Optimal Interhospital Transport Systems for the Critically Ill

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Introduction

Increasingly, critically ill patients are undergoing interhospital transportation. The reason for transport is not only for higher level care, but also as consequences of the re-distribution of critical care resources. There are many transport system issues for such patients. These issues have the potential for significant patient and transport team morbidity and financial burden upon the health services. An examination of events during the patient referral process can identify referral system based problems at many levels of health care. This chapter will review our current knowledge of the clinical and operational process for referral and transportation of critically ill adult patients as well as the available means of its evaluation and likely future direction.

Organizational Structure

The organizational structure for patient interhospital transport services is largely determined by the perceived clinical workload, regional population demographics, geographic features and transport related regulatory requirements.

Hospital-based services source their personnel and equipment from within the hospital's critical care department medical and nursing pool rostered specifically for transport duties or taken from rostered hospital duties. They have ready access to other specialized hospital clinical services and can develop the capacity to deliver specialized services (e.g., neurosurgical, thoracic, etc.) to patients at the referral site. They can also have access to a wider range of other hospital logistical support such as roster/staff pool manipulation, blood products, rapid sterilization services, and infrequently used drugs, antivenoms, and antidotes.

Hospital-based services can enhance the referral process through a dedicated communication line through which immediate advice can be provided and the referral response within that hospital initiated. As the complete referral process is co-ordinated through one site, quality measurements can be gathered for each phase of the referral and there is a single source of outcome data to referral sites. Such hospital services could be involved with uniform instruction of pre-transport patient care and preparation through outreach educational programs at potential receiving sites.

A process for the rapid deployment of vehicle and personnel, which includes aspects of communication, tasking, vehicle availability, safety, and pre-deployment ve-

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hicle familiarization training is essential. The latter would include on board procedures and equipment, including communication devices and those to do with vehicle safety.

Non-hospital based organizations are administratively independent organizations that supply the medical and aviation crew for the purpose of transporting

Table 1. Comparison of hospital and non-hospital based interhospital patient transport services

Hospital based	**Advantages**	Ready pool of staff from critical care areas
		Sole 'control and command' of referral process
		Patient preparation and management based upon familiar hospital practices
		Ease of integration of patient into hospital services
		Patient monitor compatibility
		Familiarity of crew and referral staff within each region
		Access to other hospital clinical, diagnostic, therapeutic services
		On site for data collection, outcome measures and quality assessment
	Disadvantages	Less concentration of numbers of patient transports
		Less concentration of transport medical equipment resources, and less cost efficient
		Clash of crew training activities and service audit processes with other hospital duties
		Disruption to hospital workload through removal of staff for transport duties
		Variable adherence to guidelines due to inability to provide for limited medical equipment
Non-Hospital based	**Advantages**	Concentration of expertise and skills through volume of work
		Development of true 'speciality' service by concentrating on provision of transport services only
		More efficient use of medical equipment, crew training opportunities
		Staff rostered solely for transport duties
		Greater crew familiarity with transport vehicles
		Crew training and currency easier to apply and monitor
	Disadvantages	Increased complexity of communication links between referring, transport and receiving staff
		Medical equipment incompatibility between various sites
		Patient management procedures may differ between crew and referral/receiving hospitals
		Distant from specialized hospital clinical, diagnostic, therapeutic services
		May require to maintain costly, less frequently used pharmacy items
		Data acquisition is scattered among more than one receiving site
		Medical equipment cleaning and repair less efficient due to lower volume of work

patients between non-affiliated facilities. They have the advantage that expertise is developed through their sole focus on safe interhospital patient transportation. This concentrated and higher volume of clinical and aviation transport exposure may have positive implications for crew performance [1] and patient safety [2]. Non-hospital-based patient transport services should develop links with tertiary referral hospitals for improved access to speciality medical and surgical services consultation, utilization of hospital services such as equipment sterilization, pharmacy, and blood products as well as in hospital educational and audit activities pertaining to the transport service activities. Table 1 summarizes the advantages and disadvantages of hospital and non-hospital-based organizations.

