Recommendations for the Safe Transfer of Patients with Brain Injury

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SECTION I - SUMMARY AND RECOMMENDATIONS

1. High quality transfer of patients with brain injury improves outcome.
2. There should be designated consultants in the referring hospitals and the neuroscience units* with overall responsibility for the transfer of patients with brain injuries.
3. Local guidelines on the transfer of patients with brain injuries should be drawn up between the referring hospital trusts, the neurosciences unit and the local ambulance service. These should be consistent with established national guidelines. Details of the transfer of responsibility for patient care should also be agreed.
4. While it is understood that transfer is often urgent thorough resuscitation and stabilisation of the patient must be completed before transfer to avoid complications during the journey.
5. All patients with a Glasgow Coma Scale (GCS) less than or equal to 8 requiring transfer to a neurosciences unit should be intubated and ventilated, as should any patients with the indications detailed in Appendix 1.
6. Patients with brain injuries should be accompanied by a doctor with appropriate training and experience in the transfer of patients with acute brain injury. They must have a dedicated and adequately trained assistant. Arrangements for medical indemnity and personal accident insurance should be in place.
7. The standard of monitoring during transport should adhere to previously published standards.[1]
8. The transfer team must be provided with a means of communication - a mobile telephone is suitable.
9. Education, training and audit are crucial to improving standards of transfer.

* Throughout this document the term acute neuroscience unit is taken to include neurology, neurosurgery, neuroanaesthesia, neurocritical care and neuroradiology.

SECTION II - BACKGROUND

In 1996 the Association of Anaesthetists (AAGBI) and the Neuroanaesthesia Society (NASGBI) published *Recommendations for the Transfer of Patients with Acute Head Injuries to Neurosurgical Units*. Since 1996 a number of organisations have published guidelines relating to transfer.[2-8] However, it was felt that it would be beneficial to provide an up-to-date resource to be distributed to members of the AAGBI. The National Service Framework for long term conditions has implications for neurological patients.[9] Changes in clinical practice, for example the development of intravascular treatment of subarachnoid haemorrhage,[10] will increase the number of transfers of patients with non-traumatic brain injury. It was, therefore, considered appropriate to extend the scope of the guideline to include all patients with acute brain injury. Ideally the transfer of paediatric patients will be undertaken by staff experienced in the transfer of critically ill children.

Supplementary electronic material can be obtained from many of the sources that are detailed in the References section of this document.

SECTION III - INTRODUCTION

Patients with neurotrauma or other acute brain injury often receive their initial treatment at a local hospital, which may not have a neurosciences unit. As a result, many patients with serious brain injuries have to be transferred urgently between hospitals by road ambulance, or occasionally by air. In some areas Critical Care Networks and transfer groups have been established according to national directives.[11] While no precise time targets have been set between injury and surgery, a maximum of 4 hours is aimed at because it is clear that the sooner an expanding haematoma is evacuated, the better for the patient.

Transfer of patients with brain injury is potentially hazardous if poorly executed.[12] Patients can come to harm as a result and ultimate neurological outcome may be adversely affected. This can be avoided if sound principles are applied. The main causes of secondary brain damage are raised intracranial pressure (ICP), hypotension, hypoxia, hypercarbia, cardiovascular instability and hyperpyrexia. Most principles of safe transfer are common to all seriously ill patients but there are some specific features that apply in particular to those with acute brain injury. These principles apply equally to transfer of patients both within and between hospitals.

These recommendations are provided for those responsible for planning, managing and undertaking transfer of brain injured patients. They aim to supply not only practical guidelines for ensuring safe transfer of individual patients, but also principles of organisation to assist in local negotiation when establishing new or improving existing transfer arrangements.

SECTION IV - ORGANISATION AND COMMUNICATION

Safe transfer of patients with brain injuries requires an effective partnership between the referring hospitals, the neurosciences unit and the ambulance service.

Local guidelines should be agreed between the referring hospitals and the neurosciences unit in advance. They should be subject to regular review and audit. The guidelines will include:

- which patients should be referred,
- when a transfer should be made,
- who is responsible for accepting the patient,
- the preparations and arrangements for the journey itself so that there is no unnecessary delay,
- when the responsibility for the patient is transferred from the referring to the receiving team.

Anaesthetists should be involved in agreeing local guidelines that are consistent with established national and international guidelines. Guidelines do not replace clinical judgement but they provide a safe framework within which judgement can be exercised.

