



Te Kaporeihana Āwhina Hunga Whara

Pragmatic Evidence-based Review

Best-evidence Review of Transfer Protocols for Moderate to Severe Traumatic Brain Injury

Reviewer	Mark Ayson MBChB DPH
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Important Note:

- This report is not intended to replace clinical judgement, or be used as a clinical protocol.
- A reasonable attempt has been made to find and review papers relevant to the focus of this report; however it does not claim to be exhaustive.
- The document has been prepared by the staff of the Research Unit, ACC. The content does not necessarily represent the official view of ACC or represent ACC policy.
- This report is based upon information supplied up to 12th May 2011.

Purpose

The purpose of this report is to summarise the best evidence for the safe transfer of patients with moderate to severe* traumatic brain injury (TBI) between various settings.

This report is focused on adults with moderate to severe TBI.

* based on the classification of moderate and severe TBI used in the ACC (2006) guideline

1 Key Messages

- The criteria for the mode and rapidity of transport in the pre-hospital setting are based on the risk of intracranial complications and severity of TBI (for full criteria see sections 4.3.1 & 4.3.2)
- All regions should have an organised trauma care system

1.1 From the scene of injury to emergency department/hospital

- Promptly transport people with suspected TBI directly to a centre where TBI is managed in its entirety
- If this is not possible, promptly transport people with suspected TBI directly to a centre that can stabilise their condition prior to a transfer to a centre where TBI is managed in its entirety
- Stand-by calls should be made to the destination emergency department (ED) for all patients with Glasgow Coma Score (GCS) ≤ 8
- Cervical spine immobilisation should be maintained until a full risk assessment (including imaging, if appropriate) indicates it is safe to remove

1.2 From primary care† to ED/hospital

- The referring health care professional should determine if an ambulance is required and, if not, then public transport and car are appropriate, provided the patient is accompanied
- Contact the destination hospital by phone of the impending transfer

1.3 From secondary setting to a neurosurgical unit

- Resuscitation and stabilisation of the injured person should be completed before transfer
- Do not transport a persistently hypotensive person until stabilised
- Intubate and ventilate all people with GCS ≤ 8 requiring transfer to tertiary care (for full criteria see section 4.4.1)
- People with suspected TBI should be accompanied by a health professional with the appropriate training and experience
- The transfer team should have a means of communication with their base hospital and the tertiary care facility during the transfer

1.4 From ICU to rehabilitation

- It is safe to transfer when the patient's physiological condition is stable and there is no need for further monitoring and intensive treatment

† e.g. general practice, accident & medical centre etc

2 Methodology

A comprehensive literature search focused on moderate to severe TBI search undertaken by an information specialist. The literature was critically appraised using SIGN¹ grading for systematic reviews and randomised controlled trials (RCTs), and the AGREE² instrument for appraisal of guideline quality.

3 Findings

This report is largely based upon seven guidelines³⁻⁹. One systematic review¹⁰ and one retrospective study¹¹ are also included.

3.1 Definitions

3.1.1 'Definite' TBI

This definition is taken from the ACC (2006) guideline:

“TBI is an acute brain injury resulting from mechanical energy to the head from external physical forces.”³

Operational criteria for clinical identification include one or more of the following:

- confusion or disorientation
- loss of consciousness
- post-traumatic amnesia
- other neurological abnormalities, such as focal neurological signs, seizure and/or intracranial lesion³.

These manifestations of TBI, such as coma and confusion, must not be due to drugs, alcohol or medications, or other injuries or treatment for other injuries (e.g. systemic injuries causing shock or hypoxia, facial injuries or intubation), or caused by other problems (e.g. psychological trauma, language barrier or co-existing medical conditions)³.

3.1.2 Severity of TBI

The definition of the severity of TBI used in this report based on the criteria used in the ACC (2006)³ guideline. It is based upon the Glasgow Coma score and duration of post-traumatic amnesia (PTA), however only the GCS criteria will be used in this report.

