ADULT TRAUMA CLINICAL PRACTICE GUIDELINES

Initial Management of

Closed Head Injury in Adults

NSW@HEALTH
Important notice!

'The Initial Management of Closed Head Injury in Adults' clinical practice guidelines are aimed at assisting clinicians in informed medical decision-making. They are not intended to replace decision-making. The authors appreciate the heterogeneity of the patient population and the signs and symptoms they may present with and the need to often modify management in light of a patient's co-morbidities.

The guidelines are intended to provide a general guide to the management of specified injuries. The guidelines are not a definitive statement on the correct procedures, rather they constitute a general guide to be followed subject to the clinicians judgement in each case.

The information provided is based on the best available information at the time of writing, which is December 2004. These guidelines will therefore be updated every five years and consider new evidence as it becomes available.

These guidelines are intended for use in adults only.

All guidelines regarding pre-hospital care should be read and considered in conjunction with NSW Ambulance Service protocols.
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Algorithm 1 :: Initial management of ‘Adult Closed Head Injuries’

**Initial Management of Adult Closed Head Injuries**

**Initial Assessment and Stabilisation of ABCDE’s**

- Trauma Team activation if initial GCS 3-13 or otherwise indicated

### Severe Head Injury (10%)

- GCS 3-8
  - Early intubation.
  - Supportive care ABCDE’s.
  - Prevent secondary injury.
  - Early CT scan.
  - Early neurological consult.
  - Early retrieval consult if required.
  - Consider ICP monitoring.
  - Anticonvulsants optional.
  - ICU admission.
  - Routine brain injury rehabilitation consult.

**NB.** Minimum supportive care aims to prevent secondary brain injury:

- PaO₂ >60
- SaO₂ >90
- PaCO₂ 35-40
- Systolic BP >90
- Head-up 30°

### Moderate Head Injury (10%)

- GCS 9-13
  - Supportive care ABCDE’s.
  - Prevent secondary injury.
  - Early CT scan.
  - Period of clinical observation.
  - Intubation if required to ensure adequate oxygenation and ventilation or to safely perform CT scan.
  - Early neurological consult if not clinically improving or abnormal CT scan.
  - Early retrieval consult if required.
  - Admit to hospital unless early rapid clinical improvement, normal CT scan and absence of other risk factors as listed below.
  - Consider routine post traumatic amnesia testing and refer to a brain injury rehabilitation service (or neurologist) due to high risk of cognitive behavioural social sequelae.

### Mild Head Injury (80%)

- GCS 14-15
  - Initial period of clinical observation.
  - Assess for risk factors of significant intracranial injury as listed below.
  - CT scan if GCS <15 at 2 hours post injury or if other risk factors present.
  - Admit to hospital if clinically not improving at 4 hours post injury or abnormal CT scan.
  - Consider hospital admission if elderly (>65 years), known coagulopathy (warfarin, alcoholics), intoxicated or socially isolated.
  - Discharge home with head injury advice if 4 hours post injury if clinically improving with either no risk factors or normal CT scan.
  - Refer to local doctor for routine follow up and monitoring of any post concussion symptoms.
  - Consider referral to a brain injury rehabilitation service (or neurologist) if still has post traumatic amnesia after 24 hours or if still has post concussion symptoms after 4 weeks.

**Risk factors indicating potentially significant Mild Head Injury**

- Persistent GCS <15 at 2 hours post injury.
- Depression on GCS.
- focal neurological deficit.
- Clinical suspicion of skull fracture.
- Prolonged loss of consciousness (>5 min).
- Persistent GCS <15 at 2 hours post injury.
- ICU admission.
- Anticonvulsants optional.
- Consider ICP monitoring.
- Early retrieval consult if required.
- Early CT scan.
- Prevent secondary injury.
- Supportive care ABCDE’s.
- Early intubation.

**When should patients with Closed Head Injury be transferred to hospitals with neurological facilities?**

- Potential indications for transfer
  - Patient with severe head injury (GCS 3-8).
  - Patient with moderate head injury (GCS 9-13):
    - clinical deterioration
    - abnormal CT scan
    - normal CT scan but not clinically improving
    - CT scan unavailable.
  - Patient with mild head injury (GCS 14-15): clinical deterioration
    - abnormal CT scan
    - normal CT scan but not clinically improving
    - high risk mild head injury with CT scan unavailable, particularly if:
      - persistent abnormal GCS
      - focal neurological deficit
      - clinical suspicion of skull fracture
      - persistent abnormal mental status, vomiting or severe headache at 4 hours post injury.

**Clinical approach**

- When in doubt consult your regional neurological service.
- Patients with closed head injuries should be observed in facilities that can manage any complications that are likely to arise. Clinical judgment regarding risk of deterioration is required and neurological consultation may be appropriate.
- Patients with closed head injuries should be transferred to the nearest appropriate hospital with neurological facilities if there is significant risk of intracranial injury.
- Transfer of patients to hospitals with CT scan facilities but without neurological services should be avoided.
Algorithm 2 :: Initial management of ‘Adult Mild Head Injury’

**Initial Management of Adult Mild Head Injury**

**Low risk Mild Head Injury**
- All of:
  - GCS 15 at 2 hours post injury.
  - No focal neurological deficit.
  - No clinical suspicion of skull fracture.
  - Brief loss of consciousness (<5 mins).
  - No post traumatic seizure.
  - Mild nausea or single episode of vomiting.
  - Mild headache.
  - No known coagulopathy.
  - Age <65 years.
  - Isolated head injury without dangerous mechanism.
  - No drug or alcohol ingestion.
  - No known neurosurgery / neurological impairment.

**High risk Mild Head Injury**
- Any of:
  - Persistent GCS <15 at 2 hours post injury.
  - Deterioration in GCS.
  - Focal neurological deficit.
  - Clinical suspicion of skull fracture.
  - Prolonged loss of consciousness (>5 mins).
  - Prolonged antegrade / retrograde amnesia (>30 mins).
  - Post traumatic seizure.
  - Persistent abnormal alertness / behaviour / cognition.
  - Persistent vomiting (2 or more occasions).
  - Persistent severe headache.
  - Known coagulopathy (eg warfarin / alcohol).
  - Age >65 yrs.
  - Multi-system trauma.
  - Dangerous mechanism.
  - Clinically obvious drug or alcohol intoxication.
  - Known neurosurgery / neurological impairment.

**Indication for early CT scan and prolonged clinical observation**

- Abnormal alertness / behaviour / cognition.
- Clinically deteriorates or not improving.

**Normal during observation period**
- Clinical observation until at least four hours post time of injury.
  - Normal alertness / behaviour / cognition.
  - Persisting clinical observation.

**Abnormal CT scan**
- CT scan unavailable.
- Consider urgent transfer for CT scanning if:
  - Persistent GCS <15 at 2 hours post injury.
  - Deterioration in GCS.
  - Focal neurological deficit.
  - Clinical suspicion of skull fracture.
  - Persistent abnormal mental status, vomiting or severe headache at 4 hours post time of injury.

**Normal CT scan**
- Clinical observation until at least four hours post time of injury.
  - Normal alertness / behaviour / cognition.
  - Persisting clinical observation.

**Normal CT scan. Clinical symptoms NOT improving at 4 hours post time of injury**

**Normal CT scan. Clinical symptoms improving at 4 hours post time of injury**

**Socially safe for discharge for home observation if**
- Responsible person available to take home and observe.
- Able to return if deteriorates.
- Discharge advice is understood.

**Discharge for home observation and provide written discharge advice.**

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Note – Clinical judgement required
- Age: elderly patients have increased risk of significant intracranial injury and CT scanning unless totally asymptomatic patient with no other risk factors.
- Multi-system trauma into emergency room with unstable vital signs or distracting injuries. Consider intracranial injury.
- CT scan unavailable.
- Consider both intracranial injury and post concussion symptoms and have a low threshold for CT scanning.
What is the definition of Mild Head Injury?

<table>
<thead>
<tr>
<th>DEFINITION</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A patient with an initial GCS score of 14-15 on arrival at hospital following acute blunt head trauma (with or without a definite history of loss of consciousness or amnesia).</td>
<td>III-2</td>
</tr>
<tr>
<td>Typical characteristics</td>
<td></td>
</tr>
<tr>
<td>Direct blow to the head or acceleration / deceleration injury.</td>
<td></td>
</tr>
<tr>
<td>Transient loss of consciousness or amnesia.</td>
<td></td>
</tr>
<tr>
<td>Transient abnormal alertness, behaviour or cognition.</td>
<td></td>
</tr>
<tr>
<td>Neurosurgical intervention rare.</td>
<td></td>
</tr>
<tr>
<td>Post concussion symptoms common.</td>
<td></td>
</tr>
<tr>
<td>Long term functional outcome good.</td>
<td></td>
</tr>
</tbody>
</table>

| Risk stratification | |
| Mild Head Injury may be further sub-classified into ‘High’ and ‘Low’ risk groups, based on the risk of having an intracranial injury requiring neurosurgical intervention. Stratification of ‘high’ and ‘low’ risk of intracranial injury is based on: | III-2 |
| initial GCS on admission and at two hours post injury | |
| the duration of loss of consciousness or amnesia | |
| the presence or absence of other specified risk factors. | |
Clinicians and patients should be aware of both the risk of neurosurgical intervention and the risk of cognitive-behavioural-social sequelae following Mild Head Injury.

Clinicians and patients should also be aware that the absence of a structural lesion on CT scan following Mild Head Injury does not exclude the possibility of significant cognitive-behavioural-social sequelae.

Acute life-threatening complications requiring neurosurgical intervention are rare in Mild Head Injury patients:16,17,19,24-32,47,62

- 'Low risk' Mild Head Injury range 0-3%.
- 'High risk' Mild Head Injury range 0.5-6.5%.

Post concussion symptoms are common in Mild Head Injury patients and may have significant cognitive-behavioural-social impacts on both patients and their families:3,8,9,36,48-52

- Typical post concussion symptoms include:
  - headaches
  - dizziness
  - fatigue
  - memory impairment
  - poor concentration
  - mood swings
  - behavioural changes
  - social dysfunction.

- Up to 50% of patients with Mild Head Injury may have significant post concussion symptoms which can last several weeks.
- About 10% of patients with Mild Head Injury will have persistent disabling post concussion symptoms.
Mild Head Injury patients should have a minimum of hourly observations for four hours post injury. These observations include:
- GCS
- alertness / behaviour / cognition
- pupillary reactions
- vital signs.

