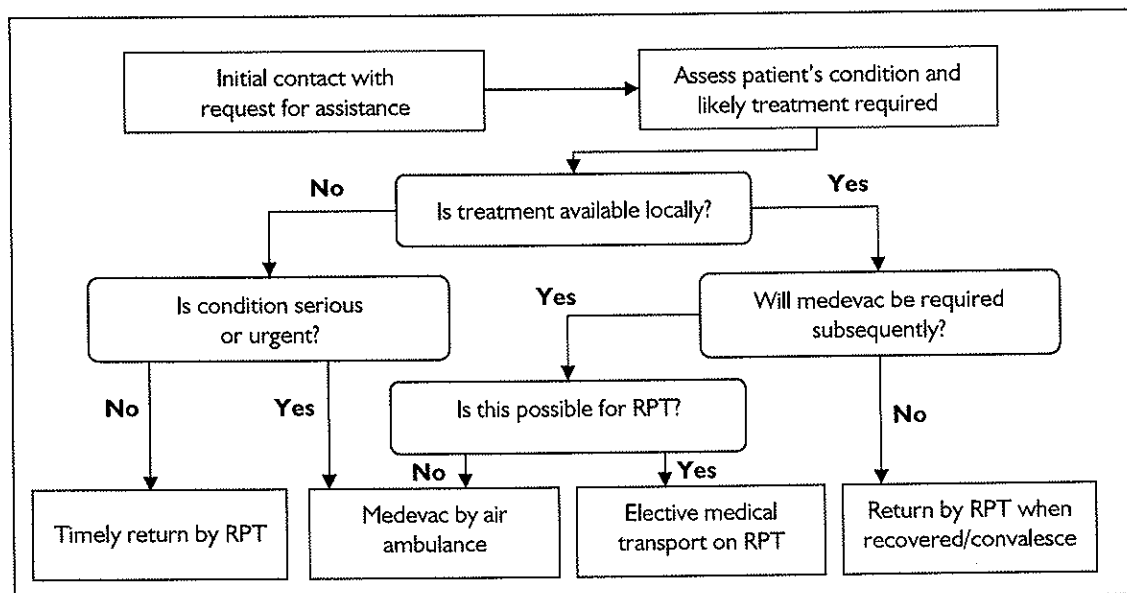


Figure 9-1: Decision Making in International Air Medical Transport

DISASTERS AND MASS CASUALTY RESPONSES

Medically, a catastrophic occurrence becomes a disaster when it generates sufficient casualties to overcome local resources, either actually or potentially. Depending on the scale of the disaster and possibly whether or not it involves foreign nationals (e.g., the "Sari Club" bombing in Bali),²³ international assistance may be sought.

In the event of international assistance being requested, air medical transport services are likely to be among the potential response agencies, although the scale of a disaster requiring international response makes it unlikely they will be the only responders. However, because international air ambulance services are by definition available and optimized for rapid activation, or "cocked and loaded" if you prefer, they may be amongst the first international responders to arrive.

Typical international air medical services responding to such a scenario have both advantages and disadvantages. The former include:

- As outlined above, international air medical teams are likely to be available and capable of rapid response.
- Equipment is similarly ready to go.
- Clinical team members are likely to be experienced in working in overseas hospitals, possibly even within the country concerned. They are likely to have up-to-date travel documentation and immunizations.
- International air medical services that also have domestic operations encompassing rotary wing scene flights will have the additional advantage of staff with training and experience in the prehospital setting.
- Operationally, the service concerned may well have experience flying into the country concerned, and may even have pre-arranged flight plans and landing clearances to a suitable airfield.

Conversely:

- Air ambulances, even for international operations, are usually small; most are unable to take more than two stretcher patients.
- Medical equipment is usually optimized for intensive therapy for one or two critically ill patients, rather than "extensive therapy," i.e., simple measures for large numbers of patients.

- Consistent with the above, standard supplies of consumables such as oxygen and intravenous fluids are likely to be limited.
- Commercial air ambulance operators may require a guarantee of reimbursement. This may well not be possible in the early stages of a disaster response, or it may take time to negotiate this with a government agency or charitable foundation.

It is most unlikely that air ambulance services could, or would, be asked to manage a medical disaster as the sole responders. It is more likely that such services would be asked to fill a niche role. One of the principles of personnel management in disasters is that role allocation should, where possible, approximate people's usual daily tasks.²⁵ International or long distance transport of the most severely ill or injured patients is the logical task for air ambulance services. This may usefully be combined with ferrying of additional staff and/or supplies on the return trips.

