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Evidence-Based Best Practice Guideline Summary

Traumatic Brain Injury: Diagnosis, Acute Management and Rehabilitation

March 2007
STATEMENT OF INTENT

Reliance upon best practice guidelines are encouraged. Health professionals and researchers make decisions about health care in specific clinical circumstances. Research has shown that, if properly developed, communicated and implemented, guidelines can improve care. This means trying guidelines is based on systematic review and other rigorous processes. Where no evidence is available but guidance is needed, recommendations for best practice are developed through a systematic process that involves the opinion of clinical experts and the research literature.

While guidelines represent a statement of best practice based on the latest available evidence (at the time of publishing), they are not intended to replace the health practitioners’ judgement in each individual case.

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Where guidelines are modified for local circumstances, particular departures from the national guidelines should be fully documented and the reasons for the differences explicitly detailed.

This summary is from the July 2007 edition of the Evidence-Based Best Practice Guideline Traumatic Brain Injury: Diagnosis, Acute Management and Early Return-to-Activity.

P.O. Box 63, The Terrace, Wellington, New Zealand
Phone: 04-473 6430, Fax: 04-473 6431
Email: info@nzgroup.org.nz
Website: www.nzgroup.org.nz, select "Publications" then "Guidelines"
then "Neurology/Rehabilitation"

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ACC
P.O. Box 102, Wellington, New Zealand
www.acc.co.nz
ACC Provider Helpdesk: 0800 222 429
ACC Patents/Claims Helpdesk: 0800 103 996
About the guideline

Thousands of New Zealanders experience traumatic brain injury (TBI) each year. The purpose of the guideline is to support informed decision-making by all practitioners working with people who have TBI, their families/whānau and carers. The guideline does not specifically address non traumatic categories of brain injury, such as those resulting from poisoning and anoxia, or stroke and other cardiovascular events. The guideline also excludes pre- and peri-natal brain damage resulting from prenatal and birth-related events.

Many aspects of both adult and paediatric rehabilitation following clinically significant TBI lack a robust evidence base. Therefore, much of the evidential support for the recommendations in the guideline is necessarily drawn from less robust research study designs, or from closely related areas such as the stroke literature.

The term 'head trauma' or 'head injury' is used to mean the original injury. A head injury does not always cause an injury to the brain, and the terms 'head' and 'brain' are used to distinguish between the original injury to the head and consequent injury to the brain respectively.

Following recent international practice, the Guideline Development Team uses, where possible, clinically significant TBI or symptomatic TBI to refer to TBI with a need for intervention or other care or support, irrespective of the initial severity of injury. Although classification of the initial severity of TBI is useful in the prediction of some short- and long-term outcomes, the relationship between initial severity of injury and medium- and long-term outcomes has been questioned.

This guideline was developed by an independent multidisciplinary team of practitioners and consumers under the auspices of the New Zealand Guidelines Group (NZGG) and was funded by ACC.

The Guideline Development Team included: Harry McNaughton (Chair), Michael Ardagh, Andrew Beattie, Vijaya Dharan, Margaret Dudley, Chris Dyson, Monique Niiumata-Faleafa, Greg Finucane, Kate Hall, Matire Harwood, Brenda Kenworthy, Peter Larking, Brigitte Larkins, Janet Leathem, William Levack, Joan Limmer, Kelly Lynch, Martin Macfarlane, John Mayhew, Jenny McClure, Siobhan Molloy, Harley Pope, Sharon Reilly, Elizabeth Rowland, Bernadette Ryan, Richard Siegert, Peter Stormer, Wendy Browne and Denise Udy.

These summaries have been developed from the TBI guideline entitled Traumatic Brain Injury: Diagnosis, Acute Management and Rehabilitation ACC2404. They are intended for use by all practitioners and address the pre-hospital assessment, the in-hospital acute phase, and the rehabilitation phase of TBI care.

There is limited evidence to guide management in children and young people with TBI. The information and recommendations for adults with TBI should be used with caution in these groups.

For a full discussion of TBI management, it is strongly recommended that you refer to the full guideline, Traumatic Brain Injury: Diagnosis, Acute Management and Rehabilitation ACC2404. This is available for download from www.acc.co.nz or www.nzgg.org.nz. A printed copy is available from 0800 THINKSAFE (0800 844 657) or the ACC Injury Prevention Unit: Phone (04) 918 7700. Email: thinksafe@acc.co.nz or info@nzgg.org.nz.
Pre-hospital Assessment, Management and Referral

KEY MESSAGES

- Always treat the greatest threat to life and avoid further harm.
- A falling or persistently reduced Glasgow Coma Scale (GCS) score and amnesia are associated with an increased risk of intracranial complications.
- Do NOT assume that signs and symptoms of a person’s injury are due to intoxication from alcohol or drugs.
- Initiate referral to the Emergency Department if there are signs and symptoms that are risk factors for acute intracranial complications of TBI.
- People who do not require further medical assessment must be provided with written information about when to seek medical help.
- Coordinated trauma systems reduce mortality in serious injury, including serious neurotrauma.
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Definition

Traumatic brain injury (TBI) is an acute brain injury arising from mechanical energy to the head from external
physical forces. Criteria for clinical identification include one or more of the following:
  • confusion or disorientation
  • loss of consciousness
  • post-traumatic amnesia
  • other neurological abnormalities (eg, focal neurological signs, seizure and/or intracranial lesion).

AIMS OF PRE-HOSPITAL ASSESSMENT

1. To establish whether trauma to the head has occurred.
2. To estimate the severity of any injury to the brain.
3. To identify hypotension and/or hypoxia (which, untreated, can magnify TBI effects).
4. To identify risk factors for acute complications of TBI which may require intervention, especially
   intracranial bleeding.
5. To identify other injuries that may require urgent management.
Pre-hospital acute assessment

Treat the greatest threat to life and avoid further harm.
Full cervical spine immobilisation should be attempted, unless there is:
- no alteration of consciousness, and
- no neck pain/tenderness, and
- no focal neurological deficit, and
- no major distracting injury.

Assess for signs and symptoms that are risk factors for acute intracranial complications of TBI. Initiate referral to the Emergency Department if these are detected.

Do NOT assume that signs and symptoms of a person’s injury are due to intoxication from alcohol or drugs, even when intoxication is suspected.