Serial neurological observations should be continued on any Mild Head Injury patients who fail to clinically improve at four hours post injury or who are found to have structural lesions requiring hospital admission.7,53

Assessment for post traumatic amnesia (PTA) should be performed on any Mild Head Injury patients who fail to clinically improve at four hours post injury or who are found to have structural lesions requiring hospital admission.3,55

Structured clinical assessment using clinical decision rules can identify those patients at increased risk of intracranial injury requiring further investigation.16,17,19,25,38,39,62

Skull x-rays are not sufficiently sensitive to be used as a routine screening investigation to identify significant intracranial lesions.37

CT scanning is the most appropriate investigation for the exclusion of neurosurgically significant lesions in mild head injured patients.

CT scanning is indicated for those Mild Head Injury patients identified by structured clinical assessment as being at increased risk of intracranial injury.16,17,19,25,38,39,62

If structured clinical assessment indicates the risk of intracranial injury is low, the routine use of CT scanning is neither clinically beneficial nor cost effective.16,17,19,25,38,39

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Head Injury patients should have a minimum of hourly observations for four hours post injury.</td>
<td>III-2</td>
</tr>
<tr>
<td>Serial neurological observations should be continued on any Mild Head Injury patients who fail to clinically improve at four hours post injury or who are found to have structural lesions requiring hospital admission.</td>
<td>III-2</td>
</tr>
<tr>
<td>Assessment for post traumatic amnesia (PTA) should be performed on any Mild Head Injury patients who fail to clinically improve at four hours post injury or who are found to have structural lesions requiring hospital admission.</td>
<td>III-2</td>
</tr>
<tr>
<td>Structured clinical assessment using clinical decision rules can identify those patients at increased risk of intracranial injury requiring further investigation.</td>
<td>III-2</td>
</tr>
<tr>
<td>Skull x-rays are not sufficiently sensitive to be used as a routine screening investigation to identify significant intracranial lesions.</td>
<td>I</td>
</tr>
<tr>
<td>CT scanning is the most appropriate investigation for the exclusion of neurosurgically significant lesions in mild head injured patients.</td>
<td>III-2</td>
</tr>
<tr>
<td>CT scanning is indicated for those Mild Head Injury patients identified by structured clinical assessment as being at increased risk of intracranial injury.</td>
<td>III-2</td>
</tr>
<tr>
<td>If structured clinical assessment indicates the risk of intracranial injury is low, the routine use of CT scanning is neither clinically beneficial nor cost effective.</td>
<td>III-2</td>
</tr>
</tbody>
</table>
Patients with ‘High Risk’ Mild Head Injury requiring CT scan

The following risk factors identify patients with Mild Head Injury (initial GCS 14-15) at increased risk of clinically significant lesions requiring acute neurosurgical intervention or prolonged observation in hospital. These patients should have early CT scanning if available, if they have any of the following features:

Any of...

Initial assessment:
- Persistent GCS <15 at two hours post injury.
- Focal neurological deficit.
- Clinical suspicion of skull fracture.
- Prolonged loss of consciousness (>5 min).
- Prolonged anterograde or retrograde amnesia (>30 min).
- Post traumatic seizure.
- Repeated vomiting (≥2 occasions).
- Persistent severe headache.
- Known coagulopathy.
- Age >65 years (clinical judgment appropriate if no other risk factors present).

After a period of observation (four hours post injury):
- Any deterioration in GCS.
- Persistent abnormal mental status (abnormal alertness, behaviour or cognition).
- Any patient who fails to clinically improve.

Clinical judgment required if:
- age >65 years
- drug or alcohol ingestion
- dangerous mechanism
- multi-system trauma
- known neurosurgery / neurological impairment
- delayed presentation or representation.

**NOTE:** Includes patients with abnormal GCS due to drug or alcohol ingestion.
Patients with ‘Low Risk’ Mild Head Injury not requiring CT scan

The following features indicate patients with Mild Head Injury (initial GCS 14-15) at low risk of clinically significant lesions requiring acute neurosurgical intervention or prolonged observation in hospital. These patients should not routinely have CT scanning if they have all of the following features:

All of...

Initial assessment
- GCS 15 at two hours post injury.
- No focal neurological deficit.
- No clinical suspicion of skull fracture.
- Brief loss of consciousness (<5min).
- Brief anterograde or retrograde amnesia (<30min).
- No post traumatic seizure.
- Mild nausea or single episode of vomiting.
- No persistent severe headache.
- No known coagulopathy.
- Age <65 years.

After a period of observation (four hours post injury)
- Normal mental status including alertness and behaviour and cognition.
- No deterioration during observation.
- Clinically improving.

Clinical judgment required if:
- age >65 years
- drug or alcohol ingestion
- dangerous mechanism
- multi-system trauma
- known neurosurgery / neurological impairment
- delayed presentation or representation.
**SUMMARY OF GUIDELINES**

**What to do with ‘High Risk’ Mild Head Injury patients when CT scan is unavailable?**

<table>
<thead>
<tr>
<th>HEAD INJURY GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘High Risk’ Mild Head Injury patients should be admitted for prolonged hospital observation and considered for transfer for CT scanning. Patients at highest risk of intracranial injury who should be transferred for CT scanning include those with:</td>
<td>III-2</td>
</tr>
<tr>
<td>persistent GCS &lt;15 at two hours post injury.</td>
<td>Consensus</td>
</tr>
<tr>
<td>deterioration in GCS.</td>
<td>Consensus</td>
</tr>
<tr>
<td>focal neurological deficit.</td>
<td>Consensus</td>
</tr>
<tr>
<td>clinical suspicion of skull fracture.</td>
<td>I</td>
</tr>
<tr>
<td>persistent abnormal mental status, vomiting or headache at four hours post injury.</td>
<td>Consensus</td>
</tr>
<tr>
<td>Patients at ‘Highest Risk’ of intracranial injury should be discussed with the regional neurosurgical service and a management plan established.</td>
<td></td>
</tr>
<tr>
<td>If patients are transferred for CT scanning they should ideally be transferred to a hospital with neurosurgical facilities to avoid secondary transfer.</td>
<td></td>
</tr>
<tr>
<td>A skull x-ray may be useful to confirm the presence of a skull fracture that mandates an early CT scan due to the increased risk of deterioration.</td>
<td></td>
</tr>
<tr>
<td>All ‘High Risk’ patients who cannot have CT scanning should at a minimum have prolonged observation in hospital for at least 24 hours and until clinically improving.</td>
<td></td>
</tr>
</tbody>
</table>
When can patients with Mild Head Injury be safely discharged home?

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Head Injury patients can be discharged for home observation after</td>
<td>III-2</td>
</tr>
<tr>
<td>initial period of in-hospital observation if they meet the following</td>
<td></td>
</tr>
<tr>
<td>clinical, social and discharge advice criteria.16,17,19,24,26,27,29,32,</td>
<td></td>
</tr>
<tr>
<td>66,68,69,77-79</td>
<td></td>
</tr>
<tr>
<td>Clinical criteria</td>
<td>III-2</td>
</tr>
<tr>
<td>Normal mental status and behaviour with clinically improving minor</td>
<td></td>
</tr>
<tr>
<td>post concussion symptoms after observation until at least four hours</td>
<td></td>
</tr>
<tr>
<td>post injury.</td>
<td></td>
</tr>
<tr>
<td>No clinical risk factors indicating the need for CT scanning or normal</td>
<td></td>
</tr>
<tr>
<td>CT scan if performed due to risk factors being present.</td>
<td></td>
</tr>
<tr>
<td>No clinical indicators for prolonged hospital observation (irrespective</td>
<td></td>
</tr>
<tr>
<td>of CT scan result) such as:</td>
<td></td>
</tr>
<tr>
<td>– clinical deterioration</td>
<td></td>
</tr>
<tr>
<td>– persistent abnormal GCS or focal neurological deficit</td>
<td></td>
</tr>
<tr>
<td>– persistent abnormal mental status or behaviour</td>
<td></td>
</tr>
<tr>
<td>– persistent severe post concussion symptoms</td>
<td></td>
</tr>
<tr>
<td>– persistent drug or alcohol intoxication</td>
<td></td>
</tr>
<tr>
<td>– presence of known coagulopathy (relative)</td>
<td></td>
</tr>
<tr>
<td>– presence of multi-system injuries (relative)</td>
<td></td>
</tr>
<tr>
<td>– presence of intercurrent medical problems (relative)</td>
<td></td>
</tr>
<tr>
<td>– age &gt;65 (relative)</td>
<td></td>
</tr>
<tr>
<td>Social criteria</td>
<td>Consensus</td>
</tr>
<tr>
<td>Responsible person available to take patient home.</td>
<td></td>
</tr>
<tr>
<td>Responsible person available for home observation.</td>
<td></td>
</tr>
<tr>
<td>Patient able to return easily in case of deterioration.</td>
<td></td>
</tr>
<tr>
<td>Written and verbal discharge advice able to be understood.</td>
<td></td>
</tr>
<tr>
<td>Discharge advice criteria</td>
<td>Consensus</td>
</tr>
<tr>
<td>Discharge summary for local doctor.</td>
<td></td>
</tr>
<tr>
<td>Written and verbal head injury advice given to patient and nominated</td>
<td></td>
</tr>
<tr>
<td>responsible person covering:</td>
<td></td>
</tr>
<tr>
<td>– symptoms and signs of acute deterioration</td>
<td></td>
</tr>
<tr>
<td>– reasons for seeking urgent medical attention</td>
<td></td>
</tr>
<tr>
<td>– typical post concussion symptoms</td>
<td></td>
</tr>
<tr>
<td>– reasons for seeking routine follow up.</td>
<td></td>
</tr>
</tbody>
</table>
### Initial management of ‘Severe Head Injuries’ (GCS 3-8)

**Standard care**

- Initial systematic resuscitation of ABCDE’s.
- Early CT scanning to identify neurosurgically correctable focal intracranial haematomas.
- Prevention of secondary brain injury by avoiding hypoxaemia (oxygen saturation <90%) and hypotension (systolic BP <90).
- Supportive care of ABCDE’s with appropriate attention, posturing (30° head up), basic nursing care and avoidance of hyperventilation.
- Early neurosurgical consult.
- Use of ICP monitoring to guide management of cerebral perfusion pressure in patients with severe brain injury.
- Optional use of anticonvulsants to prevent early post traumatic seizures.
- Routine brain injury rehabilitation consult.
- ICU admission.

**Acute neurological deterioration**

- Resuscitation and stabilisation of ABCDE’s.
- Short term hyperventilation to PaCO₂ 25-30.
- Mannitol 1g/kg IV Bolus.
- Early CT scan with neurosurgical intervention as required.