Severity of Injury	GCS Score	Duration of PTA
Mild	13-15	<24 hrs
Moderate [‡]	9-12	1-6 days
Severe	3-8	≥7 days

3.2 Transport from the scene of injury to the ED

The NICE (2007)⁶, ACC (2006)³ and one of the Brain Trauma Foundation⁵ guidelines were the only ones that made recommendations on the pre-hospital transport of people with a suspected TBI. All of the recommendations are based on lower levels of evidence:

[‡] Reed (2007) and NICE (2007) have different upper limits of GCS for moderate TBI which are 13 and 14 respectively

- Transport the person directly to a facility that has been identified as having the resources necessary to resuscitate, investigate and initially manage any person with multiple injuries⁴⁻⁶
- Stand-by calls should be made to the destination ED for all people with a GCS ≤ 8 i.e. anyone with a severe TBI⁶
- Cervical spine immobilisation should be maintained until a full risk assessment (including imaging, if appropriate) indicates it is safe to remove^{3,6}
- All regions should have an organised trauma care system^{3,5,10}
- Protocols are recommended to direct emergency services regarding destination decisions for patients with severe TBI⁵
- The mode of transport selected should minimise total pre-hospital time⁵.

The evidence for better outcomes in people with TBI being transferred directly to a facility with neurosurgery capability is limited. Two studies included in the NICE (2007) guideline suggest good recovery, better mortality and morbidity among severely injured patients who are transported directly to a neurosurgical unit and another study suggests very little difference⁶. A recent study from Norway has shown no differences in outcome between people with severe TBI transported directly to a neurosurgical unit compared to people being transferred inter-hospitals¹¹.

There is, however, good evidence for the transport of a mixed population of severely injured patients to a facility with established trauma systems: the ACC (2006)³ guideline report that there is consistent evidence that coordinated trauma systems reduce mortality for serious injury, including neurotrauma; moreover, a systematic review¹⁰ of 14 primary studies found a 15% reduction in mortality in favour of the presence of a trauma system.

Since the development group for the NICE (2007)⁶ guideline concluded that there was limited evidence for direct transport of patients with TBI from the scene of the injury to a neurosurgical unit they did not support a change in the previous guideline's recommendation. Moreover, they recognised that transporting all people with a suspected TBI to a hospital with a neurosurgical unit would require a major shift in resources of 84-100,000 beds to neurosurgery⁶.

In contrast, the ACC (2006)³ guideline is more specific about the destination for a person with TBI i.e. they recommend a person who has sustained a suspected TBI should be transported directly to a centre where TBI is managed in entirety³. If this type of facility is unavailable, they recommend transport to a centre that can stabilise the person's condition prior to transfer to a centre where TBI is managed in entirety³. They add that it is expected that all acute hospitals accepting people who have sustained a suspected TBI should have the resources to expeditiously assess and intervene to optimise outcome and that these resources should be appropriate for the person's age³.

3.3 Transfer from a primary care facility to ED

The following further recommendations were made in the NICE (2007) guideline:

- Patients referred from primary care should be accompanied by a competent adult⁶
- The referring health care professional should determine if an ambulance or air medical transport is required and, if not, then public transport and car are appropriate means, provided the patient is accompanied⁶

- The referring health care professional should also contact the destination hospital by phone of the impending transfer⁶

In addition the SIGN (2009)⁸ guideline recommends that the decision to transfer a patient from a remote or rural location should be made the transferring professional, receiving ED and neurosurgeon, where appropriate, after risk benefit analysis taking into account the appropriate mode of transport.

3.4 Criteria for the rapidity and mode of transport from the pre-hospital setting

There are criteria for the rapidity and mode of transport from the pre-hospital setting, based on the risk of clinically important[§] TBI and the acute intracranial complications of TBI^{**}. A summary of the recommendations are as follows:

3.4.1 Criteria for rapid transfer to ED using emergency services^{3,6}:

- Any deterioration in the injured person's condition
- Unconsciousness, or lack of full consciousness^{††}
- Any focal neurological deficit^{††}
- Any suspicion of a skull fracture or penetrating head injury^{§§}
- Any seizure (i.e., 'convulsion' or 'fit') since the injury
- A high-energy head injury^{***}
- Suspected neck injury
- The injured person or their carer is unable to transport the injured person safely to the ED.

3.4.2 ED review needed but could be transported by a competent adult^{3,6}:

- Any loss of consciousness as a result of the injury, unless trivial, apparently resolved and alternative observation available
- Amnesia for events before or after the injury

[§] 'clinically important' TBI is defined as any acute condition that has been identified by imaging or by assessment of risk factors.

