Transportation of the critically ill and injured patient

Peter J Shirley

Transferring the seriously ill and injured is becoming a more formalized procedure in the UK. Whether from an accident site to medical care or between hospitals, the public expects that organized services are in place for safe patient transfer. As this is a developing subspeciality it is necessary to review the developments that have occurred over the previous 5 years.

The primary and secondary transport of the critically ill patient are complementary to one another. Primary transport from the site of illness or incident has moved on from the old 'scoop and run' philosophy (Brittain, 1996) of providing minimal treatment at the scene and taking patients to the closest available accident and emergency department.

McLaren et al (1995) reviewed early patient transport by the military and reported that the first organized aeromedical operation was possibly during the Somaliland campaign of 1920 when the British used DeHaviland biplanes to evacuate injured troops. In 1944 the first helicopter evacuation of combat casualties took place in Burma (Andrew, 1994). In Vietnam 90% of hospitalized American battle casualties were evacuated by helicopter. British military experience in the Falklands and more recently in the Gulf War has complemented changes in civilian practice among medical and paramedical services involved in dealing with casualties before reaching hospital. Morley (1996) described improvements in monitoring equipment available in the prehospital environment.

Secondary transfers from initial receiving hospitals to more specialist centres have also come under scrutiny. Szem et al (1995) demonstrated a complication rate of 6% when moving ventilated patients — the main problems being hypoxaemia and hypotension. Wallen et al (1995) researched the situation with regard to paediatric transfers and showed problems are still commonplace, not all ventilated patients were escorted by a doctor and often ventilation was carried out manually, because of the lack of a mechanical ventilator.

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PRIMARY TRANSPORT

Currently most injured patients are transported from an incident scene to the nearest hospital emergency department by land ambulance and ambulance paramedics provide care at the incident. Steedman (1996) reviewed the evidence as to whether land ambulances or helicopters should be utilized, concluding that helicopters should only be used in an integrated air/ground system with proper coordination and with a strong emphasis on safety. Nicholl (1997) has suggested that the benefit of using helicopters may be greatest in remote geographical areas inaccessible by land.

In the USA scoring systems have been used to predict how much prehospital care might be needed for victims of trauma or severe medical illness. Savitsky and Rodenberg (1995) showed that the Revised Trauma Score and Glasgow Coma Scale correlated with the interventions required. The presence of a doctor on primary response units continues to be a source of controversy. Data from Bartolacci et al (1998) suggest improved prehospital stabilization and improved long-term survival in victims of major trauma attended by an air medical team containing a doctor with appropriate training as opposed to a paramedic-only air response unit. However, Cameron and Zalstein (1998) observed that such facilities only benefit a few patients and identifying them may be more of a priority than placing a doctor on all services.

The helicopter emergency medical service based at the Royal London Hospital is the only service in the UK that carries a doctor as part of the standard crew configuration. The review of the results from this service by Nicholl et al (1995) did not appear to show convincing benefit in survival following major trauma. A priority despatch system to identify life-threatening calls is being introduced by UK ambulance services and should be in place by 2001. An ambulance or first responder should arrive within 8 minutes in at least 75% of cases, rising to 90% by 2001 (Carrington, 1997).

Mackay et al (1997) showed paramedics are able to identify those patients in whom the prehospital time needs to be minimized, with longer at-scene times offset by shorter transfer times. The use of helicopters to minimize the prehospital time is controversial and may only be of benefit in rural areas (Hotvedt et al, 1996). Denver and Hodgetts (1997) reported on the French approach: Service d'Aide Medicale Urgente (SAMU) provides a physician-led prehospital immediate care system, covering 96 health administrative areas. There is no equivalent of the UK paramedic and doctors, backed up by a combined fire/ambulance service, perform all invasive procedures.