**Poor prognostic indicators**

- Low GCS (especially motor component).
- Age >60 years (prognosis deteriorates with increasing age).
- Absent pupillary reflexes (after systemic resuscitation).
- Hypotension (systolic BP <90).
- Hypoxaemia (oxygen saturation <90%).
**Initial management of ‘Moderate Head Injuries’ (GCS 9-13)**

**Standard care**

- Initial assessment and resuscitation of ABCDE's.
- Early CT scanning to identify neurosurgically correctable focal intracranial haematomas.
- Period of ED observation.
- Prevention of secondary brain injury by avoiding hypoxaemia (O₂ saturation <90%) and hypotension (systolic BP <90).
- Supportive care of ABCDE's.
- Admit for prolonged hospital observation (24-48 hours) unless rapid clinical improvement, normal CT scan and absence of other risk factors.
- Early neurosurgical consult if not clinically improving and/or abnormal CT scan.
- Routine post traumatic amnesia (PTA) testing.

**Outcome**

- Approximately 80% of moderate head injuries improve while 20% deteriorate and require management as per severe head injuries.
- The majority of patients who suffer moderate head injuries will have some degree of cognitive behavioural social sequelae and should be considered for routine follow up with a brain injury rehabilitation service or a neurologist (see Appendix D of the Adult Trauma Clinical Practice Guideline, Initial Management of Closed Head Injury in Adults).


## SUMMARY OF GUIDELINES

When should patients with Closed Head Injury be transferred to hospitals with neurosurgical facilities?

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with severe head injuries (GCS 3-8).</td>
<td>Consensus</td>
</tr>
<tr>
<td>Patients with moderate head injuries (GCS 9-13) if:</td>
<td>Consensus</td>
</tr>
<tr>
<td>i clinical deterioration</td>
<td></td>
</tr>
<tr>
<td>ii abnormal CT scan</td>
<td></td>
</tr>
<tr>
<td>iii normal CT scan but not clinically improving</td>
<td></td>
</tr>
<tr>
<td>iv CT scan unavailable.</td>
<td></td>
</tr>
<tr>
<td>Patients with mild head injuries (GCS 14-15) if:</td>
<td>Consensus</td>
</tr>
<tr>
<td>i clinical deterioration</td>
<td></td>
</tr>
<tr>
<td>ii abnormal CT scan</td>
<td></td>
</tr>
<tr>
<td>iii normal CT scan but not clinically improving</td>
<td></td>
</tr>
<tr>
<td>iv high risk Mild Head Injury with CT scan unavailable.</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Consult neurosurgical / retrieval service early.
1 Introduction

1.1 Defining closed head injury

This guideline uses the terms ‘closed head injury’ and ‘mild, moderate or severe head injury’ to identify and classify patients on arrival to hospital. The outcome following ‘closed head injury’ will vary from rapid complete recovery to a mixture of structural lesions and functional deficits ranging from trivial to life threatening. Important functional deficits following ‘closed head injury’ range from persistent post concussion symptoms and post traumatic amnesia to a variety of disabling physical-cognitive-behavioural-social sequelae.

As this guideline concentrates on the initial management of the target population it was felt that the term ‘head injury’ was more relevant to the initial clinical presentation than the term ‘traumatic brain injury’ that essentially refers to the subsequent functional outcome. It was also felt that the clinicians at whom this guideline is aimed would be far more familiar and comfortable with using the term ‘head injury.’
1.2 Classification of closed head injury

This guideline has used the ATLS/EMST classification of head injuries based on initial GCS on admission to hospital after initial resuscitation and stabilisation. This classification is widely used clinically and the ATLS/EMST course provides the common language of trauma care throughout the world. This system classifies patients with initial GCS score of 13 in the moderate head injury group due to the patients having similarly patterns of intracranial injury and cognitive behavioural sequelae. The following table is a summary based on the Brain Trauma Foundation and ATLS/EMST data gives a rough guide to classification and outcome.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial GCS</td>
<td>14-15</td>
<td>9-13</td>
<td>3-8</td>
</tr>
<tr>
<td>% of total</td>
<td>80</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Abnormal CT scan (%)</td>
<td>10-15</td>
<td>40-50</td>
<td>90</td>
</tr>
<tr>
<td>Neurosurgical intervention (%) (excluding ICP)</td>
<td>1-3</td>
<td>10-15</td>
<td>40-50</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>&lt;1</td>
<td>10-15</td>
<td>20-80</td>
</tr>
<tr>
<td>Good functional outcome (%)</td>
<td>&gt;90%</td>
<td>50</td>
<td>10-50%</td>
</tr>
</tbody>
</table>

1 Generally the lower the GCS the worse the prognosis.
2 Approximately 10% will have persistent post concussive symptom at three to six months.
3 Outcome deteriorates with increasing age - "children do better and elderly do worse".
2 Methods

The questions are listed below.

1 What is the definition of a Mild Head Injury?
2 What are the clinically important complications of Mild Head Injury?
3 How should patients with Mild Head Injury be assessed?
4 Which patients with Mild Head Injury require a CT scan?
5 What to do with high risk Mild Head Injury patients when CT scan is unavailable?
6 When can patients with mild head injury be safely discharged?
7 What are the proven treatments for patients with moderate to severe head injuries?
8 When should patients with closed head injuries be transferred to hospitals with neurosurgical facilities?

2.1 Scope of the guidelines

The guidelines are intended for use by clinicians managing patients with closed head injuries in major trauma services, regional, urban and rural hospitals. The Initial Management of Closed Head Injury Guidelines are concerned with the initial care of the mild, moderate and severely head injured patient. The guideline will make evidence based recommendations on the diagnosis, resuscitation, and disposal of patients with closed head injuries.

These guidelines however, are not prescriptive nor are they rigid procedural paths. It is recognised that the guidelines may not suit all patients in all clinical situations. The guidelines rely on individual clinicians to decipher the needs of individuals. They aim to provide information on what decisions can be made, rather than dictate what decisions should be made.

2.2 Aims and objectives

The broad objectives of the guidelines are to reduce morbidity and mortality in adult patients with closed head injuries by providing clinicians with practical evidenced based guidelines to assist them in managing such patients. It is also hoped that the guidelines may prevent unnecessary diagnostic tests and hospital admissions especially in the mild head injury group.

At the start of the process of creating the guidelines the clinicians on the Clinical Guidelines Committee posed a series of questions about the initial management of closed head injuries. The nature of the questions reflected the feeling among the clinicians that the greatest needs for guidelines related to the management of mild head injuries and the timing of transfer of patients with closed head injuries from centres with limited resources. The initial management of patients with moderate to severe head injuries was felt to be less controversial.

2.3 Literature Review


Evidence from published studies was obtained from a thorough search of MEDLINE, EMBASE and the Cochrane Database of Systematic Reviews and the Cochrane Library. Relevant articles were hand-searched. A list of search terms used in these databases are listed in Appendix E, p.66.

These databases were searched from 1980 to 30th October 2004 for English language articles that met the following general inclusion and exclusion criteria.
2.4 Inclusion and exclusion criteria

Inclusion criteria
- Meta-analysis, controlled clinical trials
- Closed head injury
- Aged >16 years

Exclusion criteria
- Case, Series, Case reports
- Penetrating head injury
- Aged <16 years

2.5 Assessment of the evidence for strength, size and relevance

2.5.1 Level of evidence

The articles were classified according to their general purpose and study type. From this each article was allocated a level of evidence.

Table 2.1 Levels of evidence

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I</td>
<td>Evidence obtained from a systematic review of all relevant randomised control trials.</td>
</tr>
<tr>
<td>Level II</td>
<td>Evidence obtained from at least one properly-designed randomised control trial.</td>
</tr>
<tr>
<td>Level III-1</td>
<td>Evidence obtained from well-designed pseudo-randomised controlled trials (alternate allocation or some other method).</td>
</tr>
<tr>
<td>Level III-2</td>
<td>Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomised, cohort studies, case-control studies, or interrupted time series with a control group.</td>
</tr>
<tr>
<td>Level III-3</td>
<td>Evidence obtained from comparative studies with historical control, two or more single arm studies or interrupted time series without a parallel control group.</td>
</tr>
<tr>
<td>Level IV</td>
<td>Evidence obtained from a case-series, either post-test or pre-test/post-test.</td>
</tr>
</tbody>
</table>

2.5.2 Quality

The included and excluded articles were appraised according to the NHMRC. The MERGE assessment tool (Liddle, Williamson, and Irwig, 1996) was used. Full text of this document and the checklists (and their criteria) used are available from http://www.health.nsw.gov.au/pubs/a-z.html.

The articles were rated for quality on a 4-point scale as follows:

Table 2.2 Codes for the overall assessment quality of study checklists

<table>
<thead>
<tr>
<th>Risk of bias</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low risk of bias</td>
<td>A</td>
<td>All or most evaluation criteria from the checklist are fulfilled. The conclusions of the study or review are unlikely to alter.</td>
</tr>
<tr>
<td>Low-moderate risk of bias</td>
<td>B1</td>
<td>Some evaluation criteria from the checklist are fulfilled. Where evaluation criteria are not fulfilled or are not adequately described, the conclusions of the study or review are thought unlikely to alter.</td>
</tr>
<tr>
<td>Moderate - High risk of bias</td>
<td>B2</td>
<td>Some evaluation criteria from the checklist are fulfilled. Where evaluation criteria are not fulfilled or are not adequately described, the conclusions of the study or review are thought to alter.</td>
</tr>
<tr>
<td>High risk of bias</td>
<td>C</td>
<td>Few or no evaluation criteria fulfilled. Where evaluation criteria are not fulfilled or adequately described, the conclusion of the study or review are thought very likely to alter.</td>
</tr>
</tbody>
</table>
A patient with an initial GCS score of 14-15 on arrival at hospital following acute blunt head trauma (with or without a definite history of loss of consciousness or amnesia).

Typical characteristics:
- Direct blow to the head or acceleration / deceleration injury.
- Transient loss of consciousness or amnesia.
- Transient abnormal alertness, behaviour or cognition.
- Neurosurgical intervention rare.
- Post concussion symptoms common.
- Long term functional outcome good.

Risk stratification
Mild Head Injury may be further sub-classified into 'High' and 'Low' risk groups, based on the risk of having an intracranial injury requiring neurosurgical intervention. Stratification of 'high' and 'low' risk of intracranial injury is based on:

- initial GCS on admission and at two hours post injury
- the duration of loss of consciousness or amnesia
- the presence or absence of other specified risk factors.

### What is the definition of Mild Head Injury?

#### DEFINITION

A patient with an initial GCS score of 14-15 on arrival at hospital following acute blunt head trauma (with or without a definite history of loss of consciousness or amnesia).

#### LEVEL OF EVIDENCE

III-2

#### Risk stratification

Mild Head Injury may be further sub-classified into 'High' and 'Low' risk groups, based on the risk of having an intracranial injury requiring neurosurgical intervention. Stratification of 'high' and 'low' risk of intracranial injury is based on:

- initial GCS on admission and at two hours post injury
- the duration of loss of consciousness or amnesia
- the presence or absence of other specified risk factors.