Promptly transport people with suspected TBI directly to a centre where TBI is managed in its entirety or to a centre that can stabilise their condition prior to a transfer to a centre where TBI is managed in its entirety.

Paramedics should be trained in the use of the Glasgow Coma Scale (GCS) and in the detection of non-accidental injury.
Assessment of need for medical attention

Focus on detecting acute complications of TBI, particularly intracranial bleeding. Various assessment tools and factors can be used as risk indicators for acute complications of TBI.

### Assessing risk indicators for acute complications

<table>
<thead>
<tr>
<th>TOOLS/ FACTORS</th>
<th>RECOMMENDATIONS/COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLASGOW COMA SCALE (GCS)</td>
<td>Use the GCS to assess people with a head injury.                                                                                                                                  The risk of intracranial complications and consequent need for surgery increases as the GCS declines. Urgent investigation and/or referral is indicated if there is a fall of ≥ 2 points in the GCS, as this may represent the development of intracranial bleeding.</td>
</tr>
<tr>
<td>LEVEL OF CONSCIOUSNESS</td>
<td>Record any loss of, or alteration in, consciousness. Altered consciousness after TBI is associated with an increased risk of developing an intracranial complication. Check blood glucose levels in all people with altered consciousness, as altered consciousness may have many causes.</td>
</tr>
<tr>
<td>POST-TRAUMATIC AMNESIA</td>
<td>Assess and record post-traumatic amnesia in all people with suspected TBI, where possible. Commence assessment for amnesia prospectively (ie, before it has resolved), to increase accuracy. Select and use one of the available validated post-traumatic amnesia measurement tools (eg, Modified Oxford Post Traumatic Amnesia Scale [MOPTAS], Westmead Post Traumatic Amnesia Scale, Galveston Orientation and Amnesia Test [GOAT]). Although post-traumatic amnesia is associated with an increased risk of intracranial complications, evidence on the precise relationship between post-traumatic amnesia and intracranial complications is inconsistent.</td>
</tr>
<tr>
<td>NEUROLOGICAL SIGNS</td>
<td>Assess and record neurological signs in people with suspected TBI. Post-traumatic neurological signs (eg, focal neurological deficit, seizure) are strongly associated with the risk of an intracranial complication.</td>
</tr>
<tr>
<td>BLEEDING DISORDERS AND USE OF ANTICOAGULANTS</td>
<td>Consider the possibility of a bleeding disorder or anticoagulant medication use when assessing people with suspected TBI, as these may contribute to an increased risk of intracranial complications. Check whether alternative or complementary therapies with an anticoagulant effect have been taken.</td>
</tr>
<tr>
<td>TOOLS/FACTORS</td>
<td>RECOMMENDATIONS/COMMENTS</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>SKULL FRACTURE</strong></td>
<td>Undertake clinical assessment of signs of skull fracture, including signs of basal skull fracture (CSF fluid leak, periorbital haematoma, depressed or open skull injury, penetrating injury). The risk of intracranial complications is higher in people with a diagnosed skull fracture. Routine use of skull X-rays is not recommended as a decision-making tool.</td>
</tr>
<tr>
<td><strong>SEIZURE</strong></td>
<td>Seizure ALONE is rarely a sign of an intracranial haematoma. However, alteration in consciousness from a seizure (or drugs used to stop the seizure) cannot be differentiated from that caused by an intracranial bleeding complication of TBI. Unless recovery is prompt and complete, referral for a CT scan is necessary to exclude such a complication.</td>
</tr>
<tr>
<td><strong>MECHANISM OF INJURY</strong></td>
<td>High-risk factors for clinically significant TBI after head injury include: • a pedestrian struck by a motor vehicle • an occupant ejected from a motor vehicle • a fall from a height of ≥1 metre or ≥5 stairs (less in infants and children).</td>
</tr>
<tr>
<td><strong>AGE</strong></td>
<td>Increasing age (&gt;65 years) is associated with an increased risk of intracranial complications and a poorer prognosis following TBI. Young infants (&lt;12 months) are also at increased risk of intracranial complications.</td>
</tr>
<tr>
<td><strong>DRUG OR ALCOHOL CONSUMPTION</strong></td>
<td>Although alcohol and drug intoxication can reduce the GCS, it is safer to assume that such signs are due to TBI or a complication of TBI rather than intoxication, and proceed accordingly.</td>
</tr>
<tr>
<td><strong>HEADACHE</strong></td>
<td>Avoid strong analgesia for headache, if possible, until a full assessment has been made in the Emergency Department. Analgesics may have a sedative effect and can mask symptoms of complications of TBI.</td>
</tr>
<tr>
<td><strong>VOMITING</strong></td>
<td>Consider any vomiting to be a risk factor for intracranial complications. There is debate about the number of vomiting episodes required to identify a high risk of intracranial complications.</td>
</tr>
<tr>
<td><strong>IRRITABILITY AND ALTERED BEHAVIOUR</strong></td>
<td>Irritability and altered behaviour may be important signs of deterioration following TBI in young children.</td>
</tr>
<tr>
<td><strong>HISTORY OF CRANIAL NEurosurgical INTERVENTIONS</strong></td>
<td>Record any previous neurosurgical intervention, especially if there has been cranial neurosurgery in the 6 weeks prior to injury, or if there is a shunt in place for hydrocephalus.</td>
</tr>
</tbody>
</table>
Referral to the Emergency Department

Initiate referral to the Emergency Department if there are signs and symptoms that are risk factors for acute intracranial complications of TBI.

Use emergency services transport to transfer to the Emergency Department if there is:
- any deterioration in the injured person’s condition
- impaired consciousness (GCS <15)
- any focal neurological deficit since the injury
- any suspicion of a skull fracture or penetrating head injury
- any seizure since the injury
- a high-energy head injury
- suspected neck injury.

Consider using a competent adult to transport to the Emergency Department for review (if specific indicators for emergency services transport are absent) when there is:
- any loss of consciousness as a result of the injury, unless trivial, apparently resolved and alternative observation is available
- amnesia for events before or after the injury
- persistent headache since the injury
- irritability or altered behaviour, particularly in infants and young children
- any vomiting since the injury
- a history of bleeding or clotting disorder
- current anticoagulant therapy
- current drug or alcohol intoxication
- any previous cranial neurosurgery
- suspicion of non-accidental injury
- age <6.5 years or ≤1 year
- concern about the cause of any symptoms by the person undertaking the assessment.

