TRANSPORTATION OF THE CRITICALLY ILL AND INJURED PATIENT

Dr Peter J. Shirley, Intensive Care Fellow, Frimley Park Hospital, Surrey, UK. pjshirl@hotmail.com

Terminology

Primary transport: from the incident site to a medical facility.

Secondary transport (Inter-hospital): patient moved between two hospitals, usually for an increased level of medical care not available locally.

Intrahospital transport: movement of patients within the hospital or its campus for investigations or treatment not available at the ward or intensive care location. (eg CT scan)

History

The primary and secondary transport of critically ill patients are complementary to one another. Primary transport from the site of illness or incident to organised medical care has now moved on from the old 'scoop and run' philosophy. Developments often occurred following experiences in major conflict. The Knights of St John crusading in the 11th century received training from Arab and Greek physicians. They acted as attendants to soldiers at the point of injury and then transported them to treatment points. Baron Dominique Jean Larrey, Napoleon's surgeon-in-chief, is credited with the first organised vehicular ambulance service, taking medical attendants into the battlefield with the French army. Until recently, ambulances were still not designed with the patient's well being in mind. 1944 saw the first helicopter evacuation of combat casualties in Burma. In Vietnam 90% of hospitalised US battle casualties were evacuated by helicopter.

Physician escorts for secondary transports are a relatively recent phenomenon. Systems in North America were the first to formalise these arrangements in the 1950's. Since then transfer teams and 'retrieval' services have been introduced in many large hospitals and health systems world-wide including Africa and SE Asia.

Primary transport

Currently most injured patients are transported from an accident site to the nearest hospital emergency department by land-ambulance with ambulance paramedics providing care at the incident. The presence of a doctor on board primary response units continues to be a source of controversy. Some data have suggested improved pre-hospital stabilisation and long term survival in victims of major trauma attended by a medical team containing a doctor, as opposed to a paramedic only response unit.

Most of the principles of trauma care covered in the primary trauma care course (PTC) are applicable in the pre-hospital setting. This will obviously depend on the level of training of the attendants and whether the facilities exist for more advanced levels of care. However, there are some simple cornerstones of treatment which form the basis of care and are available to the most basic of services:

- **Give oxygen** preferably by face mask and at high flows
- **Preserve blood volume**; compression of bleeding sites and limited fluid resuscitation
- **Splinting and packaging**; unnecessary movement of injured patients provokes bleeding. Basic splinting of fractures will provide good analgesia and contribute to preserving blood volume.
- **Analgesia**; this is humane and should be given when needed. Morphine is cheap and effective. Non-steroidal analgesia should be avoided initially in the trauma patient due to adverse effects on platelet aggregation and renal function.
- **Expeditious transport**; ultimately the patient needs to be in hospital and receiving a higher level of care than can be provided 'in the street'. Unless treatment pre-hospital is beneficial it is often better to accept the limitations of what is achievable and move them to hospital quickly but safely.

It has been argued in the past that the provision of more advanced pre-hospital care services in less affluent areas of the world is of little benefit unless sophisticated levels of care exist in receiving hospitals. This has recently been refuted in a study looking at pre-hospital care services in Cambodia and Iraq, showing a 40% reduction in mortality from major trauma after the introduction of an ambulance service with trained attendants.[1]

Secondary transport

Guidelines for the secondary transport of patients have been produced by the Australian and New Zealand College of Anaesthetists in 2003 and the UK Intensive Care Society in 2001. These attempt to bring together advice from different sources and encourage an improvement in standards. The safe and successful transport of the critically ill should follow these principles:

- **Organisation**. 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 recognised transfer team, each hospital must provide adequate staff and facilities for outgoing patients, adhering as closely as possible to the standards of care provided in the hospital. Flexibility in staffing and rostering arrangements must exist to allow this to happen, where possible not organising transfers in the middle of the night when resources and staffing are at their most stretched. 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.
- **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 (tipping, vibration,