#### LEVEL OF EVIDENCE

III-2

### 3.1 Discussion

Recently published studies and guidelines use a variety of criteria to define mild head injury, which itself, is variably referred to as either mild head injury or mild traumatic brain injury.\(^5,6,9,14,16-19,62\) The most common variations concern the initial classification according to GCS and different requirements for loss of consciousness and amnesia (as summarised in Evidence Table 1. Definitions of Mild Head Injury, p.44). This variation in the literature makes comparison between studies difficult.

The main reason for this variability is a uniform desire to identify those patients at higher risk of intracranial injury in what is a heterogeneous but essentially low risk group. There is ample evidence to suggest that patients with an initial GCS of 13 should be considered as part of the moderate head injury group due to the frequency of intracranial lesions (25-38%) and cognitive functional sequelae (see Evidence Table 2. Initial GCS versus abnormal CT/neurosurgery, p.45).\(^24,26,29,31,35\)

Further sub-classification of mild head injury is then dependent on the presence of associated risk factors and different authors have different approaches. The approaches of some of the best quality studies and guidelines are summarised in Evidence Table 1. Definitions of Mild Head Injury, p.44). It is interesting to note that when all the initial GCS criteria, inclusion/exclusion criteria and sub-classification systems are all taken into account, that the findings are very similar. These findings are that mild head injury is a heterogeneous group with patients at higher risk of increased intracranial injury identified by abnormal initial GCS, persistently abnormal GCS, presence of prolonged LOC or amnesia and certain other risk factors.\(^1,6-9,14,16-19,23-46,62\) It is important to recognise that these risk factors for intracranial injury do not necessarily predict the risk of post concussive symptoms which are the more common complication of mild head injury.
Clinicians and patients should be aware of both the risk of neurosurgical intervention and the risk of cognitive-behavioural-social sequelae following Mild Head Injury.

Clinicians and patients should also be aware that the absence of a structural lesion on CT scan following Mild Head Injury does not exclude the possibility of significant cognitive-behavioural-social sequelae.

Acute life-threatening complications requiring neurosurgical intervention are rare in Mild Head Injury patients:16,17,19,24-32,47,62

- 'Low risk' Mild Head Injury range 0-3%.
- 'High risk' Mild Head Injury range 0.5-6.5%.

Post concussion symptoms are common in Mild Head Injury patients and may have significant cognitive-behavioural-social impacts on both patients and their families:3,8,9,36,48-52

- Typical post concussion symptoms include:
  - headaches
  - dizziness
  - fatigue
  - memory impairment
  - poor concentration
  - mood swings
  - behavioural changes
  - social dysfunction.

- Up to 50% of patients with Mild Head Injury may have significant post concussion symptoms which can last several weeks.

- About 10% of patients with Mild Head Injury will have persistent disabling post concussion symptoms.

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinicians and patients should be aware of both the risk of neurosurgical intervention and the risk of cognitive-behavioural-social sequelae following Mild Head Injury.</td>
<td>II</td>
</tr>
<tr>
<td>Acute life-threatening complications requiring neurosurgical intervention are rare in Mild Head Injury patients:16,17,19,24-32,47,62</td>
<td>IV</td>
</tr>
<tr>
<td>Post concussion symptoms are common in Mild Head Injury patients and may have significant cognitive-behavioural-social impacts on both patients and their families:3,8,9,36,48-52</td>
<td>IV</td>
</tr>
</tbody>
</table>
4.1 Discussion

Clinically important complications of mild head injury include both structural lesions and functional deficits. The most important structural lesions to identify are those requiring acute neurosurgical intervention. However, functional deficits resulting in cognitive-behavioural-social sequelae are far more common and may have significant impact on patients and their families. It is important that doctors, patients and their families understand that the absence of a structural lesion on CT scan following a mild head injury does not exclude the possibility of significant cognitive-behavioural-social sequelae.

Acute intracranial haematomas requiring acute neurosurgical intervention are the most dramatic and life threatening complications of mild head injury. The identification of structural lesions requiring acute neurosurgical intervention is the most important function of CT scanning because the presence or absence of other structural lesions does not usually significantly alter outcome. However, multiple studies have shown that these neurosurgically significant lesions are relatively uncommon with incidences of 0.1-3.2% for GCS 15 and 0.5-6.5% for GCS 14 (see Evidence Table 2. Initial GCS versus abnormal CT/neurosurgery, p.45).

Other intracranial injuries and skull fractures are more frequently noted on CT scans but are usually only clinically important as indicators of the potential for clinical complications such as delayed intracranial haematomas, post traumatic seizures and post concussion symptoms.26,36 Delayed acute intracranial haematomas requiring neurosurgical intervention are uncommon following normal CT scans (range <1%).

The clinically important complications of Mild Head Injury suggest that the management priorities should be:

<p>| | |</p>
<table>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>The identification of patients requiring early acute neurosurgical intervention.</td>
</tr>
<tr>
<td>II</td>
<td>The identification of patients requiring admission to hospital due to the increased risk of deterioration from complications.</td>
</tr>
<tr>
<td>III</td>
<td>The identification of patients who can be safely discharged for home observation.</td>
</tr>
<tr>
<td>IV</td>
<td>The provision of discharge advice to allow the identification and early return of patients with unexpected deterioration.</td>
</tr>
<tr>
<td>V</td>
<td>The provision of discharge advice to allow the identification, treatment and follow-up of patients who develop disabling post concussion symptoms.</td>
</tr>
</tbody>
</table>

Post concussion symptoms are common following mild head injury and may have significant cognitive-behavioural-social impact on patients and their families.2,8,36,48-52 Post concussion symptoms have been shown to occur in up to 50% of patients with mild head injury.3,8,36,48-52 Post concussion symptoms include headaches, dizziness, fatigue and cognitive, behavioural and social dysfunction. These symptoms usually resolve within three months, but in about 10% of cases they may persist with significant psychological overlay as post concussion syndrome.3,8,9,36,48,50

The best clinical predictors of post concussion symptoms and functional outcome are initial GCS on admission, duration of loss of consciousness and duration of post traumatic amnesia (PTA).3 If post traumatic amnesia does not persist beyond 24 hours then significant post concussion symptoms are less common.3 The most widely used screening tool for PTA in New South Wales is the Westmead PTA Scale (see Appendix A, p.61).

Evidence Table 5. Post concussive symptoms and Mild Head Injury, p.54 details the most relevant studies relating to recovery from mild head injury and post concussion symptoms. The cognitive-behavioural-social dysfunction caused by mild head injury can be quite disabling, and some researchers have suggested that the severity of impact on lifestyle makes the term ‘mild’ inappropriate for some patients.3,48,49 Patients with significant post concussive symptoms should be referred to a brain injury rehabilitation service or neurologist (see Appendix D, p.65).
5 How should patients with Mild Head Injury be assessed?

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Head Injury patients should have a minimum of hourly observations for four hours post injury.</td>
<td></td>
</tr>
<tr>
<td>These observations include:</td>
<td>III-2</td>
</tr>
<tr>
<td>- GCS</td>
<td></td>
</tr>
<tr>
<td>- alertness / behaviour / cognition</td>
<td></td>
</tr>
<tr>
<td>- pupillary reactions</td>
<td></td>
</tr>
<tr>
<td>- vital signs.</td>
<td></td>
</tr>
<tr>
<td>Serial neurological observations should be continued on any Mild Head Injury patients who fail to clinically improve at four hours post injury or who are found to have structural lesions requiring hospital admission.</td>
<td></td>
</tr>
<tr>
<td>Assessment for post traumatic amnesia (PTA) should be performed on any Mild Head Injury patients who fail to clinically improve at four hours post injury or who are found to have structural lesions requiring hospital admission.</td>
<td></td>
</tr>
<tr>
<td>Structured clinical assessment using clinical decision rules can identify those patients at increased risk of intracranial injury requiring further investigation.</td>
<td></td>
</tr>
<tr>
<td>Skull x-rays are not sufficiently sensitive to be used as a routine screening investigation to identify significant intracranial lesions.</td>
<td></td>
</tr>
<tr>
<td>CT scanning is the most appropriate investigation for the exclusion of neurosurgically significant lesions in mild head injured patients.</td>
<td></td>
</tr>
<tr>
<td>CT scanning is indicated for those Mild Head Injury patients identified by structured clinical assessment as being at increased risk of intracranial injury.</td>
<td></td>
</tr>
<tr>
<td>If structured clinical assessment indicates the risk of intracranial injury is low, the routine use of CT scanning is neither clinically beneficial nor cost effective.</td>
<td></td>
</tr>
</tbody>
</table>
5.1 Discussion
Clinical history and examination remain the basis for the initial assessment of patients with closed head injury. However, additional clinical tools are available to assist in assessment and management. These clinical tools include GCS, serial neurological observation, skull x-rays, CT scanning and clinical decision rules.

5.1.1 Glasgow Coma Scale
The Glasgow Coma Scale (see Appendix C, p.64) was originally developed by Teasdale and Jennett53 for the neurological observation of patients with prolonged coma. It was intended to ensure inter-observer reliability and to identify deterioration of patients over time. Since its original introduction its use has been extended such that it is now the standard tool for assessment of level of consciousness in many clinical settings.

GCS is used both for the initial assessment and classification of closed head injuries and for serial assessment of closed head injuries. Initial GCS on admission to hospital is used to classify head injuries into the broad prognostic groups of mild (GCS 14-15), moderate (GCS 9-13) and severe (GCS 3-8). The Brain Trauma Foundation concluded that there is good quality evidence to relate initial GCS score to outcome.15 However, it must be noted that these are broad outcome measures and initial GCS is only about 75% accurate.15 GCS is unreliable if measured before initial resuscitation and stabilisation of the ABCDE's has been completed.15 Fearnside et al54 identified that both intubation and sedation interfered with accurate assessment of initial GCS in more severely injured patients and there is lack of uniformity of approach to classifying GCS in these situations.

The other significant area of controversy relates to timing of initial GCS. In unstable patients requiring resuscitation, the optimal time to record initial GCS remains controversial.15,54 Similarly, in mild head injury patients the time of presentation related to time of injury will influence the initial GCS and therefore potentially influence clinical decision making in relation to CT scanning.5,9,18,19 Perhaps the most crucial point to note about initial GCS is that it cannot predict outcome for patients with similar GCS scores.

This is particularly important for mild head injury patients because GCS primarily assesses the risk of structural lesions. Subtle cognitive changes are not well discriminated within the mild head injury group. This led to the development of the extended Glasgow Coma Scale that assesses the duration of post traumatic amnesia as a means of identifying patients at increased risk of cognitive problems.55 Thus, a patient with an initial GCS of 14-15 may have no significant injury, long-term cognitive-behavioural dysfunction or a life threatening extradural haematoma. Despite these limitations initial GCS on admission remains the standard method for initial classification of head injuries.