When more than one transport service is available and/or are multi-tasked, tasking is best co-ordinated through a central tasking authority via a dedicated communication line. This allows for prioritization of requests and establishment of communication links between referring, transporting, and receiving staff. The central tasking authority can become involved in establishment and maintenance of patient transport standards, evaluation of the critical care referral process, liaison with other services (e.g., ambulance and aircraft providers) as well as report to local hospital, regional area health service, state and or national health authorities and legislators.

Medical Crew: Crew Selection, Accreditation, and Training

Studies of the interhospital transfer of critically ill patients have documented inadequacies of patient care, significant associated morbidity and observed mortality in excess of expected mortality when compared to similar patients who were not transferred [3, 4]. Patients admitted to an intensive care unit (ICU) following transfer from another hospital have been shown on average to have higher severity of illness measures than similar non-transferred admissions to the same ICU [4, 5]. In recognition of these events, standards for the safe conduct of out of hospital patient transportation have been developed.

Major physiological disturbances such as hypoxia, hypotension, missed injuries, intravenous access, airway, ventilation, spine and limb immobilization, and communication problems are commonly documented in transit adverse patient events. Unresolved physiological instability at the referral site, and lack of transport experience by the escorting team, are predictive of such events [6, 7]. It is therefore essential that the medical team escorting the patient have the skills in monitoring, recognizing and managing acute physiological disturbances associated with a broad range of patient illness, rather than staff with medical expertise limited to specific disease categories and little expertise in acute multi-organ dysfunction.

Referrals from remote regional hospitals with limited resources and staff who only infrequently encounter critically ill patients provide the greatest challenge. The transporting medical staff should have the capabilities to provide to those sites at the very least an enhanced level of clinical expertise.

High level and well-practiced communication skills are vital to transporting medical teams. Not only must they be familiar with the range of available communication aids but also they must develop, acutely, a rapport with potentially unfamiliar

referring and receiving medical staff, patients and their relatives. They require the capacity to communicate clinical information in a clear, relevant and timely fashion. This facilitates the transfer and appropriateness of information advice that they are expected to provide to the referring, receiving and supervising staff, all of whom may be at a location distant to the team and patient.

The transport environment is more unpredictable and stressful to the inexperienced than the familiar hospital environment. The team requires a high degree of situational awareness and this is often associated with an increased clinical workload, both in terms of intensity and duration. Successful team function then becomes even more dependent upon effective interaction amongst team members, of which familiarity, communication, effective leadership, and team cultural factors play a part [8].

Selection and training of patient transport medical teams must then reflect these demands. At present a disproportionate emphasis is placed upon pilot selection than medical staff selection, even though it is the latter that has the most significant influence upon outcome of patients undergoing interhospital transfer.

Medical staff should be selected based upon extensive in-hospital critical care experience, a demonstrated ability to function unsupervised, communication and leadership skills, ability to safely adapt clinical practices to unique situations and to work within a variety of team structures. Training should incorporate clinical performance within the constraints of transport vehicles, medical and personal protective equipment as well as vehicle familiarization, especially the associated communication and safety/emergency procedures (e.g., where applicable, helicopter underwater escape training, hypoxia awareness training).

Knowledge of, and comfort within, the working transport environment is also essential. Despite the wealth of information about the physical aviation environment, there is an inadequate amount of information as to the clinical consequences and significance of that environment upon the various patient pathophysiological processes. Most such information is derived and/or accumulated through clinical exposure. Therefore, not only is a sound knowledge of the transport environment required, but instruction about the environment/patient interface and its clinical significance is essential for medical transport teams. Knowledge of local geography and meteorology is also important.

Familiarity with regional medical resource distribution, referral policy and procedures as well as referring and receiving senior medical staff is important. Resource distribution can be catalogued within a predeveloped database. At least an above average level of physical fitness should be required of transport team members as well as a pre-deployment assessment of vision and hearing.