If there are no indications for Emergency Department review, advise people to seek further assessment from a general practitioner (GP) or Accident and Medical Clinic if there are:
- adverse social factors (eg, no supervision at home)
- continuing concerns by the injured person or their carer about the diagnosis.

People with no indications for Emergency Department review or further medical assessment can go home with written information about when to seek medical help.

Delayed first assessment (>24 hours after the injury)

It is important to:
- document the episode of external force to the head and any symptoms at the time (eg, loss of consciousness, amnesia)
- document the current symptoms and their duration, including pre- and post-event amnesia
- explain that some or all of the symptoms may be related to the injury
- consider the need for acute referral to hospital, specialist referral and/or further investigation.
Criteria for classifying the severity of traumatic brain injury

<table>
<thead>
<tr>
<th>SEVERITY OF INJURY</th>
<th>GLASGOW COMA SCALE SCORE</th>
<th>DURATION OF POST-TRAUMATIC AMNESIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>13–15</td>
<td>&lt;24 hours</td>
</tr>
<tr>
<td>Moderate</td>
<td>9–12</td>
<td>1–6 days</td>
</tr>
<tr>
<td>Severe</td>
<td>3–8</td>
<td>7 days or more</td>
</tr>
</tbody>
</table>

If there is a discrepancy between the severity level for the GCS score and post-traumatic amnesia, it is appropriate to use the more severe category (e.g., GCS score of 14 but post-traumatic amnesia for 2 days = moderate TBI).

Glasgow Coma Scale

**Adults**

The GCS is scored between 3 and 15, 3 being the worst and 15 the best. It is composed of 3 parameters: Best Eye Response, Best Verbal Response and Best Motor Response. The definitions of these parameters are given below.

<table>
<thead>
<tr>
<th>BEST EYE RESPONSE (4)</th>
<th>BEST VERBAL RESPONSE (5)</th>
<th>BEST MOTOR RESPONSE (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No eye opening</td>
<td>1. No verbal response</td>
<td>1. No motor response</td>
</tr>
<tr>
<td>2. Eye opening to pain</td>
<td>2. Incomprehensible sounds</td>
<td>2. Extension to pain</td>
</tr>
<tr>
<td>3. Eye opening to verbal</td>
<td>3. Inappropriate words</td>
<td>3. Flexion to pain</td>
</tr>
<tr>
<td>command</td>
<td>4. Confused</td>
<td>4. Withdrawal from pain</td>
</tr>
<tr>
<td>4. Eyes open spontaneously</td>
<td>5. Orientated</td>
<td>5. Localizing pain</td>
</tr>
</tbody>
</table>

**Paediatric version**

The paediatric version of the GCS is scored between 3 and 15, 3 being the worst and 15 the best. It is composed of 3 parameters: Best Eye Response, Best Verbal Response or Best Grimace Response, and Best Motor Response. The definitions of these parameters are given below.

<table>
<thead>
<tr>
<th>BEST EYE RESPONSE (4)</th>
<th>BEST VERBAL RESPONSE (5)</th>
<th>BEST GRIMACE RESPONSE (5)</th>
<th>BEST MOTOR RESPONSE (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No eye opening</td>
<td>1. No vocal response</td>
<td>A ‘grimace’ alternative to verbal responses</td>
<td>1. No motor response to pain</td>
</tr>
<tr>
<td>2. Eye opening to pain</td>
<td>2. Occasionally whimpers and/or moans</td>
<td>should be used in those infants or children who</td>
<td>2. Abnormal extension to pain (decerebrate)</td>
</tr>
<tr>
<td>3. Eye opening to verbal</td>
<td>3. Cries inappropriately</td>
<td>are pre-verbal or intubated.</td>
<td>3. Abnormal flexion to pain (decorticate)</td>
</tr>
<tr>
<td>command</td>
<td>4. Less than usual ability and/or</td>
<td>1. No response to pain</td>
<td>4. Withdrawal to painful stimuli</td>
</tr>
<tr>
<td>4. Eyes open spontaneously</td>
<td>spontaneous irritable cry</td>
<td>2. Mild grimace to pain</td>
<td>5. Localises to painful stimuli or withdraws</td>
</tr>
<tr>
<td></td>
<td>5. Alert, hiccups, cries,</td>
<td>3. Vigorous grimace to pain</td>
<td>to touch</td>
</tr>
<tr>
<td></td>
<td>words or sentences to usual ability</td>
<td>4. Less than usual spontaneous ability or only</td>
<td>6. Obeys commands or performs normal</td>
</tr>
<tr>
<td></td>
<td>Communication with the infant’s or</td>
<td>responds to touch stimuli</td>
<td>spontaneous movements</td>
</tr>
<tr>
<td></td>
<td>child’s caregivers is required to</td>
<td>5. Spontaneous normal facial/oro-motor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>establish the best usual verbal</td>
<td>activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>response</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** This appendix is included in the full guideline and online at www.nzgg.org. It may be reproduced for clinical use.
Acute phase of care

**KEY MESSAGES**

- The Emergency Department assessment and management of people with suspected TBI should focus on preventing and treating hypotension and hypoxia, obtaining early imaging and attending to co-existing injuries.
- CT scanning of the head is the primary investigation of choice for the detection of clinically significant acute complications of TBI.
- The sensitivity of skull X-rays is too low to be the primary investigation.
- Avoid giving strong systemic analgesia until a full assessment has been done.
- Test for blood alcohol levels in all people with suspected TBI and GCS ≤15 and/or where alcohol intoxication is suspected.
- Consider the possibility of non-accidental injury in all children with TBI.
- Avoid corticosteroids in people with acute TBI of any severity.
- Do not discharge people presenting with suspected TBI until GCS is 15.
- Early rehabilitative intervention in clinically significant TBI improves outcomes.
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Emergency Department assessment

The Emergency Department assessment of people with suspected TBI should focus on:

- the management or avoidance of hypotension and hypoxia
- early imaging (rather than admission and observation)
- attention to co-existing injuries and other concerns.

Collect data about the following to aid decision-making:

- age
- mechanism of injury
- vomiting since the injury
- presence of headache and/or seizures since the injury
- presence of anterograde amnesia (impaired memory for events after the injury)
- presence of retrograde amnesia (impaired memory before the injury) of greater than 30 minutes
- GCS (on presentation and two hours after injury)
- evidence of suspected or open skull fracture
- signs of basal skull fracture
- evidence of trauma above the clavicles
- evidence of drug or alcohol intoxication.