When assessing initial GCS in patients with head injury it is worthwhile considering time of injury. Clearly initial GCS for a given patient may vary depending on time of presentation to hospital. Few studies have related GCS to the time of injury with the exception of Stiell et al19 who found GCS <15 at two hour post injury was a significant predictor of intracranial injury for mild head injury patients.19 Fabbri et al16 showed that most mild head injuries present around one hour post injury. Initial GCS is therefore most likely to overestimate the risk of intracranial injury in mild head injuries who present early.

Prehospital GCS, motor score and return of orientation are other factors to consider when assessing initial GCS. Prehospital GCS was felt to be unreliable15 but with more organised prehospital systems is gaining further attention.15,57 Motor score is the best predictor of outcome of the GCS components.15 Orientation returns most commonly in the sequence of person, place then time.58

The Glasgow Coma Scale is also used as one of the parameters in serial observation of head injury patients. Both the original studies and subsequent studies have validated its use in this fashion and prior to the advent of CT scanning alteration in GCS was the most useful tool in predicting intracranial injury.5,7,55 Currently, serial GCS remains a standard tool in the monitoring of head injuries when CT scanning is unavailable or when clinical symptoms persist despite normal CT scanning.
Summary

- Initial GCS score is useful to classify closed head injuries into broad prognostic groups requiring further assessment.
- The extended GCS which assesses duration of PTA may help identify mild head injury patients at increased risk of post concussion symptoms.
- Serial GCS scores are useful for identifying patients with significant risk of intracranial injury in:
  - patients with an initial abnormal GCS score who fail to improve
  - patients whose initial GCS score deteriorates.
- Initial and serial GCS scores are not as valuable in excluding significant injury in:
  - patients with an initial normal GCS score who remain normal
  - patients with an initial abnormal GCS score who improve.
- Initial GCS should only be used for prognostic purposes after initial resuscitation and stabilisation of ABCDE's.

5.1.2 Serial clinical neurological observations

In mild head injury patients the primary aims of serial neurological observation are the early identification of acute neurological deterioration and the identification and monitoring of persistent mild neurological deficits. Serial neurological observations remain the basic standard of care for the initial management of mild head injury patients and should be used in conjunction with clinical decision rules to determine the need for CT scanning and/or prolonged observation.

Serial neurological observations remain a standard tool for assessing mild head injury patients despite the advent of CT scanning. CT scanning is primarily used to identify structural abnormalities at a given point in time while serial neurological observations are used to monitor clinical conditions over a longer period of time. Serial neurological observations typically consist of hourly pupillary reactions and GCS assessment in conjunction with vital signs. The symmetry of motor responses should be routinely noted as part of the GCS assessment. Neurological assessment should also include qualitative assessment of alertness, behaviour and cognition as this may identify more subtle neurological impairment.

Controversy exists over the appropriate duration of serial neurological observation for both mild head injury patients who are improving and those who have persistent clinical symptoms or abnormalities on CT scan. Although four hours of initial neurological observations post injury are fairly standard following mild head injury, there is little evidence to support this. There is also some debate as to whether the initial period of observation should be until four hours post injury or for four hours following arrival at hospital. Stiell et al. demonstrated that GCS<15 at two hours post injury was one of the most significant risk factors for intracranial injury. Since this guideline has used this important criteria it was felt that the initial clinical observation period should also be based on time post injury. The initial period of neurological observation should therefore be until four hours post time of head injury.

If serial neurological observations are not improving at four hours post injury then clinical decisions need to be made about the need for CT scanning and/or prolonged observation. The period of prolonged observation is also controversial as there is little evidence to support the general recommendation of twenty four hours. This period of observation is derived from limited studies and case reports that show that clinical deterioration is unusual in mild head injury patients after twelve to twenty four hours. The best location for prolonged neurological observation for lower risk patients is also debated because some studies have shown that admission to hospital does not guarantee that regular neurological observation will occur.

Summary

- Serial neurological observations are a useful tool for the early identification of acute neurological deterioration and the identification and monitoring of persistent mild neurological deficits.
- Serial neurological observations should include a minimum of hourly GCS assessment, pupillary reactions and vital signs. Neurological observations should also include qualitative assessment of alertness, behaviour and cognition to detect subtle changes in mental status not assessed by the Glasgow Coma Scale.
- Mild head injury patients should have initial serial neurological observations until four hours post injury at which point decisions about further management should be made.
5.1.3 Post traumatic amnesia (PTA) testing

The assessment of the duration of PTA following mild head injury is the best tool for predicting whether a patient will have significant post concussion symptoms. PTA is most simply defined as that period of time following head injury during which a patient is unable to lay down new memories. While it has been identified that prolonged PTA is a risk factor for significant post concussion symptoms, the standard tool for identifying PTA in NSW, the Westmead PTA Scale (see Appendix A, p.61), is designed to be used over several days. There has been considerable interest in developing bedside PTA screening tools to allow early prediction of which patients are at greatest risk of developing post concussion symptoms. The Extended Glasgow Coma Score and the Modified Westmead PTA Score are examples of tools developed to try to identify persistent PTA in mild head injury patients as a marker for increased risk of post concussion symptoms.

Summary
- The identification of persistent PTA in mild head injury patients is a potentially useful marker for the risk of developing post concussive symptoms.
- PTA testing should be performed on any patient admitted to hospital following mild head injury.

5.1.4 Clinical decision rules

Clinical decision rules are increasingly being used to assist clinicians in determining the need for particular investigations or management. By identifying individual risk factors and combining them to establish clinical decision rules, which are then prospectively validated, useful evidence based diagnostic tools can be established. Well established clinical decision rules also include the NEXUS criteria for cervical spine assessment and the Ottawa Ankle Rules.

Although clinical decision rules are potentially very useful clinicians need to be aware of the specific inclusion/exclusion criteria used to develop them and the overall quality of the original studies before applying them to their patients. Sound clinical decision rules have been developed through review of large cohorts of patients and prospectively applied to patients to determine their sensitivity and specificity.

In recent years a number of attempts have been made to develop clinical decision rules for mild head injuries for both adults and children. The studies aim to identify those patients at increase risk of intracranial injury and develop clinical decision rules about those who require CT scanning or prolonged observation. The main design features of these trials and those of NEXUS II, which is currently in progress, are summarised in Evidence Table 4. Safe discharge of Mild Head Injury, pp.51,14,16,17,19

The main findings of other studies examining the accuracy of certain risk factors are summarised in Evidence Table 3. Risk factors for intracranial injury in Mild Head Injury, p.46.

The most consistent findings of these studies are that abnormal initial GCS or mental status, clinical suspicion of skull fracture and focal neurological deficit are the best predictors of risk of intracranial injury. Loss of consciousness, amnesia, vomiting, headache and seizure are also relevant predictors of risk. Depending on their inclusion / exclusion criteria the authors used combinations of those risk factors to derive clinical decision rules of varying sensitivity and specificity (see Evidence Table 3. Risk factors for intracranial injury in Mild Head Injury, p.46).

At present, the findings of Haydel et al17 have been adopted as an ACEP policy whilst the findings of Stiell et al19 have been adopted by the NICE guidelines (UK). A recent Australian study looked at applying the clinical decision rules developed by Haydel et al17 and Stell et al19 to Australian practice and concluded that both had limitations.61 The NEXUS II study which intends to enrol the largest patient groups yet, is likely to provide the most definitive clinical decision rule once completed.

In a recent study Ibanez et al62 attempted to prospectively identify clinical risk factors predicting intracranial injury and to assess the reliability of previously published clinical guidelines. They found that while clinical risk factors could not detect all intracranial injuries they could be used to detect clinically relevant lesions with a negative predictive power approaching 99%. They concluded clinicians should be aware of the limitations of clinical decision rules when using clinical guidelines.

Summary
- Clinical decision rules provide useful adjuncts to the assessment and management of mild head injury patients.
- Studies by Haydel et al17 and Stiell et al19 have provided evidence based clinical decision rules for mild head injury in adults.
5.1.5 Skull x-rays

The literature clearly identifies that both the clinical suspicion of skull fractures and the radiological evidence of skull fracture are significant risk factors for the presence of an intracranial lesion requiring neurosurgical intervention.\textsuperscript{5,16,17,19,27,37}

If CT scanning is available, the current indications for skull x-rays are few. However, if CT scanning is unavailable, the role of skull x-rays as a screening test is less clear. A detailed meta analysis by Hofman et al\textsuperscript{37} concluded that whilst the presence of skull fracture greatly increased the risk of intracranial injury, the absence of a skull fracture did not rule it out (calculated sensitivity 38\% calculated specificity 95\%). In subsequent clinical guidelines, authors have differed as to whether skull x-rays should be used to detect patients at higher risk of intracranial injury. Jagoda et al\textsuperscript{7} argued that the sensitivity of skull x-ray is not sufficient to be used as a screening test. Vos et al\textsuperscript{6} and Servadei et al\textsuperscript{6} felt that in the absence of CT scanning, a positive skull x-ray can be useful to help allocate patients into higher risk groups for management purposes. On existing evidence, both approaches seem reasonable depending on local management guidelines.