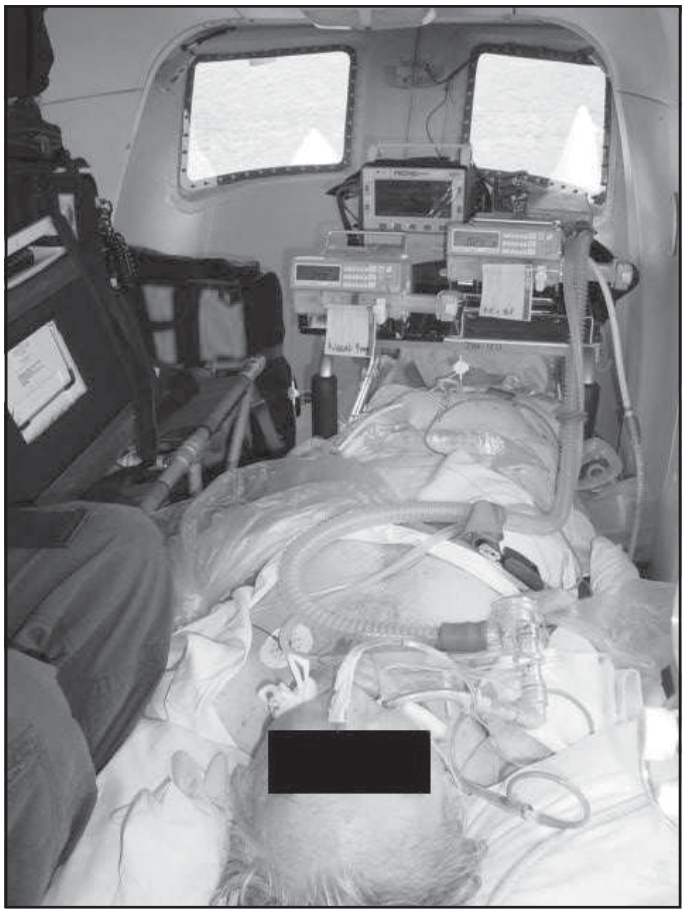
acceleration/ deceleration etc) as well as possible pressure and temperature changes which may adversely affect cardio-respiratory physiology. The risks to staff of injury or accident must not be overlooked especially in adverse weather and in unsecured areas at night. The decision to send a retrieval 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**. Keeping things simple has much to commend it. The choice of transport will obviously be influenced by what is available but other factors will come into play. The urgency of the transfer and prevailing road and weather conditions, as well as the range and speed of available vehicles. It may be necessary for a receiving hospital to provide the vehicle (and sometimes the personnel!) if this is considered appropriate. The use of aircraft and in particularly helicopters can appear attractive, however they usually do not reduce travel time unless the distances are large and the terrain rough.

- **Transfer vehicle requirements**. Well-maintained and adequately equipped vehicles should be used. Ease of access, proper heating control, lighting and good communications are all considerations. An oxygen supply and suction are also mandatory. Safety provision for staff is important and noise and vibration levels 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 should be responsible for the patient and preferably be experienced in undertaking transfers. Another doctor or experienced nurse, paramedic or technician with familiarity in transfer procedures, the vehicle and equipment should be present and acts as an assistant to the responsible doctor.

- **Equipment** must be suited to the environment i.e. be durable and lightweight and have sufficient battery life. A monitored oxygen supply with a safety margin of two hours on the transfer time is essential. There should be storage space for equipment and staff should be appropriately clothed. A portable ventilator with disconnection and high-pressure alarms and the ability to provide PEEP and variable FiO_2, I: E ratio, respiratory rate and tidal volume. Portable monitors giving SaO_2, ECG and non-invasive BP. The facility to monitor invasive pressures (arterial and CVP) are preferable depending on resources. A dedicated equipment bridge, containing ventilator, monitoring equipment and infusion devices is becoming the method of choice for providing theses requirements. (Figure 1) These can be manufactured locally but need to be robust and withstand the rigors of transport, especially over rough terrain. Alarms should be visible as well as audible. Suction and defibrillation should be immediately available. A warming blanket is also a consideration in cold climates. 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 (the Braun Perfusor FM compact syringe driver will run off standard AA battery power). **Non of these requirements should seriously affect the referring hospitals ability to deal with emergencies in terms of staff or equipment whilst the transfer team is away**. The vehicle should have communications able to contact the base hospital in emergencies and the receiving hospital to fore warn of any problems.



- **Preparation for transfer**. Stabilisation and meticulous preparation are the keys to a successful transfer. All personnel should familiarise themselves with the patient and the current treatment. As with the planning phase, it is useful to have a checklist to avoid omissions. This list is a useful starting point, when considering any treatment outside the hospital setting, whatever the circumstances. Full clinical examination with reference to on-going monitoring should be carried out. Chest drains should be fitted with flutter valves and be easily observed. A review of recent investigations: CXR, other X-rays, haematology and biochemistry results.