All people with suspected TBI need triage assessment on arrival.

- If high risk on triage for clinically significant TBI, assessment within 10 minutes by an experienced healthcare practitioner is required.
- If GCS <8, involve anaesthetist/emergency physician/critical care physician to provide appropriate airway management and assist with resuscitation.
- If low risk on triage for clinically significant TBI, reassessment within one hour by a doctor with appropriate experience is required.

Establish the need for CT imaging of the head (see 'Primary investigation: CT scanning below').

Test for blood alcohol levels in all people with suspected TBI and GCS <15 and/or where alcohol intoxication is suspected.

- There is considerable similarity in the signs of alcohol intoxication and TBI (GCS is unreliable in alcohol-intoxicated people).
- Do NOT attribute signs of possible TBI to alcohol intoxication alone when assessing people with suspected TBI.

Do NOT administer strong systemic analgesia until fully assessed.

Primary investigation: CT scanning

CT scanning of the head is the primary investigation of choice for the detection of clinically significant acute complications of TBI.

The sensitivity of skull X-rays is too low to be the primary investigation in infants, children and adults.

Request an immediate CT scan for adults who have sustained a head injury with ANY of the following risk factors:

- any deterioration in condition
- GCS ≤3 when assessed, irrespective of time elapsed since the injury
• GCS of 13 or 14 two hours after the injury
• suspected open or depressed skull fracture
• any sign of basal skull fracture
• post-traumatic seizure
• focal neurological deficit
• more than one episode of vomiting
• amnesia for >30 minutes for events before the injury.

Request an immediate CT scan for adults who have sustained a head injury with some loss of consciousness or amnesia since the injury and ANY of these risk factors:
• age \( \geq \) 65 years
• coagulopathy (history of bleeding, clotting disorder, current treatment with warfarin)
• high-risk mechanism of injury (a pedestrian struck by a motor vehicle, an occupant ejected from a motor vehicle, or a fall from a height of >1 metre or >5 stairs).

The decision to CT scan should be applied regardless of the influence of intoxication.

In some situations (eg, rural centres with limited access to CT), observation for 24 hours rather than CT scan is a reasonable option.

Discuss the appropriateness of observation with the relevant neurosurgical centre.

People with the following factors MUST be referred for CT scan:
• any deterioration in condition
• GCS \(<\) 13 at time of assessment irrespective of time elapsed since the injury or GCS of 13 to 14 two hours after injury
• any sign of basal skull fracture
• focal neurological deficit.

It is particularly important to balance the benefits and harms of CT scanning in infants and children. Consult a specialist with experience in managing TBI if there is doubt on whether a CT scan is required.

**CHILDREN AGED 0 TO 16 YEARS**

Imaging should be considered if ANY of the following factors are present (refer to algorithm):
• post-injury adverse events or signs, including focal neurological deficits and seizures (except immediate)
• a paediatric GCS of \(\leq\) 13, particularly an initial or ‘field’ (pre-hospital) GCS of \(\leq\) 13, or any decrease in GCS
• skull fracture, either obvious or suspected on the basis of clinical signs
• injury resulting from a fall from 1 metre or 5 stairs, or less in the case of younger children
• non-accidental cause of injury
• lethargy or irritability on examination.

**INFANTS AGED 2 YEARS OR YOUNGER**

For this group, there are additional risk factors for TBI supporting CT scanning, including:
• soft tissue injury such as swelling or haematoma
• occipital or temporal/parietal location of injury.
Acute phase of care

Diagnostic management and selection for imaging of children and young people aged <17 years

History of trauma to head
- Injury resulting from a fall from one metre or five stairs or more*
- Non-accidental cause of injury

Post injury
- Any deterioration
- Any seizure, except immediate

Examinations:
- Initial GCS score ≤ 13
- GCS score that decreases at any time
- Obvious or suspected skull fracture
- Lethargy or irritability
- Any focal neurological deficits

Observe and reassess at two hours

Note: Any deterioration – refer for scan immediately

Discharge with information to home observation‡
Recommended minimum observation period = four hours

Any non-surgical indicators for paediatric consult or admission?

Paediatric consult and/or admit to hospital

Scan –ve and GCS = 15

Scan +ve or GCS 13–14

Admit to hospital and/or neurosurgical consult

Any surgical indicators for paediatric consult or admission?

CT scanning of infants and children can be difficult and may require anaesthesia and pose a significant radiation risk. If uncertain about benefits of CT scan versus risks of scan, seek specialist advice (Emergency Department specialist, intensive care unit specialist, neurosurgeon, paediatrician) before scanning.

GCS = Glasgow Coma Scale

* In younger children, falls from lesser heights may have a high risk of intracranial complications.
† Use paediatric version of GCS.
‡ Children and young people with a head injury should only be discharged home if they have a responsible adult who can observe them for any deterioration.
§ CT scanning of infants and children can be difficult and may require anaesthesia and pose a significant radiation risk. If uncertain about benefits of CT scan versus risks of scan, seek specialist advice (Emergency Department specialist, intensive care unit specialist, neurosurgeon, paediatrician) before scanning.

GCS = Glasgow Coma Scale
Consider repeating the CT scan:
- if the initial scan shows an abnormality and there is clinical deterioration
- to check that an original small lesion has not progressed (next day)
- to check that an initial small lesion has resolved spontaneously (in a week or two).

Non-accidental injury in children
Consider the possibility of non-accidental injury in all children with TBI.
A full work-up for suspected non-accidental injury includes:
- skull X-rays as part of a skeletal survey
- ophthalmoscopic examination for retinal haemorrhage
- examination for pallor, anaemia, tense fontanelle
- additional investigations (CT, MRI).

Neurosurgical care
Consult a neurosurgeon if the person has:
- deteriorating status, especially a fall in GCS of ≥2, development of pupil dilatation or other new neurological deficit
- severe TBI (GCS ≤8), especially if unconscious from the time of injury
- severe neurological deficit following TBI
- surgically significant lesion on imaging.

Use of corticosteroids
There is strong evidence to avoid corticosteroids in the management of people with acute TBI of any severity. Corticosteroids are associated with an increase in mortality in people with acute TBI.