Team performance training should be based upon Crew Resource Management principles which incorporate effective communication skills, situational awareness, problem solving, decision making, stress recognition and management, team management, interpersonal skills, fatigue recognition and management [9]. Such training needs to be ongoing and tailored to conditions and experiences encountered within the patient transport service [10].

Familiarity and prior experience are crucial to such medical crew performance. Re-accreditation of personnel should reflect clinical currency in interhospital patient transportation, equipment familiarization, participation in specific quality

assurance activities, accuracy and completeness of documentation, and participation in transport vehicle familiarization briefings. Skills can be maintained through ongoing in-hospital clinical exposure within relevant critical care environments, especially intensive care and emergency departments, clinical exercises utilizing transport equipment and team scenarios, supervised transports and simulator training. Attendance and participation in quality/audit activities should be mandatory.

Not all acutely ill patients require a doctor. Although out of keeping with most currently accepted guidelines for minimum standards of patient transportation, some critically ill patients can, under medical guidance, be transported by a non-medical escort with no documented added morbidity or mortality [11]. On this basis, hospital and non-hospital-based patient transport organizations may develop a multi-tiered response capability, in terms of team crew composition and resource utilization. Such a strategy would require reliable and expert pre-transport information gathering and assessment. Currently available scoring tools to predict which patient is not at risk [12] have a low specificity and are likely to be based upon clinical judgement. Given the incidence of missed injuries and deficiencies in treatment at the referral sites, such decisions for critically ill patients should be cautiously applied after a high level of medical consideration.

Types of Transport Vehicles and Vehicle Selection

For interhospital transport of the critically ill the choice is essentially road ambulances, rotary wing aircraft (helicopters), and fixed wing aircraft (dedicated air ambulances or commercial flights).

Road ambulances are readily available all over the world, but range from being an empty vehicle only, to a sophisticated, well equipped resuscitation platform. Vehicle and patient cabin size varies according to the requirements for speed, maneuvrability, terrain and clinical patient circumstances under which the ambulance will be utilized.

Helicopters are selected based upon the considerations of working geographical environment, cost, maintenance, single/twin engine capacity, size, noise, and instrument flight rules (IFR)/non-IFR capability. A twin engine aircraft has a significant margin of safety for medical work, in that it can fly on, and land after, an engine failure whereas a single engine aircraft has no option but to auto rotate into the nearest clear space. Helicopters used for long distance patient transport over wilderness areas should be twin engine. Aircraft equipped to fly under visual flight rules (VFR) conditions only are at a safety disadvantage compared to those with equipment and pilots trained to fly using IFR when needed, either with two pilots or using an autopilot. A small, fast helicopter is maneuvrable and able to land in tight landing areas, of advantage during urban pre-hospital work. Interhospital medical work is between known safe landing zones and there may be an advantage in using a larger aircraft with the capacity for more than one patient. Noise is an issue for hospitals in populated areas, and there is a benefit to modern quieter helicopters designed to minimize tail rotor noise (such as fenestron rotors or NOTAR [no tail rotor] systems).

Fixed wing aircraft range from dedicated or reconfigured turbo prop or jet engine aircraft fitted out as air ambulances, to long haul commercial airliners with stretchers mounted to military aircraft designed for transport of mass casualties.

Depending upon the terrain, road vehicles are more efficient and quicker for distances of up to 50 km, helicopter transport is quickest, more efficient and as financially cheap as fixed wing aircraft within the range of 50–250 km, whilst fixed wing aircraft are preferred for distances beyond that.

A new aircraft, the Bell/Agusta 609 Tiltrotor, combines advantages of both rotary and fixed wing aircraft and may have a significant impact on aeromedical work in the future. It can take off from, and land at, a hospital helipad, and hover as a helicopter, then move its rotors into a rear thrust position for forward motion with the speed advantage of a fixed wing aircraft.