Preparation for transfer checklist

- Respiration
- Circulation
- Head
- Other injuries
- Monitoring
- Line placement and securing
- Investigations

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 and a base-line end tidal CO2 achieved pre-transport.

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

All documentation including referral letters should be gathered and the receiving hospital re-contacted prior to departure to confirm availability of the bed and also to confirm their understanding of what they are accepting.

- **Monitoring during transfer** should approach that expected within the hospital setting. Oxygen saturation and ECG and should be monitored continuously *whenever possible*. Invasive BP is advisable as non-invasive measurements are subject to movement artefact. Mechanically ventilated patients need end tidal CO_2 monitoring and a disconnection alarm should be used with mechanical ventilators. For long journeys and in cold weather, temperature monitoring should be instituted. The use of a stretcher bridge, with all monitoring self-contained is to be recommended.

Ideal basic ambulance equipment requirements

- Protective clothing and footwear
- Hard hats
- Robust gloves
- Safety glasses
- Simple tools and cutting equipment
- Communications
- Lighting and torches
- Restraints for staff and equipment
- Splints
- Oxygen
- Suction unit
- Secure stretcher
- Extrication (spinal) board
- Neck collars
- Defibrillators
- emperature control systems
- Dressings
- Oxygen masks

- **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! Once patients are secured on transfer stretchers and monitoring attached it is difficult to gain good access for continued treatment.

- **Aeromedical considerations**. The use of aircraft is not without risk and this is especially true if the attendants are not familiar with the flight environment. Increasing altitude potentates hypoxia and the reduction in alveolar partial pressure of oxygen necessitates supplemental oxygen in all patients. Pressurised commercial aircraft have cabin altitudes of 6000-8000 feet; pneumothoraces will expand by 20% in these conditions, hence chest drainage is mandatory if they are even remotely suspected. The air in endotracheal cuffs will similarly expand at altitude; the risk of tracheal wall pressure leading to possible airway oedema and necrosis. The pressure in air-filled cuffs should be checked regularly. Alternatively saline can be used to inflate cuffs, which will not expand with changes in pressure. Temperature control, especially in helicopters, can be a problem. Most rotary wing and small fixed wing aircraft have excessive levels of noise and vibration. Communication, monitoring, the function of equipment and the administration of fluids can all be affected. The environment is unfamiliar to most. The available space, particularly in helicopters can be limited and they can be cramped and noisy. Ideally, dedicated aircraft should be used with adaptations making them suitable for aero medical use. Both staff and patients can be affected by motion sickness. Staff who recurrently suffer with this problem should not be selected, similarly those who are unable to equalise their middle ear pressure are unsuitable as escorts. Long distance flights from abroad have special considerations and specialist advice should be sought.

Suggested briefing format for interhospital transfers

S - Situation

M - Mission

E - Equipment

A - Administration

C - Communnications

- **Receiving hospital handover**. On arrival the responsible doctor must liase with the medical officer taking over the care. A written summary of events in transfer should be added to the clinical notes and ideally a copy kept for the records at the referring centre. 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 and improve care in the future. The Australian Patient Safety Foundation introduced an anonymous self-reporting system for critical incidents during patient retrievals in July 1999. Any team member who felt that there had been a problem endangering patient or staff safety can report this on a standard form. These are collated centrally for the whole country in an attempt to identify recurring problems and improve the service. It would be a positive step if such systems could be adopted routinely everywhere. Whilst this is unrealistic for many, the utilisation of formal debriefing and mission analysis forms will enable problems to be highlighted and lessons learned at a local level.

- **Training**. Staff employed in such transfers should ideally be specifically trained and have had the opportunity to act as observers in previous cases. This is often overlooked as it takes time and often involves more staff than can be spared. Safety aspects of the vehicle employed, including safe approach and escape routes, should be highlighted. All staff should have had basic orientation and safety training whatever the mode of transport employed.