Transfer to tertiary care setting
- 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.
- People with suspected TBI should be accompanied by an experienced doctor and an adequately trained assistant.
- The transfer team should have a means of communication with their base hospital and the tertiary care facility during the transfer.

Indications for immediate intubation and ventilation in people with TBI include ANY of the following:
- coma (GCS ≤8)
- loss of protective laryngeal reflexes
- ventilatory insufficiency:
  - hypoxaemia (PaO<sub>2</sub> < 65 mm Hg on air or < 95 mm Hg on oxygen)
  - hypercarbia (PaCO<sub>2</sub> > 45 mm Hg)
- spontaneous hyperventilation causing PaCO<sub>2</sub> < 30 mm Hg
- respiratory arrhythmia.

Indications for intubation and ventilation in people with TBI before transfer include ANY of the following:
- significant deterioration in level of consciousness
• bilateral fractured mandible
• copious bleeding into the mouth
• seizures.

Fully inform carers, family/whānau about the transfer and provide them with as much access to the injured person during transfer as is practical.

Indications for hospital admission
Admit to hospital if there are ANY of the following:
• a deteriorating GCS
• clinically significant abnormalities on imaging
• GCS ≤ 5 after imaging
• criteria for CT scanning are met but CT scanning is not possible
• focal or abnormal neurological signs
• early post-traumatic seizure
• skull fracture
• high-risk mechanism of injury
• continuing signs of concern to the clinician (eg, vomiting, severe headaches, amnesia)
• other reasons for clinician concern, including drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, signs of meningeal irritation, cerebrospinal fluid leak, where a scalp laceration overlies a fracture, or the person’s age
• when there is no responsible family/whānau member, caregiver or close friend under whose care the person could be discharged
• ‘mild’ head injuries with symptoms such as headache, photophobia, nausea and vomiting, or amnesia requiring management.
Minimum neurological observations should include ALL the following:

- GCS
- pupil size and reactivity
- limb movements
- respiratory rate
- heart rate
- blood pressure
- temperature.

Perform and record observations at least every 15 minutes until GCS is 15 on two consecutive occasions.

For people with an initial GCS of 15, or who have returned to a GCS of 15 on two consecutive observations, the minimum frequency of observations following the initial assessment should be:

- half-hourly for the first two hours, then
- one-hourly for four hours, then
- two-hourly thereafter.

If a person with a GCS of 15 deteriorates at any time after the initial two-hour period, revert to observations every 15 minutes or more frequently if necessary and follow the original frequency schedule.

An urgent reappraisal should be done by the supervising doctor if any of the following signs of neurological deterioration occur:

- development of agitation or abnormal behaviour
- a sustained (≥ 30 minutes) drop of one point in GCS
- any drop of two points in GCS
- development of severe/increasing headache or persisting vomiting
- new or evolving neurological symptoms or signs.

Consider an immediate CT scan if any of the above signs of neurological deterioration occur.

Consider further CT or MRI scanning if original CT scan was normal but GCS is <15 after 24 hours of observation.

Assess for post-traumatic amnesia and focal neurological signs at regular intervals.

Provide in-hospital support for families/whānau (and carers).
DISCHARGE FROM HOSPITAL

Do not discharge people presenting with suspected TBI until GCS is 15.

People with suspected TBI may be discharged if:
- GCS is 15 and a CT scan is not indicated
- head or cervical spine imaging is normal and GCS has returned to 15
- there is resolution of all significant symptoms and signs
- no other factors are present that would warrant a hospital admission
- there are appropriate support structures for safe transfer and subsequent care and supervision.

Do not discharge infants or children with suspected TBI who require imaging of the head or cervical spine until assessed by a clinician experienced in the detection of non-accidental injury.

Ensure all people with any degree of suspected TBI receive verbal advice on discharge which:
- outlines the risk factors that may indicate complications
- explains that some people make a quick recovery, but may later experience complications
- gives instructions on contacting community services in the event of delayed complications.

Ensure that people who initially presented with drug or alcohol intoxication and are being discharged receive appropriate information and advice.

If there is no carer at home, discharge people with any degree of suspected TBI only when there is negligible risk of late complications, or when suitable supervision arrangements have been made.

Do not routinely recommend bed rest as there is no evidence that bed rest aids recovery. Advise people with excessive dizziness that bed rest may help alleviate their symptoms temporarily.

People discharged from hospital after TBI should have had their GP notified either before or at the point of discharge, with details of any residual impairments and details of the planned follow-up.

People who are discharged after suspected TBI sustained after a self-harm or suicide attempt should be referred for psychiatric assessment including a risk assessment.
Referral to Rehabilitation

Rehabilitation should start as soon as possible.
Early rehabilitative intervention in clinically significant TBI improves outcomes.
The following areas should be assessed once consciousness has been regained:
- motor impairments, such as weakness, altered tone and lack of coordination in the limbs
- problems with speech and swallowing
- sensory impairment, including visual problems, such as reduced visual acuity, loss of visual field, gaze palsies and hearing loss
- cognitive impairments, especially of memory, concentration and/or orientation
- language problems, particularly cognitive communication disorder or aphasia
- reduced control over bowels and bladder
- emotional, psychological and neurobehavioural problems.
Assess the need for rehabilitation before discharging people with TBI.
Refer to a specialist rehabilitation service if people with TBI have:
- difficulty with body functions
- difficulty with activities that they were able to complete prior to the injury
- difficulty participating in their usual social roles.
Rehabilitation: services, assessment and interventions

KEY MESSAGES

• Effective coordination, communication and information sharing between rehabilitation services is essential to ensure a seamless transition between the stages of TBI rehabilitation.
• People with TBI should be assessed for functional deficits in Activities of Daily Living (ADL) and for specific impairments in physical, cognitive, behavioural/emotional and communicative functioning.
• Assessment should include seeking information about pre-TBI functioning from family and whānau, and take into account the person’s participation goals.
• For children with TBI, neuropsychological and other assessments may need to be repeated several times as they mature to adulthood.
• Comorbid conditions, especially those with symptomatic overlap with TBI, should be identified and treated, if necessary.
• Physical rehabilitation should aim to improve functional independence.
• Return to gainful employment or an alternative occupation is often an important goal in adults with TBI and may be a central factor in the restoration of quality of life.
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Rehabilitation services

Rehabilitation services for people with TBI should:

- be based on achieving well-being rather than on a model of deficit and dependency
- approach people with TBI from a participation perspective
- have the necessary skills and experience to provide appropriate and context-specific assessments and interventions
- acknowledge that different people require different input at different stages in their recovery.