SECONDARY TRANSPORT

It has been recognized for some time that the secondary transport of the seriously injured has been neglected in terms of direct funding and Oakley (1994) suggested that monitoring of such patients should not be compromised. The Australian and New Zealand College of Anaesthetists produced guidelines in 1996 and the UK Intensive Care Society published good practice guidelines in November 1997. These combine advice from different sources and encourage an improvement in standards. Much of what is said in the UK guidelines applies equally well to the critically ill patient in the out-of-hospital setting, whether being transferred or not. Safe and successful transport of the critically ill is advised if the following principles are adhered to:

Organization

Planning of transfers should reflect local facilities and the availability of appropriately trained staff. Clear guidelines and channels of communication must exist in each hospital. In the absence of a recognized transfer team, each hospital must provide adequate staff and facilities for outgoing patients. Flexibility in staffing and rotas must exist to allow this to happen.

The planning phase is vital for a smooth transfer and a briefing format is worth considering. The military use these as a basis for most missions:

S Situation
M Mission
E Equipment
A Administration
C Communications (Captain P MacKenzie, personal communication, 1999)

Transfer decisions

These must be made jointly by senior medical staff in both the receiving and referring hospitals. The risk of transfer arising from the patient's condition must be set against the additional risk from the movement (e.g. tipping, vibration, acceleration/deceleration) as well as possible barometric and temperature changes which may adversely affect cardiorespiratory physiology. The risks of injury or accident to staff must not be overlooked (Steinberg and Forst, 1997).

The decision to send a retrieval team or use staff from the referring hospital will depend on the availability of such resources and the clinical urgency of the case.

Transfer mode: road or air?

Air transfer should be considered for long journeys (over 50 miles or 2 hours approximately) or if the terrain makes road transfer difficult. Helicopters are recommended for distances of 50–150 miles. Pressurized fixed-wing aircraft should be used for transfer distances greater than 150 miles. Recommendations for training of staff and the use of air transport are already well established (Bristow and Toff, 1992).

Urgency, the nature of the illness, geographical factors, weather, traffic and cost should be taken into account.

Transfer vehicle requirements: road or air

Well-maintained and adequately equipped vehicles should be used. Ease of access, proper heating control, lighting and good communication should all be considered. Safety provision for staff is important and noise and vibration should be at acceptable levels.

Accompanying personnel

In addition to the normal complement of crew on a given vehicle there should be two accompanying staff for the critically ill patient. An experienced doctor with skills in resuscitation and airway control, who has received training in intensive care and transport medicine, should be responsible for the patient. Another doctor or experienced nurse, paramedic or technician with familiarity in transfer procedures assists the responsible doctor.

Equipment

Equipment must be suited to the environment, i.e. be durable, lightweight and have sufficient battery life. A monitored oxygen supply with a safety margin of 2 hours on the transfer time is essential. There should be storage space for equipment and staff should be appropriately clothed.

A portable ventilator should have disconnection and high pressure alarms and the ability to provide positive end expiratory pressure and variable fractional inspired oxygen concentration, inspiratory:expiratory ratio, respiratory rate and tidal volume. Portable monitors giving arterial

oxygen saturation, electrocardiograms (ECGs) and non-invasive blood pressure with the facility to monitor invasive pressures (arterial and central venous pressure) are essential. A dedicated equipment bridge, containing ventilator, monitoring equipment and infusion devices, is becoming the method of choice for providing these (*Figure 1*). Alarms should be visible as well as audible. Suction and defibrillation should be immediately available. A warming blanket is also a consideration. A reasonable range and supply of drugs should be carried with syringe pumps to administer them, ensuring that all such devices have charged and spare batteries. A mobile phone should be carried to aid communication.

Preparation for transfer

Stabilization and meticulous preparation are the keys to a successful transfer. All personnel should familiarize themselves with the patient and the current treatment.

As with the planning phase, it is useful to have a checklist to avoid omissions (*Table 1*). This is a useful starting point for any treatment outside a hospital setting, whatever the circumstances.

Full clinical examination with reference to ongoing monitoring should be carried out. Chest drains should be fitted with Heimlich flutter valves and be easily observed.

Recent investigations including chest X-ray, other X-rays, haematology and biochemistry results should be reviewed.