Few comparisons between different modes of transportation have been done using similar patient population groups. Patients with acute coronary syndromes can be safely transported by helicopter. Comparative studies with road transportation have not shown a survival advantage but fewer adverse cardiac events have been shown to occur during road as compared to helicopter transport [13]. Patients with a broad case mix [14, 15] and more specific conditions such as hypothermia, post-thrombolytic therapy, cardiogenic shock receiving complex therapy (i.e., inotropes and intra aortic balloon pump) and trauma have also been safely transported. Of the latter, trauma patients are the group with the most consistent benefit. Our own (submitted in 2000, yet unpublished), and others [16], retrospective comparison of patients with spinal injuries undergoing interhospital transfer showed that no form of transportation was associated with documented exacerbation of neurological injury. Our data showed that, compared to road transport, helicopter transports were associated with fewer overall transport incidents, but a similar number of patient only related incidents.

There are only a very few specific contraindications for the available modes of transportation. There should be no patient who is 'too sick to transport' provided that the patient receives appropriate in-transit care and stands to benefit from the improved level of care at the receiving institution. Potential benefits to the patient from care at the receiving site do not often outweigh the non-insurmountable transport related risks. Choice of vehicle is mostly based upon clinical urgency, geography, weather and vehicle availability. The majority of adverse patient related events are related to clinical rather than vehicle related factors. Overall, the transport process itself may, however, contribute to patient morbidity and mortality for certain patient groups [4, 17], but these are poorly defined.

Patterns of Patient Referral, Selection, and Acceptance of Clinical Transport Responsibility

Each region should assess and document their requirements for interhospital patient transportation. Based upon this information a regional strategy should be developed and redefined as ongoing evaluation of those requirements occur.

It is important that referral process guidelines, as distinct to specific, clinical, patient transport-related guidelines, be established. These should be designed to re-

duce the burden at hospitals with the least resources, which are the most likely to initiate a referral. The referring hospital staff only need to make a single call, which triggers a standardized process. This call also initiates the tasking process for the patient transport service. This single contact point can also be utilized as a source for immediate clinical advice [18].

These communication channels can be via a dedicated telephone landline, radio or Internet facilitated information transfer such as e-mail, still and/or video picture transfer. A conferencing system can be established where referring, retrieval, and receiving doctors and any coordinating personnel can simultaneously be part of the one call. That way, operational planning and clinical management advice [19] can proceed simultaneously. For efficiency, such communication must run according to a set protocol. This protocol should define who leads or 'chairs' the conversation, minimizes debate and non-directed discussions. Such communication should be recorded, protected from liability, and utilized for quality purposes. In situations where transport team dispatch is urgent, they can be dispatched while the other parties complete the exchange of information.

The receiving hospital specialist to whose care the patient is being referred, in conjunction with a senior member of the patient transport service should take joint responsibility for the process and define the indication for referral. This is a crucial step towards the timely, organized and safe transfer of the patient to an appropriate and prepared receiving hospital. All necessary assistance (e.g., information, personnel and equipment) for the referral site should be offered at that time. A management plan that extends into the time after the arrival of the patient at the receiving hospital should be developed at this stage. This process will provide all carers with common therapeutic objectives, simplify the clinical interaction at each patient handover point and maintain continuity of care. Time consuming interventional procedures and/or patient stabilization would not be necessary for transporting teams if patients are adequately prepared prior to their arrival. Similarly all clinical patient information and documentation should be well known to the transporting team and prepared prior to their arrival. The role of the team is then the continuation of treatment, clinical monitoring and communication with the receiving hospital. Those responsible for the referral process should remain readily contactable in case of consultation.