Air medical services, or their physicians and other clinical personnel, may be incorporated into regional or national disaster response plans, either generally or in specific roles such as clinical support to urban search and rescue (USAR) teams. As outlined above, air medical personnel may have superior training, experience and equipment for such roles compared to hospital staff.²⁶ Many air medical physicians have experience with on-line medical control, and with relevant training in disaster medicine, may be well suited to the role of forward or even overall Medical Commander for the disaster team.²⁷

It is difficult to plan precisely for disasters because they are by definition unpredictable, relatively infrequent, and each is unique. In the mass casualty situation the usual standards for air medical transport will be impractical, and considerable flexibility will be required. Consideration should be given to transport of walking wounded and uncomplicated stretcher patients aboard commercial flights with a small medical escort. If military resources are amongst the responding agencies, air force medical aircraft may be the best option for evacuation of large numbers of stretcher patients. The use of such a combination of resources in the recent Bali bombing has been described.^{23, 28}

Clinical priorities in disaster situations are very different. The guiding principle must always be: "*the greatest good for the greatest number.*" This may very well mandate a decision not to resuscitate critical patients, who will consume considerable resources with limited chance of survival. This can be very distressing for the staff involved, particularly when such victims include children. For air medical teams and other critical care personnel, who are used to caring for critical

Principles and Direction of Air Medical Transport

patients and seeing some of them survive, it can be especially distressing; it may also be frustrating insofar as they cannot practice their core skills. Staff placed in this situation must know in advance that the situation and the rules will be very different and that they will be exposed to countless human "mini tragedies." Critical incident stress debriefing and stress counseling should routinely be made available to air medical personnel involved in disaster responses.

INADVERTENT AIR MEDICAL TRANSPORT

Just as the increase in international flying has led to an increase in the requirement for air medical transport, it has also increased the number of medical emergencies occurring during scheduled international airline flights. Obviously, emergencies can also occur in domestic flights, but these flights are likely to be of shorter duration and easier to divert to alternate landing sites.

Air medical physicians are probably no more or less likely than other physicians (given equivalent amounts of airline travel) to encounter such an event, but they may be amongst the best placed to render meaningful assistance. It is beyond the scope of this chapter to cover this topic in depth, but several useful reviews are available.²⁹⁻³¹ What follows is a brief summary.

INCIDENCE

The death rate in flight has not been reported recently, but an earlier study estimated about 1 in flight death per 3 million passengers.²⁴ It may be that this has increased, as two studies a decade apart reported a near four-fold increase in incidences of inflight medical emergencies, from 1 in 39,000 to 1 in 11,000 passengers.^{32,33} Using the latter figure, and given that a typical international jet carries up to 400 passengers, an approximate incidence of 1 emergency per 30 typical flights can be deduced; this estimate is probably consistent with another study that reported over 60% of physicians had been asked to provide assistance on one or more occasions.³⁴ This potentially includes some cases of patients who do not have or have inadequate travel medical insurance coverage, so attempt to travel back as a regular airline passengers and decompensate in transit.

TYPES OF EMERGENCIES

The most common reported emergencies are syncope, followed by angina, other cardiac events, gastrointestinal complaints (other than simple vomiting due to motion sickness or alcohol, which is probably the

commonest of all), asthma, and anxiety/panic attacks. Alcohol abuse, anxiety, sleep deprivation and the effects of cabin altitude were identified as contributing factors in some cases.³⁵

AIRLINE MEDICAL KITS

In the event of an inflight emergency, the medical resources available vary widely between different airliners.³⁵ There are Federal Aviation Administration (FAA) minimum standards for medical equipment aboard airliners.³⁶ As these apply to any airliner entering U.S. jurisdiction, they are in essence *de facto* international minimum standards. They are, however, fairly basic. Although some airlines have carried automatic external defibrillators since the early 1990s, FAA standards have only recently (2004) mandated their availability and the need to have cabin crew trained in their use.³⁶ Other items of note in the FAA standards include: self inflating bags, masks, and oropharyngeal airways; IV cannulae, tubing and a 500ml bag of saline; and epinephrine, bronchodilators; nitroglycerin and antihistamines. A notable omission is any form of suction apparatus. Some airliners choose to carry a considerably more comprehensive kit than this, including suction, sedatives, and equipment for endotracheal intubation.³⁷ Others do not, perhaps due to the risk of vicarious liability for complications, e.g., an unrecognized esophageal intubation by a physician inexperienced in airway management.