Summary

\begin{itemize}
\item Clinical evidence or suspicion of skull fracture is associated with increased risk of intracranial injury.
\item Skull x-rays are not sufficiently sensitive to be used as a routine screening test to identify patients at increased risk of intracranial injury.
\item Where CT scanning is unavailable, skull x-ray may be used as an adjunct to identify patients at greater risk of intracranial injury (but not to exclude intracranial injury).
\end{itemize}

5.1.6 CT scanning

The widespread availability of CT scanning has greatly assisted the management of patients with head injuries. CT scanning has been particularly useful in identifying focal injuries in patients with altered level of consciousness. CT scanning is regarded as mandatory for all head injury patients with an initial or persistent altered level of consciousness. However, the role of the CT scanning in a patient with mild head injury with a normal level of consciousness remains controversial. Particular concerns about the routine use of CT scanning for mild head injury include the financial-resource burden, the potential hazards of radiation and the potential pitfalls of reliance on technology at the expense of clinical assessment.\textsuperscript{20,36,47,63-65}

Furthermore CT scans do not identify patients who have cognitive dysfunction which is the most significant complication for most patients. The various pros and cons of CT scanning are summarised below:

\begin{itemize}
\item **Pros**
\item Early identification of patients with intracranial injuries requiring acute neurosurgical intervention (see Evidence Table 3. Risk factors for intracranial injury for Mild Head Injury, p.46 and Evidence Table 4. Safe discharge of Mild Head Injury, p.51).
\item Early identification of patients with other intracranial injuries requiring admission to hospital due to risk of deterioration (see Evidence Table 1. Risk factors for intracranial injury for Mild Head Injury, p.46 and Evidence Table 4. Safe discharge of Mild Head Injury, p.51).
\item Identification of patients at low risk of deterioration and suitable for discharge (see Evidence Table 4. Safe discharge of Mild Head Injury, p.51).
\item Identification of patients with structural lesions indicating increased risk of post concussive symptoms.\textsuperscript{36}
\item Potential cost benefit due to early CT scanning allowing discharge home rather than hospital admission in some patients.\textsuperscript{63}
\end{itemize}

\begin{itemize}
\item **Cons**
\item Routine use of CT scanning for mild head injury has a huge financial and resource impact given that more than 90\% of scans are negative and less than 1\% of scans indicate the need for neurosurgical intervention.\textsuperscript{14,19}
\item Patients may develop focal neurological lesions (especially subdurals) despite initial normal CT scanning.\textsuperscript{54,55,67}
\item Early CT scans may not demonstrate intra-cerebral contusions which take time to become apparent on CT scanning.
\item CT scanning will not demonstrate diffuse axonal injury in most patients.\textsuperscript{3}
\item Patients may suffer significant post concussive symptoms despite an initial normal CT scan.\textsuperscript{3,38,48-50}
\item Routine use of CT scanning does not guarantee better identification of significant intracranial injuries if different institutions are compared.\textsuperscript{52,53}
\item The risk of cumulative radiation exposure especially among children is of concern.\textsuperscript{54,65}
\item May delay definitive management of more significant injuries in multi system trauma patients.
\end{itemize}
Timing of CT scanning
There is no direct evidence to confirm what the best time to perform CT scanning in relation to time of injury is. The primary role of early CT scanning in mild head injury is early recognition of extradural haematomas prior to clinical deterioration. Early neurosurgical intervention prior to clinical deterioration is associated with improved outcome. However, early CT scan may potentially miss other intracranial injuries such as subdural or contusions which are slower to become evident. Fortunately, most studies have shown that an initial normal CT scan allows safe discharge and that the few patients who deteriorate usually have good outcome. Therefore, it is reasonable to suggest that CT scans should be performed shortly after a decision is made that one is necessary.

Summary
- CT scanning is the best investigation for the early identification of neurosurgically significant focal intracranial lesions following mild head injury.
- Early CT scanning may not demonstrate some subdural haematomas and cerebral contusions.
- CT scanning should be used as an adjunct to clinical assessment.
- CT scanning does not accurately predict the risk of post concussion symptoms in mild head injury patients.
- Where clinical assessment indicates the risk of significant intracranial lesion is low, the routine use of CT scanning is unlikely to be of benefit.
### Which patients with Mild Head Injury require a CT scan?

**GUIDELINE**

<table>
<thead>
<tr>
<th>Patients with ‘High Risk’ Mild Head Injury requiring CT scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>The following risk factors identify patients with Mild Head Injury (initial GCS 14-15) at increased risk of clinically significant lesions requiring acute neurosurgical intervention or prolonged observation in hospital. These patients should have early CT scanning if available, if they have any of the following features:</td>
</tr>
<tr>
<td><strong>Any of...</strong></td>
</tr>
<tr>
<td>Initial assessment</td>
</tr>
<tr>
<td>☐ Persistent GCS &lt;15 at two hours post injury.</td>
</tr>
<tr>
<td>☐ Focal neurological deficit.</td>
</tr>
<tr>
<td>☐ Clinical suspicion of skull fracture.</td>
</tr>
<tr>
<td>☐ Prolonged loss of consciousness (&gt;5min).</td>
</tr>
<tr>
<td>☐ Prolonged anterograde or retrograde amnesia (&gt;30min).</td>
</tr>
<tr>
<td>☐ Post traumatic seizure.</td>
</tr>
<tr>
<td>☐ Repeated vomiting (&gt;2 occasions).</td>
</tr>
<tr>
<td>☐ Persistent severe headache.</td>
</tr>
<tr>
<td>☐ Known coagulopathy.</td>
</tr>
<tr>
<td>☐ Age &gt;65 years (clinical judgment appropriate if no other risk factors present).</td>
</tr>
<tr>
<td>After a period of observation (four hours post injury)</td>
</tr>
<tr>
<td>☐ Any deterioration in GCS.</td>
</tr>
<tr>
<td>☐ Persistent abnormal mental status (abnormal alertness, behaviour or cognition).</td>
</tr>
<tr>
<td>☐ Any patient who fails to clinically improve.</td>
</tr>
<tr>
<td>Clinical judgment required if:</td>
</tr>
<tr>
<td>☐ age &gt;65 years</td>
</tr>
<tr>
<td>☐ drug or alcohol ingestion</td>
</tr>
<tr>
<td>☐ dangerous mechanism</td>
</tr>
<tr>
<td>☐ multi-system trauma</td>
</tr>
<tr>
<td>☐ known neurosurgery / neurological impairment</td>
</tr>
<tr>
<td>☐ delayed presentation or representation.</td>
</tr>
</tbody>
</table>

**NOTE:** Includes patients with abnormal GCS due to drug or alcohol ingestion.

---

**LEVEL OF EVIDENCE**

III-2
6 WHICH PATIENTS WITH MILD HEAD INJURY REQUIRE A CT SCAN?

GUIDELINE

Patients with ‘Low Risk’ Mild Head Injury not requiring CT scan

The following features indicate patients with Mild Head Injury (initial GCS 14-15) at low risk of clinically significant lesions requiring acute neurosurgical intervention or prolonged observation in hospital. These patients should not routinely have CT scanning if they have all of the following features:

All of...

Initial assessment

- GCS 15 at two hours post injury.
- No focal neurological deficit.
- No clinical suspicion of skull fracture.
- Brief loss of consciousness (<5min).
- Brief anterograde or retrograde amnesia (<30min).
- No post traumatic seizure.
- Mild nausea or single episode of vomiting.
- No persistent severe headache.
- No known coagulopathy.
- Age <65 years.

After a period of observation (four hours post injury)

- Normal mental status including alertness and behaviour and cognition.
- No deterioration during observation.
- Clinically improving.

Clinical judgment required if:

- Age >65 years
- Drug or alcohol ingestion
- Dangerous mechanism
- Multi-system trauma
- Known neurosurgery / neurological impairment
- Delayed presentation or representation.
6.1 Discussion

Mild head injury patients (initial GCS 14-15) require a CT scan if they are clinically assessed as being at significant risk of acute deterioration from an underlying intracranial injury. The clinical risk factors that indicate patients are at increased risk of intracranial injury are discussed in the following text, and most of the relevant studies summarised in the evidentiary tables. The absence of clinical risk factors on initial assessment combined with a period of observation during which the patients clinically improves makes the probability of a significant intracranial injury extremely unlikely. These low risk mild head injury patients can be discharged for home observation without CT scanning. In the high risk group, which includes initially low risk patients who fail to clinically improve, both CT scanning and prolonged clinical observation are indicated.

Early CT scanning allows identification of acute intracranial haematomas requiring urgent neurosurgical intervention and other structural lesions that put the patient at increased risk of deterioration from complications such as delayed intracranial haematomas, raised intracranial pressure, post traumatic seizures, Syndrome of Inappropriate Antidiuretic Hormone (SIADH) and disabling post concussive symptoms. However it is important to recognise that the absence of a structural lesion on CT scan does not exclude the possibility of significant post concussion symptoms.

Patients with an abnormal CT scan should be admitted for prolonged observation in hospital. Conversely, a normal CT scan makes acute clinical deterioration highly unlikely and allows safe discharge for home observation as long as the patient is clinically improving. It is important to stress that CT scanning should be used as a clinical tool in conjunction with clinical assessment and observation as part of an overall management strategy for mild head injury patterns.

### Individual factors predicting risk of intracranial injury and therefore the need for CT scanning in patients with mild head injury:

#### 6.1.1 Initial GCS

A persistent GCS <15 at two hours post injury is an absolute indication for CT scanning. An initial GCS <15 is a relative indication for CT scanning.

Several studies have noted the heterogeneity of the original GCS 13-15 mild head injury classification and these findings are summarised in Evidence Table 2. Initial GCS versus abnormal CT/neurosurgery, p.45. Patients with an initial GCS 13 have been shown to have similar rates of intracranial injury to those with initial GCS 9-12.24,25 Although patients with initial GCS 14-15 have lower rates of intracranial injury as a group, the more recent studies16,17,19 have confirmed a higher risk of intracranial injury for initial GCS 14. This higher risk of intracranial injury for initial GCS 14 does not take into account either associated risk factors nor the time of injury.

A number of recent, well designed studies have attempted to identify risk factors which can predict which patients with initial GCS 14-15 are at highest risk.16,17,19 The evidence would suggest that other risk factors can be used to stratify risk within the initial GCS 14-15 group.

Perhaps the most relevant finding to clinical practice is that of Stiell et al [19] who showed that for patients with an initial GCS 13-15 that GCS <15 at two hours post injury was a useful predictor of risk of intracranial injury. By applying this criteria, both time of injury and GCS are usefully combined in a clinically practical assessment tool.

#### 6.1.2 Focal neurological deficits

Focal neurological deficits have been shown to significantly increase the risk of intracranial injury.16,18,19,31 Both Haydel et al17 and Stiell et al19 excluded focal neurological deficits in their studies due to the previously proven nature of risk. Conversely Vilke et al45 showed that a normal neurological examination does not rule out underlying brain injury in mild head injuries.
Clinical suspicion or evidence of skull fracture has been shown to be a significant risk factor for intracranial injury. The meta analyses by Hofman et al [37] showed that the x-ray presence of skull fracture had a specificity of 95% for intracranial injury. Clinical suspicion or evidence of skull fracture has been shown by several authors including Stiell et al [19], Haydel et al [17] and Palchek et al [18] to be a major risk factor for the presence of intracranial injury. Clinical suspicion of open, depressed or base of skull fractures is based on the presence of large scalp lacerations or haematomas (especially in children <2 years), obvious skull depression, and base of skull signs such as raccoon eyes, haemotympanum, Battle’s sign, or CSF leak. The presence of significant facial fracture may also indicate the possibility of skull fracture.

### 6 WHICH PATIENTS WITH MILD HEAD INJURY REQUIRE A CT SCAN?

#### 6.1.3 Skull fractures

**GUIDELINE**

Clinical suspicion or evidence of skull fracture is an absolute indication for CT scanning.

17, 19, 27, 29, 30, 31, 34, 37, 38, 47, 62, 71

Clinical suspicion or evidence of skull fracture has been shown to be a significant risk factor for intracranial injury and is used by many authorities to define mild head injury (See Evidence Table 1. Definitions of Mild Head Injury, p.44).