^{**} see 'Best-evidence Review of Acute Care for Moderate to Severe TBI' for more details

^{††} i.e., Glasgow Coma Scale score <15

^{††} i.e., restricted to a particular part of the body or a particular activity) since the injury (e.g., problems understanding, speaking, reading or writing; loss of feeling in part of the body; problems balancing; general weakness; any changes in eyesight; difficulty walking

^{§§} e.g., clear fluid running from the ears or nose; black eye with no associated damage around the eye; bleeding from one or both ears; new deafness in one or both ears; bruising behind one or both ears; penetrating injury signs; visible trauma to the scalp or skull

^{***} e.g., pedestrian struck by motor vehicle; occupant ejected from motor vehicle; a fall from a height of greater than one metre or more than five stairs, or less for infants and children aged under five; diving accident; high-speed motor vehicle collision; rollover motor accident; accident involving motorised recreational vehicles; bicycle collision; or any other potentially high energy mechanism

- Persistent headache since the injury
- Irritability or altered behaviour
- Any vomiting episodes since the injury
- History of bleeding or clotting disorder
- Current anticoagulant therapy
- Current drug or alcohol intoxication
- Any previous cranial neurosurgical interventions
- Suspicion of non-accidental injury
- Age 65 years and older; one year or younger
- Concern about the cause of any symptoms by the person undertaking the assessment.

Depending on local availability, assessment at an after hours medical clinic or accident and medical clinic may be appropriate for this group of people and this arrangement should be described in local ambulance and hospital protocols³.

Some people whose presentation lies outside the definition of 'definite TBI', but who have one or more risk factors for acute complications (e.g., aged 65 years or older or alcohol intoxication) should also be reviewed in the Emergency Department.

People who present with none of the indications for ED assessment should seek medical assessment from a GP or accident and medical clinic if there are adverse social factors or continuing concerns by the injured person or their carer about the diagnosis.

All people who meet the definition of 'definite TBI' should be referred for an ED assessment³.

3.5 Transfer from secondary setting to a neurosurgical unit

The risk of further injury to patients during transfer to tertiary care is well established⁶ and high quality transfer of patients with brain injuries improves outcome⁴.

The guidance in the NICE (2007)⁶ guideline relies heavily on the principles set out by the Association of Anaesthetists of Great Britain and Ireland's recommendations for the safe transfer of patients with brain injury⁴. The SIGN (2009)⁸ guidance recommends that the transfer of adult patients should follow these principles but does not elaborate.

A summary of recommendations from these documents follows:

- Local guidelines^{†††} on the transfer of patients with brain injuries should be drawn up between the appropriate groups^{3,4,6}
- There should be designated consultants in both the referring hospitals and the neurosurgical unit with overall responsibility for the transfer of patients^{3,4,6}
- Resuscitation and stabilisation of the patient must be completed before transfer^{3,4,6}

^{†††} consistent with established national guidelines

- All patients with a GCS ≤ 8 requiring transfer to a neurosurgical unit should be intubated and ventilated^{3,4,6}, as should any patients with the indications detailed in section 4.4.1 below
- Patients should be accompanied by a doctor and an assistant with appropriate training and experience^{3,4,6}
- The standard of monitoring during transport should adhere to previously published standards^{4,6}
- The transfer team must be provided with a means of communication with their base hospital and the tertiary care facility during transfer; a mobile telephone is suitable^{3,4,6}
- Do not transport patients who are persistently hypoxic or hypotensive^{†††} until stabilised^{3,6}
- Transfer of patients purely for imaging should be avoided^{7,8}.

More extensive guidance is given in the Association of Anaesthetists of Great Britain and Ireland (2006)⁴ document regarding preparation, monitoring, equipment and drugs required for the safe inter-hospital transfer. See the Appendix 1 for the complete list.

3.5.1 Indications for intubation and ventilation

Intubate and ventilate immediately, if ANY of the following^{3,4,6}:

- Coma / GCS ≤ 8
- Loss of protective laryngeal reflexes
- Ventilatory insufficiency: hypoxaemia (PaO₂ <95 mmHg on O₂ or <65 mmHg on air); hypercarbia (PaCO₂ >45 mmHg)
- Spontaneous hyperventilation causing PaCO₂ <30 mmHg
- Irregular respirations^{§§§}

Intubate and ventilate before transfer, if ANY of the following^{3,4,6}:

- Significantly deteriorating conscious level (≥ 1 on motor score), even if not coma
- Unstable fractures of the facial skeleton/bilateral fractured mandible
- Copious bleeding into mouth
- Seizures

Ventilate an intubated patient with muscle relaxation and appropriate short-acting sedation and analgesia^{4,6}.