A patient should not be transported until all possible sources of continuing blood loss and sepsis have been located and controlled. Satisfactory perfusion and optimum tissue oxygen delivery must be achieved. Respiratory support is fundamental. Intubation during transfer is difficult and hazardous — if any doubts exist about respiratory function, intubation and mechanical ventilation must be carried out pre-transport. For ventilated patients the pattern of ventilation should be established — end tidal carbon dioxide (CO_2) should be monitored continuously.

Adequate venous access must be in place. A urinary catheter and naso/orogastric tube should be passed. All lines and tubes must be securely fixed.

All documentation including referral letters should be gathered and the receiving hospital re-contacted before departure to confirm availability of the bed.

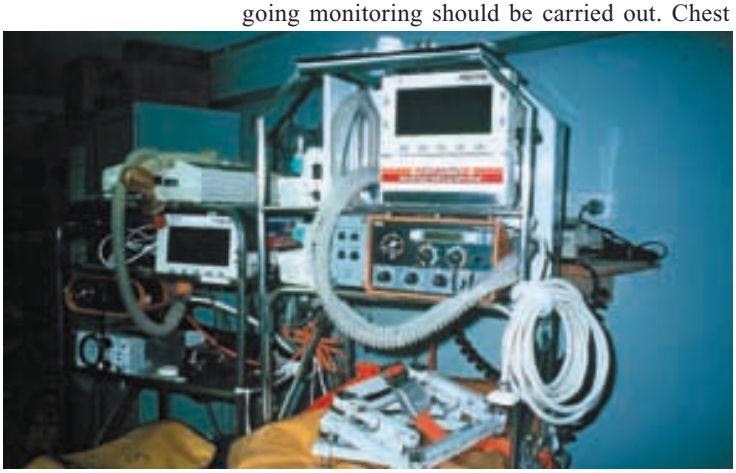

Figure 1. Transfer equipment bridges showing portable ventilators, monitoring and syringe drivers.

TABLE 1.
Checklist for transport of the critically ill

Respiration
Circulation
Head
Other injuries
Monitoring
Line placement and securing
Investigations
Documentation and communication

Monitoring during transfer

The standard of monitoring should approach that expected within the hospital setting. Arterial oxygen, ECG and arterial pressure should be monitored continuously. Invasive blood pressure is advisable as non-invasive measurements are subject to movement artefact.

Mechanically ventilated patients need end tidal CO_2 monitoring and a disconnection alarm as described by Palmon et al (1996).

For long journeys and in cold weather, temperature monitoring is instituted.

Inter-hospital management

Despite good preparation, interventions may need to be carried out en-route; this may involve stopping the vehicle if transport is by road. A slow smooth journey may be preferable to a fast bumpy one (*Figure 2*).

Aeromedical considerations

Increasing altitude may result in hypoxia because of the fall in the alveolar partial pressure of oxygen. Supplemental oxygen is required in all patients. Pressurized commercial aircraft have cabin altitudes of 6 000–8 000 feet; pneumothoraces will expand by 20% in these conditions, hence chest drainage is mandatory if a pneumothorax is even remotely suspected. It is recommended that the time between abdominal surgery and transport in an aircraft not able to maintain sea-level altitude should be at least 10 days, as a

pneumoperitoneum will also expand, unless large drains are in situ. The air in endotracheal cuffs will similarly expand at altitude — the risk of tracheal wall pressure leading to possible airway oedema and necrosis must not be overlooked. The pressure in air-filled cuffs should be checked regularly, or alternatively saline can be used to inflate cuffs.

Temperature control, especially in helicopters, can be a problem. Most rotary wing and small fixed wing aircraft produce excessive noise and vibration. Communication, monitoring, the function of equipment and the administration of fluids can all be affected.

The environment is unfamiliar to most. Space can be limited, particularly in helicopters, and they can be cramped and noisy (*Figure 3*).

Ideally dedicated aircraft should be used with adaptations making them suitable for aeromedical use (*Figure 4*). Both staff and patients can be affected by motion sickness. Staff who recurrently suffer from this problem should not be selected, similarly those who are unable to equalize their middle ear pressure are unsuitable as escorts.

Long-distance flights from abroad have special considerations and specialist advice should be sought. The Civil Aviation Authority has medical officers available for this purpose.