#### 6.1.4 Loss of consciousness

**GUIDELINE**

Brief loss of consciousness (<5 minutes) should not be considered an independent indication for CT scan. Prolonged loss of consciousness (>5 minutes) should be considered a strong indication for CT scanning.

1, 6, 16-18, 27, 33, 39-44

Loss of consciousness increases the risk of intracranial injury and is used by many authorities to classify patients as ‘minimal risk’. The absence of loss of consciousness or amnesia has been used to classify patients as ‘minimal risk’. The absence of loss of consciousness has been shown not to rule out intracranial lesions in children. Similarly, adult studies have shown that transient LOC does not accurately predict the risk of intracranial injury. Duration of loss of consciousness is also controversial. ‘Brief’ loss of consciousness in mild head injury patients is usually associated with good functional outcome while ‘prolonged’ loss of consciousness is not clearly associated with poorer outcome. However, the exact definitions of what should be considered a low-risk duration vary greatly from momentary to five minutes, to 20 minutes to 30 minutes. From a practical viewpoint obtaining a definite history and duration of loss of consciousness is often difficult. Head injuries are frequently unwitnessed, observers unreliable and patients often affected by alcohol. It is perhaps simplest to consider loss of consciousness in terms of no loss of consciousness, brief loss of consciousness less than five minutes, prolonged loss of consciousness greater than five minutes or unreliable history. The clinical recommendation of the neurological committee of the Royal Australasian College of Surgeons (RACS) is that loss of consciousness should be considered brief if less than five minutes.

#### 6.1.5 Amnesia

**GUIDELINE**

Persistent anterograde or retrograde amnesia of greater than 30 minutes duration mandates CT scanning. Amnesia for the event does not warrant CT scanning.

16, 17, 18, 27

The presence of amnesia is associated with higher risk of intracranial injury and recent studies have established certain durations as significant. Amnesia for the event implies transient neurological dysfunction and indicates mildly increased risk of intracranial injury although the absolute risk remains small.27 Retrograde amnesia (defined as the period of loss of memory prior to the event) has been shown by Stiell et al19 to be of significance if greater than 30 minutes duration. Duration of anterograde amnesia or post traumatic amnesia (the period of inability to lay down new memories post event) has been shown to be associated with both risk of intracranial injury and cognitive – behavioural sequelae.5, 17, 18
Haydel et al identified short term memory deficit (a surrogate for PTA) as a significant risk factor for intracranial injury. Post traumatic amnesia that persists for more than 24 hours has been shown to be a significant risk factor for persistent cognitive-behavioral-social dysfunction. Stiell et al also identified anterograde amnesia of more than 30 minutes as a risk factor but did not include it in their clinical decision rule.

From a practical point of view, any patient with persistent anterograde or retrograde amnesia for more than 30 minutes should be considered at higher risk. It is useful to assess the patients recall of events following their injury by asking specific questions such as what is their first clear memory, who helped them at the scene and how they got to hospital. This can be used to estimate the period of anterograde amnesia. A simple memory assessment technique such as three object recall can be used as a bedside screening test for anterograde amnesia, to supplement the 'history' of amnesia for events.

6.1.4 Post traumatic seizure

**GUIDELINE**

Post traumatic seizures are an indication for CT scanning.

Brief generalised post traumatic seizures are common immediately following mild head injury and are not usually associated with poor outcome. They are frequently seen on sporting fields and in young children. Prolonged, delayed or focal post traumatic seizures are more likely to be associated with significant intracranial injury. However, most mild head injury studies do not differentiate between types of seizures when assessing risk factors for intracranial injury. Most published guidelines have identified any post traumatic seizures as risk factors warranting routine CT scanning.

6.1.5 Vomiting

**GUIDELINE**

Persistent or recurrent vomiting is an indication for CT scanning.

Vomiting has been identified as a significant risk factor for intracranial injury in many studies. There has been some debate whether persistent vomiting is more relevant than isolated vomiting. Stiell et al identified repeated vomiting (more than one occasion) as being a significant risk factor.

6.1.6 Headache

**GUIDELINE**

Persistent severe headache is an indication for CT scanning.

Many studies have identified headache as a significant risk factor for intracranial injury. The general trend of the literature would suggest that persistent moderate to severe headache should be considered a significant risk factor.
6 WHICH PATIENTS WITH MILD HEAD INJURY REQUIRE A CT SCAN?

6.1.7 Coagulopathy

**GUIDELINE**

Known coagulopathy is both an indication for CT scan and also an indication to consider prolonged hospital observation.6-9,16,17,19,72

Most guidelines and studies on mild head injury mention coagulopathy either as a significant risk factor or an exclusion criteria in the assessment of risk of intracranial injury6-9,16,17,19. However, there is no compelling evidence to either support or refute this reasonable assertion in the mild head injury patient group.

Mina et al72 demonstrated that pre-existing anticoagulation significantly increased the risk of death from intracranial injury in trauma patients with head injury. However, this was a heterogenous patient group with significantly abnormal ISS (mean 17.0 +/- 7.8) and GCS (mean 11.8 +/- 4.0).

6.1.8 Age

**GUIDELINE**

Patient age >65 years is a relative indication for CT scanning. Clinical judgment may be used in an asymptomatic patient age >65 years if no other risk factors are present.6,16,17,19,24,30,31

Extremes of age have been shown to be associated with increased risk of intracranial injury. The paediatric literature identifies young children (age <5 years and particularly <2 years) as being at increased risk of intracranial injury due to a combination of communication difficulties, non-accidental injury, anatomical considerations and the lack of localising clinical signs and symptoms.18,73

Several published studies have shown that there is an increased risk of intracranial injury for patients aged over 60-65 years with mild head injury.17,19,24,30,31 In particular, both Haydel et al17 and Stiell et al19 included age >60-65 years as indicators of the need for CT scan. Mack et al74 recommended routine head CT for elderly patients suffering mild head injury as they could not identify any useful predictors of intracranial injury in the elderly. The Brain Trauma Foundation concluded that ‘increasing age is a strong independent factor in prognosis, with significant increase in poor outcome above 60 years of age’ for patients with severe head injuries.15 Similarly Williams et al75 demonstrated that elderly patients were more likely to sustain complications of mild head injury. Although there is no doubt advanced age is a risk factor for mild head injury, there are practical difficulties in applying this to the general population. As Servadei et al6 have pointed out it is unlikely there is a specific age at which risk of intracranial injury dramatically increases. Fabbri et al16 found that using age >60 years alone to predict the need for CT scanning in patients with mild head injury was impractical from a cost-resource consideration during a study to validate a set of guidelines. Interestingly, of the 705 patients meeting guidelines criteria for CT scanning based on age >60 years alone (who did no have CT scans) Fabbri et al found that only one patient deteriorated within 48 hours. From a practical viewpoint extremes of age need to be recognised as risk factors for intracranial injury. Whether all patients age >60 years with mild head injury should have CT scans based on age alone remains controversial. It is worth noting that the NSW Institute of Trauma and Injury Management Trauma Death Review Committee has identified that in 2003 / 2004 elderly NSW patients with head injuries represented a significant number of potentially preventable deaths.75
6.1.9 Abnormal mental status

**GUIDELINE**

Persistent abnormal mental status manifested by drowsiness, abnormal behaviour or cognitive impairment is an indication for CT scanning.\(^{17-19,28,32,39,70}\)

Although initial GCS partially assesses mental status it primarily addresses level of consciousness. Clinical observation of alertness, behaviour and cognition will detect more subtle changes in mental status than GCS and should be part of routine neurological observation. Abnormal alertness, abnormal behaviour and cognitive impairment have also been shown to be associated with intracranial injury \(^{17-19}\). Abnormal alertness or behaviour and cognitive impairment requires careful observation by staff and relatives and is particularly important in children or adults with pre-existing neurological impairment. In patients with pre-existing neurological conditions a lower threshold for CT scanning is appropriate \(^{6, 62}\).

6.1.10 Drug or alcohol intoxication

**GUIDELINE**

Drug or alcohol ingestion with a normal mental state is not an indication for CT scanning. Drug or alcohol intoxication resulting in an abnormal mental state is an indication for CT scanning.\(^{16,17,19,23}\)

Drug or alcohol intoxication is frequently present in patients with head injuries and makes patients difficult to assess and manage. Cook et al.\(^{23}\) in a study of alcohol intoxicated patients found that clinical examination could not predict which alcohol intoxicated patients had abnormal CT scans. However, they observed that the rate of abnormal CT scan and neurosurgical intervention was similar to that of the non-intoxicated mild head injury population. Several studies have shown that drug or alcohol intoxication is a risk factor for intracranial injury but the exact definition of intoxication remains vague.\(^{16-17}\)

Stiell et al.\(^{19}\) took a different approach and used GCS \(<15\) at two hours post injury as their variable to predict abnormal mental status for whatever reason. They argued that drug or alcohol intoxication was not an independent predictor of intracranial injury if the patient had a normal mental status at two hours post injury. From a practical viewpoint, clinically obvious drug or alcohol intoxication should be treated as a risk factor for intracranial injury because it manifests as abnormal mental status which impairs clinical assessment and must be assumed to be due to intracranial injury.

6.1.11 Dangerous mechanisms of injury

**GUIDELINE**

In the absence of other risk factors, dangerous mechanism is only a relative indication for CT scan. Clinical judgment is required.\(^{19,30,31,46}\)

Epidemiological studies have generally identified motor vehicle accidents, falls and assaults as the commonest causes of head injuries. In studies on patients with mild head injuries, specific high risk factors for intracranial injury that have been identified include assault,\(^{20,46}\) pedestrians or cyclists struck by motor vehicles\(^{19,30,31}\) and falls >1m.\(^{19}\)
6.1.11 Multi-system trauma

**GUIDELINE**
In mild injury patients with multi-system trauma clinical judgement is required regarding the need for CT scanning.

Most guidelines and studies on mild head injury have specifically excluded patients with multi-system trauma or unstable vital signs. It is therefore difficult to make evidence based recommendations and clinical judgment is required. A relatively low threshold for performing head CT scan in multi-system trauma patients should be used as subtle signs of neurological deficit are easily missed in the presence of distracting injuries.

6.1.12 Pre-existing neurosurgery / neurological impairment

**GUIDELINE**
Pre-existing neurosurgery or neurological impairment is a relative indication for CT scanning [6, 62].

Pre-existing neurosurgery has been suggested as an indication for CT scanning particularly in the presence of hydrocephalus and shunt placement. The World Federation of Neurosurgical Societies guideline recommended routine CT scanning for patients with either previous neurosurgery or epilepsy. From a practical viewpoint any pre-existing medical condition resulting in neurological impairment (eg stroke, dementia, and developmental delay) may make clinical assessment difficult.