Aim for:

- PaO₂ > 13 kPa^{****}

††† blood pressure <80mmHg

§§§ not included in the Association of Anaesthetists of Great Britain and Ireland guidance

**** equivalent to <95 mmHg

- PaCO₂ 4.5–5.0 kPa^{††††} 4,6

If clinical or radiological evidence of raised ICP, more aggressive hyperventilation is justified^{4,6}

Increase the inspired oxygen concentration if hyperventilation is used^{4,6}

Maintain mean arterial pressure at ≥ 80 mmHg by infusing fluid and vasopressors as indicated⁶

3.6 Transfer from Intensive Care Units (ICU) to rehabilitation facilities

This guidance is from a consensus guideline of the criteria for referral and safe transfer of patients with TBI from ICU to rehabilitation facilities that was developed in Italy⁹. The criteria are divided into general and specific criteria and are as follows:

1. General criteria

- their physiological condition is stable
- no further need for monitoring and intensive treatment
- no additional urgent surgical interventions are necessary

2. Specific criteria

a. Medical stabilisation

- continuous cardiac and respiratory monitoring is unnecessary
- haemodynamic instability has been resolved without use of drugs in continuous infusion
- absence of hypo/hypertensive crises
- absence of cardiac arrhythmia
- patient has been spontaneously breathing for >48 hours (even if O₂ therapy is necessary) with SpO₂ >95%^{††††}, PaO₂ > 60 mmHg, and CO₂ not >45 mmHg; tracheotomy cannula does not contraindicate transfer
- absence of any acute organ failure or diabetes not properly controlled
- absence of sepsis i.e. no systemic acute inflammatory infection^{§§§§}
- no foreseeable need for parenteral nutrition in next 7-10 days; adequate water & electrolyte balance and metabolism well maintained by enteral nutrition (oral feeding, naso-gastric tube or PEG^{*****})
- no priority indications for any general/orthopaedic surgery

^{††††} equivalent to 34-38 mmHg

^{††††} in people with chronic obstructive lung disease SpO₂ >90% may be acceptable

^{§§§§} defined as the presence of 2 or more of the following: temp >38°C or <36°C; heart rate >90/min; respiratory rate >20/min or pCO₂ <32 mmHg; white cells >12,000/mm³ or <4,000/mm³ or >10% immature cells

^{*****} percutaneous endoscopic gastrostomy

b. Neurosurgical stabilisation

- no expanding mass indicated by CT and no fungus in patients who have been decompressed
- absence of CSF accumulation evolving below the surgical flap that may need surgical intervention

4 Appendix 1

Association of Anaesthetists of Great Britain and Ireland 2006 “Recommendations For Safe Transfer Of Patients With Brain Injury”

SUMMARY AND RECOMMENDATIONS

- High quality transfer of patients with brain injury improves outcome.
- There should be designated consultants in the referring hospitals and the neuroscience units* with overall responsibility for the transfer of patients with brain injuries.
- 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.
- 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.
- 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 significantly deteriorating conscious level (i.e. fall in motor score of two points or more), loss of protective laryngeal reflexes, hypoxaemia ($\text{PaO}_2 < 13 \text{ kPa}$ on oxygen), hypercarbia ($\text{PaCO}_2 > 6 \text{ kPa}$), spontaneous hyperventilation causing $\text{PaCO}_2 < 4.0 \text{ kPa}$, bilateral fractured mandible, copious bleeding into the mouth (e.g. from skull base fracture), or seizures.
- 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.
- The standard of monitoring during transport should adhere to previously published standards [Association of Anaesthetists of Great Britain and Ireland, 2000. “Recommendations for standards of monitoring (3rd edition)”]
- The transfer team must be provided with a means of communication - a mobile telephone is suitable.
- 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.