Guidelines for pre-transport patient preparation can be distributed for use by referring staff. Examples of such guidelines are those published by the Association of Anaesthetists of Great Britain and Ireland for serious head injured patients and those currently in use within the South Western Sydney Area Health Service, Liverpool Hospital Trauma Service for trauma referrals. The latter incorporate a dedicated phone landline, the 'Trauma Hotline' [20] through which initial contact for all trauma referrals is made and a checklist pnemonic, the NEWS ABCDEFGH. This checklist is printed on the cover of a large envelope into which all referral patient documentation and radiology are enclosed. NEWS refers to the questions asked, i.e., Needed? Enough? Working? Secure? about Airway (plus cervical spine), Breathing, Circulation, Disability, Equipment, Family, Gastric tube, History/handover and was developed by Dr Patrick Schoettaker at the Liverpool Hospital Trauma Service (personal communication, 2000).

Proximate or remote supervision of the transport phase should be through a senior member of the patient transport service. This includes logistical and other organizational tasks and team briefing prior to departure. The means for regular and rapid communication with the transport team should be always available. The receiving hospital specialist, in conjunction with the transport service, should ensure that the appropriate resources (e.g., monitoring equipment, drug infusions, preparation for investigation, operating rooms, etc.) are arranged prior to the patient's arrival at the receiving hospital. Preliminary data from the Retrieval Incident Monitoring study shows that of incidents at the receiving facility, the majority was related to deficiencies in the preparations for patient reception.

A feedback process to referral staff, at 24 hours and at time of patient hospital discharge is highly desirable. It completes the 'referral process loop' for the referring medical staff and provides positive feedback for the process as a whole.

Finally, before leaving the referring hospital, it must be confirmed that the patient or surrogate consents to the transport. In the USA it is now mandatory that written consent to transport be obtained [21]. In addition it must be confirmed that the transport is legal and does not violate regulatory requirements or managed care requirements. US federal legislation was passed in 1986 preventing 'dumping' of uninsured patients, and this has now been amended within the Emergency Medical Treatment and Active Labor Act (EMTALA) [22].

Medical Monitoring Equipment and Oxygen Supply

Despite guidelines for patient monitoring during transportation they are at times not consistently applied [23]. The transport environment is unforgiving to patient monitors, and few have been developed specifically for such an environment. Many organizations have developed innovative structures, such as the stretcher bridge to incorporate patient monitors into their practice. Preliminary, unpublished data from our Retrieval Incident Monitoring pilot project (Dr A. Flabouris, 2000) suggests that equipment related incidents make up 27% of all reported incidents and 35% of those are related to patient monitors. This compares to a 9% reporting of anesthetic equipment related incidents in the Anaesthetic Incident Monitoring Study [24], of which 24% (i.e., 2% of all reported incidents) were related to patient monitors.

As access to patients may be restricted in transit, and clinical signs can be difficult to illicit, a greater than usual clinical dependence is placed upon the information provided and sought from patient monitors. Within an ICU environment, monitor alarms have a 5% true positive rate for clinically significant patient events [25]. Pulse oximeters may register a false alarm for nearly 30 minutes of every hour [26]. These are significant added stressors for escorting medical teams and place further demands on the monitor's ability to monitor accurately.

Point of care testing is a developing technology with potential for application in the out of hospital environment. Such testing can be affected by the pressure and temperature differences encountered at altitude. The impact of point of care testing upon patient benefit in a critical care area, apart from the enhancement of the medical therapeutic decision making process has not yet been established [27] and this

appears to be the case on the little documentation that is available for interhospital transportation. The clinical utility of arterial blood gas analysis in transit in the presence of pulse oximetry and capnography remains to be determined.

Our data shows that even though our scene time during interhospital patient transportation is on average 50 minutes, monitor power related adverse events account for the majority of reported equipment related adverse events. Most fixed wing aircraft operate on 12 V DC and helicopters on 12 or 28 V DC systems. Conversion of aircraft power to a suitable AC current requires the installation of an inverter, which are costly, heavy and sensitive to frequency fluctuations. DC to DC conversion to adapt to monitor battery packs and the carriage of replaceable batteries are alternative power sources. Problems with replaceable batteries include the range in varieties, not all monitors have replaceable batteries, loss of monitoring during the battery changes and subsequent recalibration period. Replaceable batteries must be of the sealed type. A maintenance program for the recharging and restocking of batteries should be part of each service's equipment maintenance program.