Every hospital to which the ambulance services take patients with serious brain injuries must have facilities for resuscitation and diagnosis, including 24-hour access to computerised tomography. Appropriate staff and equipment should be available to ensure a safe transfer to the neurosciences unit when necessary. There should be a designated consultant within that hospital who has overall responsibility for secondary transfers and a consultant at the neurosciences unit who has overall responsibility for receiving transfers. These duties should be recognised in job plans.

Education and training are crucial to improving standards of transfer. Appropriate resources must be provided by those who plan and

purchase these services. They must be available to all professionals who share responsibility for the safety of the patient. There are obvious advantages in having a common philosophy of care and standardised terminology, such as those provided by the Advanced Trauma Life Support (ATLS) system and the GCS. A modified GCS should be used for paediatric patients.[3]

Good verbal and written communications are vital. This is especially so at the time of referral and when a patient is handed over at the end of the transfer. They will include precise details of where, within the neurosciences centre, the patient is to be taken. The ambulance service appreciate an early warning to facilitate their arrangements.

SECTION V - STAFFING REQUIREMENTS AND STANDARDS

Expediency should not dictate the level of expertise available for the transfer of patients. Critically ill patients with acute brain injuries must be accompanied by a doctor with suitable training, skills, competencies and experience of brain injury transfer.

It must be recognised that a trainee alone in an ambulance is working in an unsupervised capacity. Changes in working patterns may reduce the availability of trainees for transfers and consultant time for transfers must be built into manpower projections. Account should be taken of shift arrangements when deciding who should accompany the patient. A dedicated trained assistant must be provided for the escorting doctor. This might be an appropriately trained operating department practitioner, nurse or paramedic.

Employers must ensure that there is appropriate medical indemnity insurance for such transfers. In addition, the Association of Anaesthetists (AAGBI) recommends that doctors are members of medical defence organisations. Adequate death and personal injury insurance must also be provided for the members of the transfer team by the employer; existing employer insurance may be inadequate and local arrangements should be clarified. Details of appropriate insurance schemes are available from the AAGBI (www.aagbi.org) and such cover is a benefit of membership.

SECTION VI - PREPARATION FOR THE TRANSFER

Many critical care networks have reached consensus with local ambulance providers to ensure that all Trusts have common standards of transfer equipment. These developments are highly desirable, and likely to result in better organisation and delivery of patient care

The decision to transfer a patient with a brain injury must be made by senior medical staff at the referring hospital in consultation with senior staff at the neurosciences unit, who should provide written advice on neurosurgical management. Thorough resuscitation and stabilisation of the patient before transfer is the key to avoiding complications during the journey. The fundamental requirement before transfer is to ensure satisfactory oxygen delivery. A mean blood pressure greater than 80 mmHg (paediatric values - appendix III), PaO_2 greater than 13 kPa and $PaCO_2$ between 4.5 – 5.0 kPa should be achieved.

Monitoring should include:
pupillary size and reaction to light
ECG
pulse oximetry
invasive blood pressure
urine output by urinary catheter
capnography
central venous pressure monitoring where indicated
temperature (preferably core and peripheral)

Investigations undertaken prior to transfer should include:
arterial blood gas estimation
chest, lateral cervical spine pelvis, and other appropriate X-rays [13]
haematology FBC and coagulation screen
biochemistry blood sugar
other investigations as appropriate
blood should be cross matched if appropriate, and sent in the transferring ambulance (not in a separate taxi)

Appropriate respiratory support must be established. Tracheal intubation during transfer is difficult and dangerous. All patients with a GCS of 8 or less require intubation prior to transfer. In addition, whatever the baseline GCS, intubation should be considered if the GCS has fallen by 2 or more points. Intubation is essential if there is a fall of 2 or more points in the motor score. Intubation requires adequate sedation and muscle relaxation to avoid an increase in (ICP), and measures to prevent aspiration of gastric contents. This will normally involve rapid sequence induction with in-line stabilisation of the cervical spine. After intubation, appropriate drugs should be employed to maintain sedation, analgesia and muscle relaxation, (preferably administered by syringe driver), while avoiding hypotension and reduced cerebral perfusion pressure (CPP). Patients should be ventilated with the aim of achieving a PaO_2 greater than 13 kPa and a $PaCO_2$ of 4.5 – 5.0 kPa unless there is clinical or radiological evidence of raised intracranial pressure when more aggressive hyperventilation is justified (but not below 4 kPa). If hyperventilation is used the F_IO_2 should be increased.

Inspired oxygen should be guided by blood gas estimations before departure. Expired carbon dioxide should be monitored continuously. A chest drain should be inserted if a pneumothorax is present or considered a potential problem, eg due to fractured ribs. Underwater seals should normally be replaced by leaflet valve (Heimlich type) drainage systems. Chest drains should not be clamped.[2] A large bore orogastric tube should be passed and left on free drainage (not nasogastric in case the patient has a base of skull fracture).