There are four distinct stages of rehabilitation.
1. Acute care/neurosurgery
2. Residential rehabilitation
3. Non-residential rehabilitation
4. Longer-term community support

Not all people with TBI will require each of these stages (see full guideline for more information).

Effective coordination of services, communication and information sharing is essential to ensure a seamless transition between the stages of TBI rehabilitation.

There is international agreement on the benefits of individual ‘case coordinators’ or ‘key workers’ to support the individual and their family/whānau throughout the course of their recovery.

Delivery of rehabilitation is most effective when done by a coordinated, multidisciplinary team of people from a range of disciplines.
Rehabilitation assessment

A TBI can result in physical, cognitive, behavioural/emotional or communicative deficits.

Assessment by rehabilitation services should:

• determine whether there is a probable TBI
• ascertain the nature and extent of the TBI
• identify the resulting deficits and their possible impact on functioning
• consider whether there are potential medical and psychiatric comorbidities which have symptomatic overlap with the TBI.

Assess for functional deficits in ADL and for specific impairments in:

• control over bowels and bladder
• speech and swallowing
• motor control
• sensory function
• language production and comprehension
• cognition, especially memory
• behaviour and emotion.

Consider referring all people with TBI for a neuropsychological assessment to evaluate cognitive functioning.

For children with TBI, neuropsychological and other assessments may need to be repeated several times as they mature to adulthood.

Seek information about pre-TBI functioning from family/whānau and carers.

Take into consideration the person’s participation goals when assessing activity limitation and impairments.

Assessment of the severity of TBI may be complicated by:

• the presence of non-brain injuries
• TBI symptoms that are masked by medical problems.

It is important to assess for potential medical complications of TBI and to refer for appropriate treatment.

Differential diagnosis

It is important to attribute symptoms correctly to TBI or other medical conditions, and to identify and treat comorbid conditions.

Many of the symptoms of TBI overlap with other conditions (both physical and psychological/psychiatric).
In children and young people, various developmental, psychological and psychiatric conditions may have symptomatic overlap with the effects of TBI. These conditions include:

- Attention Deficit Hyperactivity Disorder (ADHD)
- Fetal alcohol effects
- Hearing and visual impairments
- Drug and alcohol use in adolescents
- Developmental disorders
- Non-TBI-related cognitive difficulties and emotional problems.

Request specialist assessment where there is a lack of clarity about the aetiology of the symptoms, or where progress is poorer than expected.

**Physical assessment**

Assessment of the physical functioning of people with TBI should include checking for the following:

- Motor deficits
  - Muscle weakness and paralysis
  - Abnormal muscle tone (spasticity)
  - Deficits in joint range of motion
  - Ataxia/incoordination
- Sensory deficits
  - Visual/hearing loss
- Physical symptoms
  - E.g., headache, fatigue, pain
- Dysphagia
- Seizures
- Impaired functional mobility
  - Changing and maintaining body position
  - Carrying, moving and handling objects
  - Walking and moving (including, but not limited to, crawling, climbing, running, jumping and swimming)
  - Mobilising with the aid of assistive technology.

**Dysphagia assessment**

A speech-language therapist should lead both the assessment and planning of dysphagia therapy. This should include:

- A detailed diagnostic assessment, to address issues of diagnosis, aetiology and functional impairment
- A rehabilitation-focused assessment, which addresses the need for, and the potential to benefit from, rehabilitation.

**Communicative assessment**

Communicative assessments should be performed by a speech-language therapist, in conjunction with others in the team.

Assessments of the communicative functioning of people with TBI should include assessments for:

- Language deficits — expression and comprehension
- Cognitive communication disorders
Neuropsychological assessment

All people with clinically significant TBI should have a neuropsychological assessment of cognitive and behavioural/emotional functioning by a neuropsychologist.

Assessment includes an interview with the person with TBI and their family/whānau and carers, plus standard assessment measures.

A detailed neuropsychological assessment can:
• contribute to the evaluation of the likely impact of cognitive impairment on the rehabilitation programme
• contribute to the evaluation of areas of strength on which the person may be able to build during rehabilitation, and the person’s prognosis in terms of their ability to function independently in the community or to return to work or study
• help to identify the appropriate areas for effective rehabilitation input.

The assessment can encompass any or all of the following:
• a detailed diagnostic assessment
• a rehabilitation-focused assessment
• a vocation-focused assessment
• a permanent functional impairment assessment
• a behavioural management assessment.

When TBI is sustained in childhood, neuropsychological assessment may need to be repeated several times as the child matures to adulthood.

Cognitive assessment

Cognitive assessment requires input from a multidisciplinary rehabilitation team along with family/whānau and carers.

Cognitive assessment identifies the person’s functional cognitive abilities through an occupational therapy assessment in the home, work, school or community context. Face-to-face contact is essential for assessment.

Assessment of the cognitive functioning of people with TBI should include the following areas:
• insight and awareness
• attention
• memory
• speed of information processing
• perception
• complex problem-solving
• self-monitoring
• social judgement.

- dysarthria
- apraxia of speech
- acquired dyslexia
- acquired dysgraphia.
Behavioral/Emotional assessment

Assessment of the behavioral and emotional functioning of people with TBI should include assessment for:

- emotional lability
- poor initiation
- mood change
- adjustment problems
- personality changes, including:
  - aggressive outbursts
  - disinhibition
  - inappropriate sexual behaviour
- poor motivation.

It is also important to consider the possibility of drug and alcohol misuse and mental health disorders, particularly depression, anxiety disorders and psychosis.

Rehabilitation interventions

Currently, there is little robust evidence about commonly used interventions. Many of the following recommendations are extrapolated from findings in populations with other brain injuries (particularly stroke) or in mixed populations including some people with TBI.

Physical rehabilitation

The aims of physical rehabilitation are to:

- aid the recovery of normal functioning as far as possible
- provide compensatory strategies to minimise the negative impact of the symptoms that persist
- increase independence through the facilitation of motor control and skills.

There is strong evidence of the effectiveness of physical rehabilitation in improving functional independence.

A physiotherapist or occupational therapist with neurological expertise should coordinate the physical therapy to improve the motor function of people with TBI.