Due to the current diversity of monitors, transport related monitor incompatibility problems could arise at the time of patient reception and transfer at referral and receiving hospitals. Transport services can develop a database of referral site equipment compatibilities, modify cable connections for the use with a range of monitors, or initiate a complete change of recording device, e.g., pressure transducers, at the time of transfer.

The adverse transport environment, however, does not preclude the monitoring of even sensitive physiological signals. Ultrasound and even electroencephalogram (EEG) signal recording have been applied clinically. As technology develops, the configuration and capabilities of patient monitors will alter. Importantly their capabilities for the storage of recorded information, analysis, reporting and transfer of such data to and from remote sites, enabling distant real time supervision of patient care, will also improve. There will be an increasing pressure upon transferring staff, based upon current monitor deficiencies and need for more clinical information to adopt newer technology. Transport services should have an equipment evaluation process to assess equipment clinical efficacy and suitability within their operational environment. The sharing of such information among patient transport services adds further to current information, and encourages the development of monitors with greater specificity to the transport environment.

The most common source of medical oxygen during patient transportation is replaceable, bulky and heavy high-pressure oxygen cylinders. In our experience, reported adverse incidents in relation to the use of oxygen cylinders is rare. In Australia, however, there has been a serious fire and aircraft explosion in relation to the faulty installation of an on board helicopter oxygen system.

Alternatives to oxygen cylinders are on board oxygen generating systems (OBOGS), liquid oxygen, and oxygen concentrators. Oxygen produced by OBOGS is via chemical, electrochemical, permeable membrane and molecular sieve technologies. They minimize the extent of logistical support required for other oxygen systems but oxygen flow is largely uncontrolled and insufficiently pressurized for most pneumatically controlled ventilators and chemical processes, once initiated are irreversible. Oxygen concentrators are impractical for transported critically ill patients as they are noisy, bulky, limited to the achievable oxygen concentration, do not

supply oxygen at a medically workable pressure, and require a high voltage, AC power source.

Liquid oxygen has a smaller and lighter storage capacity than similar quantities of cylinder oxygen, allows for refilling of partially empty containers, and more recent devices can provide high flow oxygen at 450 kPa [28], sufficient to drive most pneumatically controlled portable ventilators. Disadvantages are that resupply is not readily available at remote sites, contamination may occur during resupply, the phenomenon of temperature stratification if the container is disturbed soon after filling, the need to adequately warm the oxygen produced, and they require a more complex storage and delivery system than gaseous oxygen.

The challenge with the various oxygen systems is to deliver sufficient flow rates of oxygen to provide maximal non-invasive ventilatory support during interhospital transport, the median time for road and helicopter vehicles in our experience, is 31 (IQ 22 and 44) minutes. Gaseous oxygen is the only source of oxygen that currently meets these requirements.

Quality Assurance

To date, most quality assurance activities have been audits of in-transit clinical events. The limitation of such audits is that they examine only select segments of the overall patient interhospital transfer process, that is, clinical in-transit events. Non clinical aspects of patient transportation often undergo a totally separate audit process, and if these processes are not combined or examined as a whole, system based antecedents to incidents may be overlooked or underestimated. This is important if future team training needs, through Crew Resource Management techniques, are to address quality related issues [9].

Examples of potential audit processes are confidential surveys, the use of expert non-operational observers [9], and incident monitoring. Incident monitoring is well established in commercial aviation and the critical care areas of anesthesia, intensive care and emergency medicine. Anonymous reporting of incidents can identify, monitor and improve process quality by using corrective strategies to close the loop and through ongoing incident reporting evaluate the effect of such change. Incident reporting can be applied as almost real time reporting by frequent feedback of trends and accumulated incidents.