Intravenous volume loading should be undertaken with crystalloid or colloid initially to maintain or restore satisfactory peripheral perfusion, blood pressure and urine output. 5% Dextrose should be avoided and blood products should be given as required. Hypovolaemic patients tolerate transfer poorly and the circulating volume should be normal or supra-normal before transfer, preferably with a haematocrit over 30%. A central venous catheter may be useful to optimise filling pressures and for the administration of drugs and fluids during the transfer.

A patient who remains hypotensive despite resuscitation must not be transported until all possible causes of the hypotension have been identified and the patient stabilised.

Correction of major haemorrhage takes precedence over transfer. It is important that these measures are not omitted in an attempt to speed transfer of the patient, as resultant complications may be impossible to deal with once the journey has begun.

Persistent hypotension will adversely affect neurological outcome. When other causes of hypotension have been excluded, consider the judicious use of inotropes/vasopressors to offset the hypotensive effects of sedative agents.

If the patient has had a seizure, loading with anticonvulsant agents (usually phenytoin) should be considered prior to transfer. Unstable or compound long bone fractures should have preliminary toilet and be splinted to provide neurovascular protection and analgesia.

If the transfer team has not been involved in the initial stages they should familiarise themselves with treatment already given and independently assess the general status of the patient before departure. All lines and tubes must be fixed securely and ready access to them ensured.

The transfer team should confirm the availability of an appropriate transfer vehicle and check the function of all equipment, including battery charge status.[14] Oxygen requirements for the journey including possible delays should be estimated and should include driving gas requirements of the ventilator. A minimum reserve of oxygen and drugs should be one hour or twice the estimated journey time. If transfer times are unduly long, it may be necessary to arrange for back up oxygen supplies to be made available en route if possible. Before departure, case notes, X-rays, a referral letter and investigation reports should be collated and any required blood or blood products collected. The neurosciences unit should be contacted and informed of the estimated journey time.

SECTION VII - THE TRANSFER

The transfer team should be relieved of all other duties, be appropriately dressed, equipped and insured. Ideally, the transfer team should be involved in the initial resuscitation and management of the patient. If this is not possible, they should receive a formal hand-over from the resuscitation team. All notes (or photocopies), X-rays, CT scans, blood results and cross-matched blood should accompany the patient. The duty consultant anaesthetist in the referring hospital should be made aware of the planned transfer. All monitoring equipment should be checked, connected to the patient and securely mounted so that it cannot fall on to the patient during transfer or cause injury to ambulance occupants in the event of an accident.

The patient should be transferred onto the transport trolley/stretcher, properly secured and padded with due regard to any possible spinal injury.[2, 15] The patient should be positioned with a 20° head up tilt. The development of ambulance trolleys that allow this degree of tilt, while maintaining spinal immobilisation, should be encouraged. Most transfers will be by land ambulance but for transfers over longer distances local protocols may include transfer by air.[16]

During transfer, patient management will be centred upon maintaining oxygenation and adequate blood pressure and minimising rises in ICP. Monitoring ECG, invasive blood pressure, SpO_2, P_ECO_2, temperature, pupillary size and reaction to light, and the administration of drugs and other infusions should be continued.

A paper record must be maintained during the transfer. This may be aided by a dictaphone or by the electronic memory in monitors. The development of standardised documentation is encouraged and many critical care networks have developed local transfer documentation. Transfers should be undertaken smoothly and not at high speed.

The transfer team should be equipped with a mobile telephone to contact the neurosciences unit and their base hospital *en route*.

A patient who has been made physiologically stable before departure is more likely to remain so for the duration of the transfer, although there is still the need for constant vigilance and prompt action to deal with complications. If, despite thorough preparation, there is a need to perform any procedure during the transfer this should be done with the ambulance brought to a halt.

Staff at the neurosciences unit should be available to receive a comprehensive hand-over following which they assume responsibility for the patient's care. Notes, X-rays, scans and a copy of the transfer record should be left with the receiving staff. The neurosciences unit should be prepared to provide the transfer team with refreshments.

A protocol should be established to ensure the immediate return of the referring team with their equipment to their hospital. Often a contract exists with a local taxi firm for this purpose. Personal injury insurance should also cover the return journey.

The referring team should keep a copy of the summary and transfer record for audit purposes.

The relatives should be notified about the transfer by the referring hospital, but they should not normally accompany the patient in the ambulance.