Physical treatment approaches should take account of any associated orthopaedic or musculoskeletal injuries.

The physical rehabilitation programme should include an illustrated written plan for other members of the team, including family/whānau and carers.

A speech-language therapist with dysphagia expertise should coordinate the dysphagia therapy.

Any programme should be adapted to accommodate the person’s normal environment and activities as far as possible.
Motor control and function, and spasticity

Recovering mobility is an important goal for people who are immobile following TBI.

Provide age-appropriate supportive seating and wheelchairs for people with TBI who are unable to maintain their own sitting balance.

Refer people with complex postural needs to a specialist interdisciplinary team with expertise in specialist seating.

Consider walking or standing aids for people with mobility problems.

Orthoses should be individually fitted.

Consider the following when planning a programme to improve motor control and general fitness:
• treadmill training with partial bodyweight support
• strength training
• gait re-education
• exercise training.

Any rehabilitation programme should include a flexibility routine when there is any spasticity.

Consider a carefully monitored trial of:
• botulinum toxin A (BTX-A) or tizanidine for treatment of problematic focal spasticity
• intrathecal baclofen for treatment of severe spasticity unresponsive to other treatments.

Continenence

Urinary and faecal incontinence are common following severe TBI, and can be distressing, socially disruptive and hinder progress in other areas of rehabilitation.

Bladder and bowel management plans should be developed with the full knowledge and support of the person’s primary carer.

Do not discharge people with continence problems from residential care until continence aids and services have been arranged at home and the carer has been adequately prepared.

**URINARY INCONTINENCE**

Rehabilitation of urinary incontinence should include:
• a regular monitoring programme
• strategies for alerting carers to the person’s need to pass urine where there are communication problems
• a toileting regimen based on reinforcement in cases of cognitive impairment.

Anticholinergic medication should only be prescribed after demonstration of an overactive bladder (e.g., on a 24-hour urine collection or by urodynamic investigation) and a postmicturition residual volume of <100 ml.

Consider intermittent catheterisation in adults with a postmicturition residual volume of >150 ml and in children with a postmicturition residual volume of >10% of bladder capacity.

If long-term catheters are necessary, they should be used as part of a planned catheter management programme using an agreed protocol, and after consideration of the impact on sexual function.

Supra-pubic catheters are preferred over long-term urethral catheters.
CONSTITUTION

For the management of constipation, institute an active bowel management regimen which includes:

- sufficient fluid intake
- natural or simple bulk laxatives
- exercise and standing (if possible)
- avoiding medications which slow gut motility
- maximum privacy and comfort during defecation
- supported sitting up for defecation at the earliest safe opportunity, and at a regular time each day.

Where the rectum is full but no spontaneous evacuation occurs, daily rectal stimulation may be used.

If the rectum is empty for three days consecutively despite continuing oral intake, consider the use of an osmotic laxative or a stimulant.

Sensory impairment

Sensory impairment after TBI, including partial loss of hearing or vision, may exacerbate disorientation and confusional states or impact on higher cognitive function.

People with visual and/or hearing loss should be assessed and treated by a team with appropriate experience or in conjunction with a specialist service.

All people presenting post TBI with persistent visual neglect or field defects should be offered specific retraining strategies.

Pain is frequently under-diagnosed in people with TBI, especially those with communication difficulties.

All people should be assessed for pain on a regular basis and treated actively in accordance with their wishes.

Specially adapted assessment tools or the skills of a speech-language therapist, and family/whānau and carers may be required to elicit pain symptoms accurately.

People with TBI, health care practitioners and carers should be educated about:

- hypersensitivity and neurogenic pain
- appropriate handling of the paretic upper limb during transfers.

Pain management protocols should be implemented, and encompass:

- handling, support and pain relief appropriate to the individual needs of the person with TBI
- regular review and adjustment according to changing need.
Communication and language rehabilitation

People with specific communication difficulties following TBI should be assessed by a speech-language therapist for suitability for speech-language therapy.

Where achievable goals are identified, an appropriate communication rehabilitation programme should be offered, with monitoring of progress.

A communication rehabilitation programme should:
• take into account the person's premorbid communication style and any cognitive deficits
• provide opportunities to rehearse communication skills in natural situations
• include family/whānau and carers in developing strategies for optimum communication
• include communication aids where appropriate
• provide compensatory strategies to manage communication difficulties.

Assessment and intervention for communication deficits in children should be appropriate to age and development, and performed by paediatric speech-language therapists with expertise in TBI.

Cognitive rehabilitation

Cognitive rehabilitation, in general, has been shown to be effective, although the effectiveness of specific interventions is unclear.

Where cognitive impairment is causing management difficulties or limiting response to rehabilitation, specialist advice should be sought.

Cognitive deficits are likely to be more difficult for the family/whānau, carers and employers to recognise, accept and accommodate, than the physical effects of TBI.

People with persistent cognitive deficits following TBI should be offered functionally oriented cognitive rehabilitation.

Cognitive rehabilitation should include:
• in the acute phase, management in a structured and distraction-free environment, and targeted programmes for those with executive difficulties (ie, problems with planning, organisation, problem-solving and divided attention)
• efforts to improve attention and information-processing skills
• teaching compensatory techniques
• use of external memory aids
• procedural learning information and principles.

Avoid trial-and-error learning in people with memory impairment.

There is very little evidence for the effectiveness of medications for the cognitive sequelae of TBI.
Consider a trial of methylphenidate for adults or children with TBI who have deficits in speed of mental processing, or ADHD secondary to TBI.

Consider a trial of donepezil hydrochloride for adults with TBI who have deficits in memory and attention.

Any trial of medication for people with TBI should be:
- commenced at low doses, with cautious increases in dose
- carefully monitored for effectiveness and adverse side effects
- preceded by a clear explanation to the person with TBI and their carers (including a caution that the effects of medications are less predictable in people with TBI).

Psychosocial/Behavioural rehabilitation

Refer people with severe behavioural problems after TBI to specialist behavioural management services.

Provide information and ongoing support to families/whānau and carers to help them:
- understand cognitive and behavioural problems
- interact appropriately with the people with TBI
- know how to access services.

Psychotropic medications used to manage agitation and aggression in people with TBI should be carefully selected for their side effect profile, and closely monitored. If no effect is observed within six weeks the drug should be 'tailed off' and another drug trialled after a suitable wash-out period.