Receiving hospital handover

On arrival the responsible doctor must liaise with the medical officer taking over the care. A written summary of events in transfer should be added to the clinical notes.

Figure 2. Equipment bridge in-situ with subject in vacuum splint for spinal injury transport.

The transfer team as well as the receiving hospital should retain full documentation of changes in physiology. This will enable information to be supplied for local audit and, if necessary, regional or national audit. Without good documentation it is difficult to measure meaningful outcomes.

Training

Staff employed in such transfers should be trained and have had the opportunity to act as observers in previous cases. The health and safety aspects of the vehicle used should be highlighted, and in the case of aircraft, safe approach and escape routes indicated. All staff should have regular simulated escape training if working on aircraft.

Insurance

Cover for accident or injury to staff must be provided. Individuals should check the conditions of personal life policies if air transfers are undertaken. Medical indemnity must be provided by relevant employing hospitals. Personal cover is also recommended. The provision of insurance does not diminish the need for regular safety training for all staff involved in retrieval medicine. In 1999 the Association of Anaesthetists of Great Britain and Ireland (AAGBI) announced automatic death and injury insurance for members partaking in such patient transfers.

Figure 3. Rear view of cabin of aeromedical helicopter.

Figure 4. Dedicated fixed-wing aircraft showing cargo door adapted for stretcher access.

CONCLUSIONS

The Intensive Care Society (1997) highlighted the potential pitfalls in transporting the critically ill. This has been reinforced recently by Wallace and Ridley (1999). Taken in conjunction with the guidelines on the head-injured patient published by the Neuroanaesthesia Society and AAGBI (1996) they have raised the awareness of the difficulties involved and will hopefully improve care in the UK. Application of standard algorithms together with special training for personnel and careful planning are emphasized in all of these guidelines. Shirley and Klein (1999) reported that long-established retrieval services in Australia already have clinical guidelines and systems in place for medical crew training. Gilligan et al (1999) described the system in South Australia where specialized medical teams, travelling by road, helicopter or fixed wing aircraft, stabilize critically ill patients in rural areas, and transport them to tertiary referral centres in the capital.

Scenario-based teaching following training has shown that intensive care staff can use standardized guidelines appropriately when deciding when and how to transfer critically ill patients (Lee et al, 1996). Use of protocols depends on effective means to ensure that standards are maintained and outcomes are monitored; an in-hospital study into the documentation of vital signs in the sickest trauma patients highlighted deficits in data recording (Williams et al, 1997). Detailed research into outcomes will be required to see whether this has been the case once standard practice becomes more widespread in the UK.

The Australian Patient Safety Foundation (1999) introduced an anonymous self-reporting system for critical incidents during patient retrievals in July 1999. Any team member who feels there has been a problem which endangered patient or staff safety can report this on a standard form. These are collated for the whole country to try and identify recurring problems and improve the service. It would be a positive step if such a system could be introduced in the UK. In the meantime formal debriefing and mission analysis forms would enable problems to be highlighted and lessons learned at a local level. **HM**

KEY POINTS

- Transportation of the seriously ill is still a developing specialty in the UK.
- Several transport modes are now routinely available: road ambulance, helicopter and fixed-wing aircraft.
- Medical escort staff should be of appropriate seniority and have had specific training to undertake patient transfers.
- Good lines of communication between referring and receiving hospitals and the ambulance service are essential.

Conflict of interest: none.

Andrew DR (1994) Helicopter ambulances in critical care. *J R Army Med Corps* **140:** 22–5

Australian Patient Safety Foundation (1999) *Australian Incident Monitoring Study (Retrieval Medicine).* GPO Box 2050, Adelaide, SA 5001

Bartolacci RA, Munford BJ, Lee A, McDougall PA (1998) Air Medical scene response to blunt trauma: effect on early survival. *Med J Aust* **169:** 612–16

Bristow A, Toff NJ (1992) A report- recommended standards for UK fixed wing medical air transport systems and for patient management during transfer by fixed wing aircraft. *J Royal Soc Med* **85:** 767–71