Other, longer term, more specific monitors, such as predetermined process indicators (e.g., time to initiation of referral, time to definitive care upon arrival at receiving hospital, in transit accidental extubations/loss of intravascular access, no referral hospital ICU bed availability, vehicle related refused/delayed transfers, etc.) can be incorporated into quality programs across most services.

A pilot Retrieval Incident Monitoring Study in conjunction with NRMA CareFlight and the Australian Patient Safety Foundation has been underway and is nearing preliminary evaluation. Preliminary data from that study are illustrated in Figures 1 and 2. The figures shows that incidents occur most frequently at the referral hospital, patient and equipment related incidents are the most frequent and that moderate or greater adverse patient sequelae, as determined by the transporting team members, occur in 26% of reported incidents.

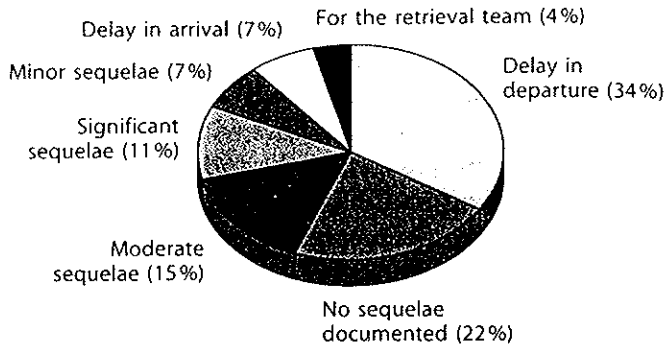

Fig. 1. Type of interhospital patient transfer incident

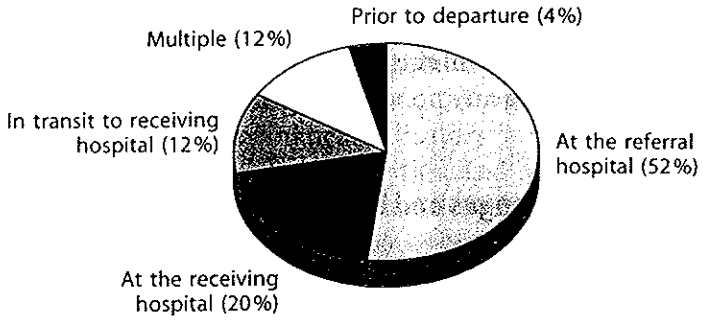

Fig. 2. Location of interhospital transfer incident

Cost

Measuring the cost benefit of a helicopter organization used solely for interhospital transportation is difficult as the patient population who are most likely to benefit is narrow and undefined. For prehospital scene responses, it is estimated that a helicopter service must save approximately 3 lives per year to be cost effective [29]. Although a small and possibly achievable number, 90% of transported patients are thought to not benefit directly from helicopter transfer, with obstetric emergencies, very young patients with acute respiratory problems and life threatening infections benefiting the most, in terms of life years and quality adjusted life years gained [15].

Choice of vehicle for trauma patients remains controversial and is dependent on severity of injury, with those with the highest severity of injury most likely to benefit from earlier delivery to definitive care by helicopter transport. This benefit lessens as the time delay to request for transfer increases to beyond 60 minutes [14] and is likely to reflect a different trauma patient population. Another factor that influences this finding is the quality of initial care at the referral hospital.

Regionalization of specialty services, e.g., trauma, neonatal, paediatric cardiac, etc., has resulted in documented reduction in patient mortality. One of the challenges of regionalization is the equity of care for those in rural areas. The cost benefit per year of life saved through regionalization of such services may be sufficient to fund a regional patient transport service. The community's attitude to helicopter services is positive and expresses a willingness to pay through an additional taxation burden amongst residents in remote areas, when they perceive an overall community benefit and view the service as a means of maintaining equal access to health care and

gain reassurance from its presence. A willingness to pay was also present when the threat of removal of such a service was suggested [30].