SECTION VIII - EQUIPMENT AND DRUGS

All equipment must be serviced regularly, checked daily and rechecked immediately before any transfer. If the ambulance ventilator is to be used then it must be checked before departure, as should the ambulance oxygen supply and suction. It is advisable before purchasing any new equipment to consult the ambulance service, to ensure that it is compatible with the oxygen and power supply in their vehicles.

The patient should receive the same standard of physiological monitoring during transfer as they would receive in an intensive care unit. The transfer team must be familiar with all of the equipment and drugs in the transfer kit and the transfer vehicle.

Essential equipment to go with the patient in the ambulance
The following equipment should be readily available, purpose designed, dedicated for transfers and be stored in a suitable container which should have some form of seal, which when broken, would indicate that the equipment has been used and requires restocking and checking:

1. **Portable mechanical ventilator** with airway pressure and minute volume monitor, and disconnect alarm

2. **Adequate supply of oxygen** for the journey, including unforeseen delays (see Section VI)

3. **Portable battery powered multifunction monitor** to include:
   - ECG
   - invasive blood pressure monitoring
   - non invasive blood pressure monitoring as a backup
   - central venous pressure monitoring
   - pulse oximetry
   - capnography
   - temperature

4. **Other equipment**
   - suction
   - battery powered syringe pumps
   - battery powered IV volumetric pumps (infusion by gravity is unreliable during transfer)
   - intubation equipment
   - self-inflating bag, valve and mask
   - venous access equipment
   - chest drain equipment
   - DC defibrillator
   - spare batteries
   - warming blanket

5. **An adequate supply of essential drugs to go with the patient**
   - Hypnotics, eg propofol or midazolam
   - muscle relaxants, eg atracurium, vecuronium,- suxamethonium may be required for re-intubation
   - analgesics, eg alfentanil, fentanyl,
   - anticonvulsants, eg diazepam, thiopentone
   - mannitol 20%, furosemide
   - vasoactive drugs, eg ephedrine, dopamine, noradrenaline
   - resuscitation drugs as in hospital resuscitation boxes
   - intravenous fluids

6. **Communication equipment**

It is essential that the transfer team should be able to communicate easily with the designated consultant or his deputy in the referring hospital and the neurosurgical team during the transfer. The benefits of a mobile telephone which can be pre-programmed with useful numbers outweigh the minimal risk of it interfering with electronic equipment.[17]

7. Paediatric equipment

The transfer of paediatric patients will require size specific equipment and staff experienced in the transfer of critically ill children.[6,7,18]

SECTION IX - EDUCATION AND TRAINING

Good practice depends upon sound education, adequate resources of expertise, time for training and a commitment to quality throughout all levels of the organisation. Ensuring and facilitating good educational standards and arrangements will be a function of the consultant responsible for inter-hospital transfers.

The fundamental requirement is that every doctor, nurse and paramedic likely to be involved in the transfer of seriously brain injured patients has had formal training in the theoretical and practical aspects of the subject. This will include:

- the principles of managing a patient with an acute brain injury;
- the principles and practice of ATLS;
- the adverse physiological changes associated with moving the patient;
- manual handling of the patient;
- practical aspects of working in an ambulance or aircraft;
- knowledge of the equipment and drugs used in transfer;
- the legal and safety aspects of transfer;
- communications.

The setting in which this education is provided will vary locally. Learning opportunities will range from mandatory induction courses for new hospital staff to formal multidisciplinary training courses on transfer medicine. The latter are now run in a number of centres, and may be particularly appropriate for consultants responsible for developing and maintaining the standards of transfer.[19] All doctors, nurses and other allied health professionals who are new to a hospital should attend teaching sessions to learn local arrangements and policies and meet the staff involved.

Much of the educational value of any training post comes from gaining clinical experience under supervision. The designated transfer consultant should be aware of the educational opportunities offered by transfers of patients with brain injuries to the neurosciences unit. It is

important to involve those who take part in regular interdepartmental audit. This will include A&E personnel, anaesthetists, paramedics, etc. Participation of the neurosciences unit in such audit is particularly valuable.

The quality of transfer should be audited, and critical incidents recorded. Such information is invaluable in refining and improving local transfer protocols. Appropriate audit tools for transfer are available from the Royal College of Anaesthetists.[20]

SECTION X - RESOURCE IMPLICATIONS FOR TRANSFER OF PATIENTS WITH BRAIN INJURIES

Without adequate resources it is not possible to have a good quality transfer service. Each organisation that provides acute healthcare should recognise that this requires specific funding which should be considered in discussions with purchasers. Resources include staff and equipment that may be similar to, and shared with, those used for other secondary transfers including the movement of ICU patients within the hospital. It should be recognised that there are significant resource implications to the transferring hospital on-call anaesthetic team.