Brittain C (1996) Pre-hospital care. *Care of the Critically Ill* **12:** 103–5

Cameron PA, Zalstein S (1998) Transport of the critically ill. Is there a doctor in the helicopter? *Med J Aust* **169:** 610–11

Carrington DJ (1997) Review of emergency ambulance performance standards. *Care of the Critically Ill* **13:** 19–20

Denver M, Hodgetts T (1997) Pre-hospital immediate care in France: personal observations. *Pre-Hospital Immediate Care* **3:** 134–6

Faculty of Intensive Care of the Australian and New Zealand College Of Anaesthetists and Australasian College for Emergency Medicine (1996) *Minimum Standards for Transport of the Critically Ill.* Faculty of Intensive Care of the Australian and New Zealand College Of Anaesthetists and Australasian College for Emergency Medicine, Melbourne

Gilligan JE, Griggs WM, Jelly MT et al (1999) Mobile intensive care services in rural South Australia. *Med J Aust* **171:** 617–20

Hotvedt R, Kristiansen IS, Forde OH et al (1996) Which groups of patients benefit from helicopter evacuation? *Lancet* **347:** 1362–6

Intensive Care Society (1997) *Guidelines for the Transport of the Critically Ill.* Intensive Care Society, UK

Lee A, Lum ME, Beehan SJ, Hillman KM (1996) Interhospital transfers: decision-making in critical care areas. *Crit Care Med* **24:** 618–22

Mackay CA, Burke DP, Bowden DF (1997) Effect of paramedic scene times on patient outcome. *Pre-hospital Immediate Care* **1:** 4–7

McLaren CAB, Guzzi LM, Bellamy RF (1995) Military medical evacuation. In: Zajchuk R, Grande CM, eds. *Anaesthesia and Preoperative Care of the Combat Casualty.* Office of the Surgeon General US Army, Walter Reed Army Medical Center, Washington DC: 751–85

Morley AP (1996) Prehospital monitoring of trauma patients; experience of a helicopter emergency medical service. *Br J Anaesth* **76:** 726–30

Neuroanaesthesia Society of Great Britain and Ireland, and AAGBI (1996) *Recommendations for the Transfer of Patients with Acute Head Injuries to Neurosurgical Units.* Neuroanaesthesia Society of Great Britain and Ireland, and AAGBI, London

Nicholl J (1997) The role of helicopters in pre-hospital care. *Pre-hospital Immediate Care* **1:** 82–90

Nicholl JP, Brazier JE, Snooks HA (1995) Effects of London helicopter emergency medical service on survival after trauma. *Br Med J* **311:** 217–22

Oakley PA (1994) The need for standards in inter-hospital transfer. *Anaesthesia* **49:** 565–6

Palmon SC, Liu M, Moore LE, Kirsch JR (1996) Capnography facilities tight control of ventilation during transport. *Crit Care Med* **24:** 608–11

Savitsky E, Rodenberg H (1995) Prediction of the intensity of patient care in prehospital helicopter transport: use of the revised trauma score. *Aviat Space Environment Med* **66:** 11–14

Shirley PJ, Klein AA (1999) Sydney Aeromedical Retrieval Service. *Pre-Hospital Immediate Care* **3:** 233–7

Steedman DJ (1996) Ambulance or helicopter? *Br J Hosp Med* **55:** 460–2

Steinberg HS, Forst H (1997) Transport of critically ill patients. *Curr Opin Anaesthesiol* **10:** 309–12

Szem JW, Hydo LJ, Fischer E, Kapur S, Klemperer J, Barie PS (1995) High risk intrahospital transport of critically ill patients: safety and outcome of the necessary 'road trip.' *Crit Care Med* **23:** 1660–6

Wallace PGM, Ridley SA (1999) ABC of intensive care. Transport of critically ill patients. *Br Med J* **319:** 368–71

Wallen E, Venkataraman ST, Grosso MJ, Kiene K, Orr RA (1995) Intrahospital transport of critically ill paediatric patients. *Crit Care Med* **23:** 1588–95

Williams HR, Templeton PA, Smith RM (1997) An audit of trauma documentation. *Injury* **28:** 165–7