Intrahospital transport

It must be remembered that transporting critically ill patients within the hospital is in also potentially dangerous. These patients have reduced physiological reserves and adverse changes can occur during the transport process. Careful planning is required when moving patients between facilities (eg theatres, wards, X-ray etc). Many of the points described above under interhospital transport are applicable. In addition the transport team should be freed from other duties and the departure and destination times be agreed well in advance. All equipment to be used should be checked beforehand and in particular emergency equipment such as resuscitators and suction units. The route used within the hospital should be identified and lifts and corridors secured as necessary before the transfer begins. Any physiological changes occurring during transport should be acted on where appropriate and the patient transferred back to the Intensive Care Unit if necessary. Documentation of the transport process and any adverse events should be made in the clinical record. The overall process in any one hospital should be evaluated regularly, so that recurrent problems can be identified and appropriate changes made.

Considerations in intra-hospital transport

- Is it necessary ?
- What is the best route ?
- Who should act as escort ?
- What equipment is required ?
- Do they know we are coming ?
- Do the benefits outweight the risks ?
- When should it happen ?
- What preparations are necessary ?
- Has the equipment been checked ?
- Have we got notes and request forms ?

Case study: Closed head injury

A 25 year-old man is involved in a road traffic accident and is brought to the emergency room of a rural hospital. He is semi-conscious with a Glasgow Coma Score of 6. Following an 'ABCDE' assessment in line with Primary trauma care guidelines he is intubated, with appropriate neck control and a hard cervical collar applied. The nearest hospital with imaging facilities and an intensive care unit is 65 miles away. The doctor in charge of care at the rural hospital makes contact with the doctor in charge of the intensive care unit at the regional hospital. It is decided that the patient will be transferred by the rural hospital team in an ambulance sent by the regional hospital. They will send an oxygen supply for the trip. The rural hospital can supply an anaesthetic technical officer and nurse to escort the patient. They use the time whilst waiting for the ambulance to re-examine the patient and make sure all his venous access is secure and he is cardiovascularly stable. They ensure he has been given sedative drugs and muscle relaxants and these are reviewed regularly. The position of the endotracheal tube is checked on chest X-ray and a pelvic and C-spine films are performed. The pelvic and chest x-rays are normal.

His family arrive to find out what has happened to him and the doctor speaks to them about his current condition and need to go to the regional centre. The ambulance arrives and the escorting personnel check that it is suitable before moving the patient. He is attached to a portable blood pressure, ECG and saturation probe. He is hand ventilated with a self-inflating respirator attached. All notes and X-rays are collected to be passed onto the receiving medical team. Ideally, this man would be transported on a mechanical ventilator such as an Oxylog 2000 (Draeger Corporation), with end-tidal CO2 monitoring and with an arterial line in-situ for continuous blood pressure measurement and an anaesthetist to escort. The reality is that many hospitals do not have the resources to provide these for the transported patients. The balance of risks for this patient are that he is better cared for in the regional hospital with its better imaging and intensive care facilities despite the less than ideal transport conditions. On arrival, the anaesthetic technical officer and nurse give a verbal hand-over of the case and pass all notes and x-rays to the medical team.

References / further reading

1. Husum H, Gilbert M, Wisborg T, Van Heng Y, Murad M. Rural Prehospital Trauma Systems in Low- Income Countries: a prospective study from North Iraq and Cambodia. J Trauma 2003;**54**:118-1196.

2. Advanced Life Support Group. Safe Transfer and Retrieval: The Practical Approach. BMJ Books, London, 2002. (ISBN 0 7279 1583 5)

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

4. Faculty of Intensive Care of the Australian and New Zealand College Of Anaesthetists and Australasian College for Emergency Medicine. (2003) Minimum standards for transport of the critically ill.

5. Faculty of Intensive Care of the Australian and New Zealand College Of Anaesthetists and Australasian College for Emergency Medicine. (2003) Minimum standards for intrahospital transport of the critically ill.

6. Gilligan JE, Griggs WM, Jelly MT et al. 1999 Mobile intensive care services in rural South Australia. Medical Journal of Australia 1999 **171**:617-620.

7. Martin TE. Handbook of Patient Transportation. (2001) Greenwich Medical Media, 137 Euston Road, London, NW1 2AA. (ISBN 1 84110 071 4)

8. Intensive Care Society.(2001) Guidelines for the transport of the critically ill. UK.

9. Wallace PGM, Ridley SA. ABC of intensive care. Transport of critically ill patients. British Medical Journal 1999 **319**:368-371.