Hospitals involved in transfer of patients with brain injuries should set aside a budget for this work. The budget will include the capital equipment, the cost of which will depend upon its complexity and the demand placed upon it, as well as the cost of servicing, maintenance, insurance and renewal/upgrading at appropriate intervals. Portable equipment will need regular battery replacement and will have a shorter life than static equipment. There must be adequate provision for clothing and personal insurance.

The responsibilities of the designated consultant for transfers include logistics, training, audit and liaison between the parties involved and may require dedicated programmed activities in job plans. Rotas of doctors and nurses must take account of this work and allow staff of adequate seniority to be released from other duties.

Retrieval teams have been set up in some regions eg Northern Ireland [21] and are of particular importance in paediatric practice.[22] However, the speed of transfer required for head injuries may not permit a team to travel from the neuroscience centre. In addition, on a rare occasion two transfers may be required simultaneously, hence the referring hospitals will have to maintain the capability to transfer transfer patients with a time-critical lesion. This means that any unit potentially admitting children with head trauma should have a contingency to undertake such a transfer and have an appropriate kit with paediatric equipment ready for use. In an ideal world the funding of suitably situated retrieval teams would not be an issue.

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APPENDIX I

INDICATIONS FOR INTUBATION AND VENTILATION FOR TRANSFER AFTER BRAIN INJURY

- GCS 8 or less
- Significantly deteriorating conscious level (i.e. fall in motor score of two points or more)
- Loss of protective laryngeal reflexes
- Hypoxaemia (PaO_2 < 13 kPa on oxygen)
- Hypercarbia ($PaCO_2$ > 6 kPa)
- Spontaneous hyperventilation causing $PaCO_2$ < 4.0 kPa
- Bilateral fractured mandible
- Copious bleeding into the mouth (e.g. from skull base fracture)
- Seizures

An intubated patient should be ventilated with muscle relaxation, and appropriate sedation and analgesia. Aim for a PaO_2 > 13 kPa, $PaCO_2$ 4.5 – 5.0 kPa unless there is clinical or radiological evidence of raised intracranial pressure when more aggressive hyperventilation is justified to a $PaCO_2$ of not less than 4 kPa. If hyperventilation is used the F_IO_2 should be increased.

APPENDIX II

TRANSFER CHECKLIST FOR NEUROSURGICAL PATIENTS	
SYSTEM	CHECKLIST
Respiration	PaO_2 > 13 kPa? $PaCO_2$ < 5 kPa? Airway clear? Airway protected adequately? Intubation and ventilation required?
Circulation	BP mean > 80 mmHg? (adults) Pulse < 100/min? (adults) Peripheral perfusion? Two reliable large iv cannulae in situ? Estimated blood loss already replaced? Arterial line? Central venous access if appropriate?
Head injury	GCS? GCS trend (improving/deteriorating)? Focal signs? Skull fracture? Seizures controlled? Raised ICP appropriately managed?
Other injuries	Cervical spine injury (cervical spine protection), chest injury, fractured ribs, pneumothorax excluded? Intrathoracic, intra-abdominal bleed? Pelvic, long bone fracture? Extracranial injuries splinted?
Escort	Doctor & escort adequately experienced? Instructed about this case? Adequate equipment and drugs? Can use equipment and drugs? Sufficient oxygen supplies? Case notes and X-rays? Transfer documentation prepared? Where to go in the neurosurgical unit? Telephone numbers programmed into mobile phone? Mobile phone battery fully charged? Name and bleep number of receiving doctor? Money in case of emergencies?

APPENDIX III

ADDITIONAL INFORMATION FOR PAEDIATRICS

Most paediatric critical care networks operate an emergency retrieval service [22]. The most appropriate method of transfer to the neurosurgical centre or PICU should be identified according to the clinical situation. The choice is between an emergency retrieval and one way transfer by the referring hospital team.
The local referring hospital team should always transfer time critical cases to avoid delay:

- rapidly expanding space occupying lesion e.g. extradural
- penetrating injury
- uncontrollable bleeding from skull base

If CT scanning is unavailable in the referring unit for any reason then a time critical one way transfer should also occur.

Age specific mean arterial blood pressure targets to maintain CPP [22]

Age	Mean arterial blood pressure (mmHg)
< 3months	40 - 60
3 months – 1 year	45 -75
1 – 5 years	50 - 90
6 – 11 years	60 - 90
12 – 14 years	65 - 95

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