Ask about the use of any non-prescription medicines, supplements and complementary or alternative medicine.

Consider referral to a neuropsychiatrist to:
- differentiate neurobehavioural difficulties from symptoms of functional illness
- treat people who may require medication for irritability and aggression.
Optimising performance in daily living tasks

**DAILY LIVING SKILLS**

All people with TBI who have difficulties in ADL should be assessed by an occupational therapist, physiotherapist, nurse or other health care practitioner with expertise in TBI and experience in assessment of ADL.

An individual rehabilitation programme aimed at maximising independence in areas of self-maintenance, productivity and leisure should be developed and implemented.

People with TBI should be given the opportunity to practise daily living skills outside therapy sessions. All daily living tasks should be practised in the most realistic and appropriate environments.

Family/whānau and carers should be involved in establishing the most appropriate routines for ADL for people with TBI.

Services should recognise that the provision of ‘care’ for some people with TBI may mean the supervision and practice of community living skills, rather than the provision of ‘hands-on’ physical care.

Carers and family/whānau should be trained and supported to help with rehabilitation, if willing and if acceptable to the person with TBI.

**EQUIPMENT AND TECHNOLOGY**

People with TBI who have difficulties in functioning should be assessed to determine whether equipment or adaptations could increase their safety and/or independence.

Prescription of equipment should take account of any cognitive and behavioural deficits and their constraints on the person's ability, or their carer's ability, to use the equipment safely and appropriately.

When an item of equipment has been identified as required for a person with TBI, it should be provided as quickly as possible and before the person is discharged to the community.

People with TBI and their families/whānau or carers should be trained in the safe and effective use of equipment, and clear written information should be given on whom to contact for repairs or replacement, or for future help and advice regarding the equipment.

The ongoing effectiveness of equipment should be reviewed on a regular basis and in accordance with the manufacturers’ guidelines.

Rehabilitation teams should consider the use of computers and other technology as an adaptive source of meaningful occupation or as compensatory strategies for people with significant sequelae of TBI.

Where necessary, a specialist assessment of each individual’s ability to use a personal computer and the need for adapted hardware and software should be arranged.

People with TBI should be given information about changes in technology relevant to their needs.

Assessments for, and prescriptions of, augmentative communication devices should be made by suitably accredited clinicians.

Careful consideration of the appropriateness of technology for individuals who may be vulnerable, such as people with symptoms of disinhibition or impaired judgement, is required.
Sleep and fatigue

Sleep difficulties and fatigue are very common following TBI of all severities. Advice from a professional experienced in managing fatigue and/or sleep disorders can be useful in establishing a suitable rehabilitation programme.

Vocational rehabilitation

Return to previous employment or an alternative occupation is often an important goal in adults with TBI and may be a central factor in the restoration of quality of life.

Assess the need for vocational rehabilitation to assist return or entry to the workforce, and provide vocational rehabilitation if needed.

There is strong evidence that vocational rehabilitation improves vocational outcomes for people with TBI, and is cost effective.

Monitor the effectiveness of standard vocational rehabilitation interventions, such as cognitive training and behaviour modification.

Provide supported employment for those for whom standard interventions are inadequate. Table 1 below provides examples of how support can be provided in various areas.

**Table 1: Examples of Vocational Support for People with TBI**

| Job Placement  | Match job needs to abilities and potential  
|                | Facilitate communication between the person, the employer and carers  
|                | Arrange travel and training  
|                | Assess the job environment for potential problems  

| Job Site Training and Advocacy by the Job Coach  | Provide appropriate job site training  
|                                                 | Proactively identify problems  
|                                                 | Design solutions in cooperation with the person with TBI, carers and the employer  
|                                                 | Ensure ongoing assessment with continuous monitoring of key aspects of the person’s performance in work  

| Job Retention and Follow-up by the Job Coach  | Monitor progress to anticipate problems, and intervene proactively when necessary  

Sexuality
A substantial proportion of people with TBI experience sexual dysfunction.

Health professionals should initiate discussion relating to sexual dysfunction early after significant TBI, to both the person and their partner.

Advice about sexuality should cover:
- physical aspects (e.g., positioning, sensory deficits, erectile dysfunction)
- psychological aspects (e.g., communication, fears, altered roles and sense of attractiveness).

Reassure family, whānau and carers that sexually inappropriate behaviour is not unusual in people who are in the early stages of recovery from TBI and should improve with time.

Provide family, whānau and carers with training in how to avoid inadvertently reinforcing inappropriate sexual behaviour.

Leisure and recreation
Rehabilitation services should support people with clinically significant TBI in developing alternative leisure and social activities, in liaison with local voluntary organisations.

It is important to identify:
- levels of participation in leisure activities
- barriers or contributing factors which inhibit return to leisure, sports and social activities.

A goal-directed, community-based programme aimed at increasing participation in leisure and social activities should be offered to people with TBI who have difficulty undertaking the leisure activities of their choice.

Provide carers with advice on how to maintain their own leisure and social activities while in a caring role.

Discharge from rehabilitation services
Continuous or intermittent input from a rehabilitation team may be appropriate for long periods of time following TBI.

Discharge may be appropriate when:
- there is a wish to exit from a formal rehabilitation programme
- no new achievable goals can be identified.
STATEMENT OF INTENT

Evidence-based practice guidelines are produced to help health practitioners and consumers make decisions about health care in specific clinical situations. Research has shown that, if properly developed, communicated and implemented, guidelines can improve care. This means the guidelines are based on systematic reviews of the medical literature and other rigorous evidence. Where no evidence is available or guidance is needed, recommendations for best practice are developed through a systematic consensus process based on the expertise of clinicians provided internationally.

While guidelines represent a statement of best practice based on the latest available evidence (at the time of publishing), they are not intended to replace the health practitioner’s judgement in each individual case.

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P.O. Box 665, The Terrace, Wellington, New Zealand
Phone +64 4 473 3488, Facsimile +64 4 473 4638
Email: info@nzgg.org.nz
Website: www.nzgg.org.nz > Select "Publications" > "Guidelines" > "Traumatic Brain Injury: Diagnostics, Acute Management and Rehabilitation"

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ACC
P O Box 102, Wellington, New Zealand

www.acc.co.nz
ACC Provider Helpdesk: 0800 222 420
ACC Patents/Claims Helpdesk: 0800 100 396
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