Every hospital to which ambulance services take patients with serious brain injuries must have facilities for resuscitation and diagnosis, including 24-hour access to CT scanning

PREPARATION FOR TRANSFER

- Decision to transfer should be made by senior medical staff at the referring hospital in consultation with senior staff at the neuroscience unit
- Thorough resuscitation and stabilisation before transfer is the key to avoiding complications en route
- The fundamental requirement before transfer is to ensure satisfactory O_2 delivery
- Mean BP $>80 \text{ mmHg}$, $\text{PaO}_2 >13 \text{ kPa}$, and PaCO_2 between $4.5 - 5.0 \text{ kPa}$ should be achieved
- Monitoring to include: pupil size and reaction to light, ECG, pulse oximetry, invasive BP, urine output by urinary catheter, capnography, central venous pressure (where indicated), and temperature (preferably core and peripheral)

- Investigations before transfer should include: arterial blood gas estimation, chest/lateral cervical spine/pelvic/other appropriate x-rays, full blood count, coagulation screen, blood sugar, other investigations as appropriate, cross-matched blood if appropriate

Appropriate respiratory support must be established

- All patients with GCS ≤ 8 require intubation before transfer
- Consider intubation if GCS has fallen by ≤ 2 points
- Intubation is essential if motor score has fallen by ≤ 2 points
- Intubation requires adequate sedation and muscle relaxation to avoid an increase in ICP, and prevention of aspiration of gastric contents
- After intubation, maintain adequate sedation, analgesia and muscle relaxation while avoiding hypotension and reduced CPP
- Ventilate with the aim to achieve PaO₂ >13 kPa and PaCO₂ of 4.5 - 5.0 kPa (unless signs of raised ICP where more aggressive hyperventilation is justified)

Inspired O₂ should be guided by blood gas estimations before departure

Monitor expired CO₂ continuously

Insert chest drain if pneumothorax present (or potential problem); replace underwater seals with leaflet valves; do not clamp

Pass a large bore orogastric tube and leave on free drainage

Intravenous volume loading should be undertaken to maintain or restore satisfactory peripheral perfusion, BP, and urine output

- Avoid 5% dextrose
- Give blood products as required
- Circulating blood volume should be normal or supra-normal before transfer (haematocrit >30% preferable)
- A central venous catheter may be useful to optimise filling pressures and to administer drugs and fluids during transfer
- Do not transfer a patient who remains hypotensive despite resuscitation⁺⁺⁺⁺ until all causes have been identified and patient stabilised
- Correction of major haemorrhage takes precedence over transfer
- If a patient has had a seizure, consider loading with an anticonvulsant (usually phenytoin)
- Unstable/compound long bone fractures should be toileted and splinted
- All lines/tubes should be secure and easily accessible

THE TRANSFER

- All notes, x-rays, CT scans, blood results etc should accompany the patient
- Contact destination hospital consultant
- Check all equipment
- Ensure proper padding/securing to stretcher/trolley (remember possibility of spinal injury)
- Position patient with 20° head up tilt
- Patient management will focus on maintaining oxygenation, adequate BP, and minimising increases in ICP
- Continue ECG, invasive BP, SpO₂, P_ECO₂, temperature, pupillary size/reaction, and drug/fluid administration
- Undertake transfers smoothly and not at high speed

⁺⁺⁺⁺ persistent hypotension adversely affects neurological outcome; when other causes of hypotension have been excluded, consider inotropes/vasopressors to offset hypotensive effects of sedatives

- Team should have a cell phone
- Maintain paper record
- If any procedure is required en route, this should be done with the ambulance halted
- Notify relatives but, normally, they should not accompany the patient in the ambulance

Equipment and drugs

- Service regularly, checked daily, and rechecked immediately before transfer
- The patient should receive the same standard of physiological monitoring during transfer as they would receive in an intensive care unit
- Essential equipment:
 - portable mechanical ventilator
 - adequate supply of O₂
 - portable battery powered multifunction monitor to include:
 - ECG
 - invasive BP monitoring
 - non-invasive BP backup
 - central venous pressure monitoring
 - pulse oximetry
 - capnography
 - temperature
- 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
- An adequate supply of essential drugs to go with the patient
 - hypnotics, e.g. propofol or midazolam
 - muscle relaxants, e.g. atracurium, vecuronium, suxamethonium may be required for re-intubation
 - analgesics, e.g. alfentanil, fentanyl,
 - anticonvulsants, e.g. diazepam, thiopentone
 - mannitol 20%, furosemide
 - vasoactive drugs, e.g. ephedrine, dopamine, noradrenaline
 - resuscitation drugs as in hospital resuscitation boxes
 - intravenous fluids
- Communication Equipment

5 References

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