Hence, unless familiar from previous experience, an air medical (or any other) physician is unlikely to be familiar with the features and limitations of a particular airline's medical kit until actually agreeing to assist with an inflight medical emergency. Also, it is not inconceivable that air medical personnel will be confronted with an inflight medical emergency while engaged in a medical transport aboard an airliner – in which case they are very likely to have a far better range of equipment and drugs than any airline medical kit. However, in such a situation the first responsibility of a medical team remains their designated patient.

MEDICOLEGAL ISSUES

The legal obligations and liabilities of physicians confronted with an inflight medical emergency are complex. They vary between nations – and hence between airlines, whose aircraft are sovereign territories of their countries of origin – although also subject to many of the laws of the country over which they are flying.³⁸ In the United States, specific legislation protects doctors rendering aid aboard airliners under the "Good Samaritan" principle, i.e., emergency care not performed for reimbursement (although this probably does not preclude acceptance of

Air Medical Physician Association

a gift from the airline, such as an upgrade) for all but gross negligence or willful misconduct.³⁹ Some other countries, e.g., France, impose upon physicians a legal obligation to render assistance if requested; conversely, some countries, such as the United Kingdom, do not recognize a difference between serendipitous aid and paid consultation in terms of duty of care and potential liability. It should be borne in mind that the role of medical personnel should be to assist and advise the airline crew, who have the ultimate control and responsibility. This also implies vicarious liability for assistance rendered. There have been instances of litigation against airlines arising from medical incidents. Despite the wide variation in legal framework, at the time of writing the authors are unaware of any action for damages brought against a physician or other health care professional arising from assistance rendered inflight.

PRINCIPLES OF MANAGEMENT

Air medical physicians are perhaps the most ideally suited of any health professionals to assist with inflight medical emergencies. They can be expected to be knowledgeable about altitude physiology and aviation medicine, experienced at working in the transport environment, and in interim management with limited resources for a wide variety of conditions. They may also be carrying additional medical equipment and supplies.

There are a wide range of inflight medical emergencies, and it is not within the scope of this chapter to discuss more than a few brief principles:

- Assessment and diagnosis is likely to be even more difficult than in normal air medical transport, due to limited resources and privacy.
- Always seek consent and respect privacy as far as possible. If possible, move the patient to a (relatively) quiet and private area.
- Diagnosis is nice, but less important than basic stabilization. Sometimes it is as simple as: ***“Air goes in and out; blood goes round and round; and variations on this are always bad.”*** Sometimes this is all that can be done with the resources available.
- Oxygen is good. In the absence of pulse oximetry and at typical cabin altitudes it is wise to assume all patients are hypoxic till proven otherwise. Inflight oxygen supplies have been outlined above. If hypoxia is still suspected in spite of supplementary O₂, it may be advisable to request that the aircraft descend to a height where a sea level cabin altitude can be maintained.
- Due to the cabin environment, all patients are at increased risk of dehydration and hypothermia. Appropriate protective measures should be instituted.

Advice may be available – either from the airline’s medical department, or a specialized provider, such as the MedLink Global Response Centre,⁴⁰ who have arrangements with many international airlines to provide on-line medical advice.

If the patient cannot be stabilized, or remains in a severe condition (e.g., coma, or persisting angina), then a recommendation should be made for the aircraft to divert. Obviously this recommendation has significant implications for the other passengers and the airline. Sometimes, despite the best management that can be offered in the situation, the outcome may still be poor.

SUMMARY

International air medical transport is a challenging field of practice that is growing in conjunction with the expanding population of potential patients, such as expatriates, travelers and aid workers, plus those within their own country who need to travel to seek medical care abroad.

It is also a unique sub-discipline that encompasses a much wider range of patients than, for example, a typical domestic rotor wing air medical program – from the walking wounded to the critically ill. It also has many unique aspects, such as language barriers, prolonged transport times, and problems with differences in medical systems between countries.

Training and experience in domestic air medical transport provide a good grounding for international work, especially in dealing with very high acuity patients, such as those requiring major cardiorespiratory support therapy. However, these abilities need to be complemented by the necessary administrative, logistics and language skills, either by the use of combined teams, or specific training programs for international staff.

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