Some patient groups have only a marginal gain from helicopter transportation over other vehicles, such as those with cardiovascular disease, adults with infections, and intoxications [15]. The risks and potential loss of crew and patient life years as a result of accident and injury during patient transportation may negate any added benefit. The current emergency medical helicopter accident fatality rate is approximately 4–6 per 100 000 flight hours, with non-fatal accidents being approximately ten times greater.

In summary, there remain significant regional factors that impact upon the cost effectiveness of the various forms of interhospital patient transportation services and their evaluation is essential for the optimization of such a services. From the perspective of public policy, the benefits of regionalization need to be balanced with the maintenance of equity of health care services provision. This must be without disadvantaging any population group or a community perception of disadvantage.

Current Challenges and Future Trends

The current challenge for interhospital patient transport services is to meet the higher standards and expectations that will be placed upon these services. These challenges will arise through the regionalization of medical services, fiscal restraints, development of complex new therapeutic and/or diagnostic modalities that are costly and require unique expertize for their clinical application. The development of critical care networks and the resultant increased redistribution of patients within those networks will also have significant impact.

Fiscal restraint will result in fewer hospital based patient transport services as hospitals look less favorably at their cost implications and see the benefits of concentration of resources in stand alone organizations.

This has implications for team selection, composition, training (medical and operational), experience, supervision and accreditation as well as transport vehicle and medical equipment selection and utilization. The interaction between medical and operational transport arms will strengthen through adoption of common outcome aims, quality-measuring tools and integrated crew resource management training. Interhospital patient transportation could justifiably expand to be a unique medical sub-specialty as a result of these forces encouraging enhanced quality outcome and research.

Justification of the type of patient transport will increasingly be demanded, both in terms of patient benefit and financial implication. Validated outcome measures that are both specific to the transport service (medical and operational) and the referral process, in its entirety, need to be developed. These can include generic ICU severity of illness measures, trauma scoring systems, generic hospital data such as diagnosis-related groups (DRG), outcome, length of stay and resource utilization or more regional specific variables.

In terms of audit and quality processes much can be learnt, borrowed and utilized from the commercial aviation industry. Incident monitoring as a quality tool has the potential to provide an assessment of the critical care referral system as a whole as

well as the patient transport service. This is vital as adverse critical care system based factors have the potential to impact on the performance of the transport service.

As regional changes occur, newer regional costing and reimbursement models for each region would need to be negotiated following consultation with all the significant users. Such models should be carefully developed so that a disincentive to appropriate patient referral is not created and they sustain the viability of a quality and effective patient transport service. Geographic information systems, utilizing existing mapping programs and aviation navigational aids would contribute valuable information to the patient referral patterns and future enhance such services.

Future developments in health care such as telemedicine, advances in patient monitoring and therapeutic devices such as organ support technologies need to be systematically applied and evaluated in terms of clinical benefit and cost. This requires close collaboration with the operational crew and regulatory authorities.

Collaborative exchange of information between interhospital patient transport services and the possible development of performance indicators is crucial. It enables evaluation of the services, justification of their activities, and may be forced upon them through legislation if cohesive voluntary adoption does not occur.

Conclusion

Interhospital patient transport services are a unique collaboration between clinical and operational transport services. The utilization of such services has received much scrutiny in the past and will receive even greater scrutiny in the future. Their role is continually changing, driven largely by the changing nature of critically ill patients, regionalization and networking of health resources, fiscal policy, equity of health service provision, public perceptions and expectations. It is important for each regional health service to define its patient referral requirements, develop a process for such referrals, and incorporate the patient transport service within that process.

All this has significant implications as to the organizational structure of such services, including crew selection and training, medical equipment utilization, patient selection, and choice of vehicle. Strong and validated audit process will be essential to defining their ongoing function and activities.

Future collaboration between patient transport services will add strength to each service and provide a platform for more evidence based practise and guideline development. Through these processes, and increased interest and demand, the future recognition of patient transportation as a unique and important aspect of critical care medicine in terms of formal education and research status can be developed.

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