6.1.13 Presentation

Although mild head injuries are very common it is thought that the majority do not present to hospital. Therefore, those that do present to hospital are already a group at slightly increased risk. Of particular concern are those who have a delayed presentation due to persistence of symptoms or those who represent because of ongoing or new symptoms.

However, as Fabbri et al showed the overall risk of intracranial injury in patients who represent after mild head injuries is low if their initial risk was low.

6.1.14 Unwitnessed event / unreliable history

A good history of injury may help predict risk of intracranial injury by identifying dangerous mechanism of injury or significant features such as prolong loss of consciousness or seizures. This is of particular importance in children. However, in the absence of other significant risk factors there are few studies identifying unwitnessed event or unreliable history as a significant independent risk factor.
### What to do with ‘High Risk’ Mild Head Injury patients when CT scan is unavailable?

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘High Risk’ Mild Head Injury patients should be admitted for prolonged hospital observation and considered for transfer for CT scanning. Patients at highest risk of intracranial injury who should be transferred for CT scanning include those with: persistent GCS &lt;15 at two hours post injury, deterioration in GCS, focal neurological deficit, clinical suspicion of skull fracture, persistent abnormal mental status, vomiting or headache at four hours post injury.</td>
<td>III-2</td>
</tr>
<tr>
<td>Patients at ‘Highest Risk’ of intracranial injury should be discussed with the regional neurosurgical service and a management plan established.</td>
<td>Consensus</td>
</tr>
<tr>
<td>If patients are transferred for CT scanning they should ideally be transferred to a hospital with neurosurgical facilities to avoid secondary transfer.</td>
<td>Consensus</td>
</tr>
<tr>
<td>A skull x-ray may be useful to confirm the presence of a skull fracture that mandates an early CT scan due to the increased risk of deterioration.</td>
<td>1</td>
</tr>
<tr>
<td>All ‘High Risk’ patients who cannot have CT scanning should at a minimum have prolonged observation in hospital for at least 24 hours and until clinically improving.</td>
<td>Consensus</td>
</tr>
</tbody>
</table>

#### 7.1 Discussion

In patients with high risk mild head injury, a normal CT scan combined with clinical assessment will allow the patient to be safely discharged for home observation. If CT scan is unavailable then the patient will require either admission for prolonged observation or early transfer for CT scanning depending on clinical assessment of risk. Prolonged clinical observation for at least 24 hours, associated with clinical improvement, has been shown to make a significant injury unlikely in the majority of mild head injury patients. However, those patients at highest risk for an intracranial injury identified by persistently abnormal GCS or mental status, deterioration in GCS, focal neurological deficit, or clinical suspicion of skull fracture should be transferred for CT scan to allow the early identification of potentially neurosurgically significant injury.
8 When can patients with Mild Head Injury be safely discharged home?

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild Head Injury patients can be discharged for home observation after initial period of in-hospital observation if they meet the following clinical, social and discharge advice criteria</td>
<td>III-2</td>
</tr>
</tbody>
</table>

**Clinical criteria**
- Normal mental status and behaviour with clinically improving minor post concussion symptoms after observation until at least four hours post injury.
- No clinical risk factors indicating the need for CT scanning or normal CT scan if performed due to risk factors being present.
- No clinical indicators for prolonged hospital observation (irrespective of CT scan result) such as:
  - clinical deterioration
  - persistent abnormal GCS or focal neurological deficit
  - persistent abnormal mental status or behaviour
  - persistent severe post concussion symptoms
  - persistent drug or alcohol intoxication
  - presence of known coagulopathy (relative)
  - presence of multi-system injuries (relative)
  - presence of intercurrent medical problems (relative)
  - age >65 (relative).

**Social criteria**
- Responsible person available to take patient home.
- Responsible person available for home observation.
- Patient able to return easily in case of deterioration.
- Written and verbal discharge advice able to be understood.

**Discharge advice criteria**
- Discharge summary for local doctor.
- Written and verbal head injury advice given to patient and nominated responsible person covering:
  - symptoms and signs of acute deterioration
  - reasons for seeking urgent medical attention
  - typical post concussion symptoms
  - reasons for seeking routine follow up.

**GUIDELINE LEVEL OF EVIDENCE**
- Consensus
8.1 Discussion

Mild head injury patients can be safely discharged from hospital for home observation when the risk of acute deterioration from an underlying intracranial injury is assessed as being low. Safe discharge also requires that the patient has adequate social supports and appropriate advice on when to return to hospital.

The duration of in-hospital observation required will be determined by clinical assessment combined with selective use of imaging. Deterioration following mild head injury may occur due to missed or delayed intracranial haematomas or other complications such as SIADH, post traumatic seizures or severe post concussive symptoms. Although clinical assessment and observation combined with appropriate imaging will identify most at risk patients, the risk of deterioration is never zero. Although uncommon, deterioration may occur even after prolonged periods of observation and/or following normal CT scanning. The challenge of managing mild head injuries is to identify what is reasonable risk and to ensure that the patient is aware of the potential for delayed deterioration.

The mild head injury management algorithm summarises the key points in management relating to safe discharge and Evidence Table 4. Safe discharge of Mild Head Injury, p.51 present some of the significant studies relating to safe discharge. Mild head injury patients should essentially be divided into low and high risk groups based on clinical assessment. Low risk mild head injury patients can be discharged for home observation after a short period of observation in hospital if clinically improving. High risk patients require CT scanning and/or prolonged observation. High risk patients with clinically important abnormalities on CT scan require admission for prolonged observation. High risk patients with normal CT scanning should also be admitted for prolonged observation unless rapid clinical improvement occurs. In both high and low risk mild head injury patients’ potential clinical indications for admission such as intercurrent medical problems and injuries need to be considered. Whatever the period of observation selected, the provision of safe discharge advice and assessment of the patients social situation is mandatory because occasional cases of deterioration following discharge are unavoidable. An example of a suitable head injury discharge advice sheet is attached in Appendix C, p.63.
9 What are the proven treatments for patients with ‘Moderate’ to ‘Severe’ Head Injuries?

<table>
<thead>
<tr>
<th>GUIDELINE</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial management of ‘Severe Head Injuries’ (GCS 3-8)</td>
<td>III-2</td>
</tr>
<tr>
<td>▪ Initial systematic resuscitation of ABCDE’s.</td>
<td></td>
</tr>
<tr>
<td>▪ Early CT scanning to identify neurosurgically correctable focal intracranial haematomas.</td>
<td></td>
</tr>
<tr>
<td>▪ Prevention of secondary brain injury by avoiding hypoxaemia (oxygen saturation &lt;90%) and hypotension (systolic BP &lt;90).</td>
<td></td>
</tr>
<tr>
<td>▪ Supportive care of ABCDE’s with appropriate attention, posturing (30° head up), basic nursing care and avoidance of hyperventilation.</td>
<td></td>
</tr>
<tr>
<td>▪ Early neurosurgical consult.</td>
<td></td>
</tr>
<tr>
<td>▪ Use of ICP monitoring to guide management of cerebral perfusion pressure in patients with severe brain injury.</td>
<td></td>
</tr>
<tr>
<td>▪ Optional use of anticonvulsants to prevent early post traumatic seizures.</td>
<td></td>
</tr>
<tr>
<td>▪ Routine brain injury rehabilitation consult.</td>
<td></td>
</tr>
<tr>
<td>▪ ICU admission.</td>
<td></td>
</tr>
<tr>
<td>Acute neurological deterioration</td>
<td></td>
</tr>
<tr>
<td>▪ Resuscitation and stabilisation of ABCDE’s.</td>
<td></td>
</tr>
<tr>
<td>▪ Short term hyperventilation to PaCO2 25-30.</td>
<td></td>
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<tr>
<td>▪ Mannitol 1g/kg IV Bolus.</td>
<td></td>
</tr>
<tr>
<td>▪ Early CT scan with neurosurgical intervention as required.</td>
<td></td>
</tr>
<tr>
<td>Poor prognostic indicators</td>
<td></td>
</tr>
<tr>
<td>▪ Low GCS (especially motor component).</td>
<td></td>
</tr>
<tr>
<td>▪ Age &gt;60 years (prognosis deteriorates with increasing age).</td>
<td></td>
</tr>
<tr>
<td>▪ Absent pupillary reflexes (after systemic resuscitation).</td>
<td></td>
</tr>
<tr>
<td>▪ Hypotension (systolic BP &lt;90).</td>
<td></td>
</tr>
<tr>
<td>▪ Hypoxaemia (oxygen saturation &lt;90%).</td>
<td></td>
</tr>
</tbody>
</table>
**9.1 Discussion**

Recent exhaustive reviews by the Brain Trauma Foundation and The Cochrane Review Group have looked at the management of severe head injuries.\textsuperscript{15, 22, 80-87} The findings of those reviews are summarised in Evidence Table 6. Management of severe head injury, p.56. For the purposes of this guidelines it is assumed that moderate head injury patients (GCS 9-13) either improve (80%) and should be managed in a similar fashion to complicated mild head injuries or deteriorate (20%) and should be managed as severe head injuries.\textsuperscript{22}

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**HEAD INJURY GUIDELINE**

**Initial management of ‘Moderate Head Injuries’ (GCS 9-13)**

**Standard care**\textsuperscript{15, 22, 80-87}

- Initial assessment and resuscitation of ABCDE's.
- Early CT scanning to identify neurosurgically correctable focal intracranial haematomas.
- Period of ED observation.
- Prevention of secondary brain injury by avoiding hypoxaemia (O2 saturation <90%) and hypotension (systolic BP <90).
- Supportive care of ABCDE's.
- Admit for prolonged hospital observation (24-48 hours) unless rapid clinical improvement, normal CT scan and absence of other risk factors.
- Early neurosurgical consult if not clinically improving and/or abnormal CT scan.
- Routine post traumatic amnesia (PTA) testing.

**Outcome**

- Approximately 80% of moderate head injuries improve while 20% deteriorate and require management as per severe head injuries.
- The majority of patients who suffer moderate head injuries will have some degree of cognitive behavioural social sequelae and should be considered for routine follow up with a brain injury rehabilitation service or a neurologist (see Appendix D of the Adult Trauma Clinical Practice Guideline, Initial Management of Closed Head Injury in Adults).
10 When should patients with Closed Head Injury be transferred to hospitals with neurosurgical facilities?

<table>
<thead>
<tr>
<th>DEFINITION</th>
<th>LEVEL OF EVIDENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with severe head injuries (GCS 3-8).</td>
<td>Consensus</td>
</tr>
<tr>
<td>Patients with moderate head injuries (GCS 9-13) if:</td>
<td>Consensus</td>
</tr>
<tr>
<td>i clinical deterioration</td>
<td></td>
</tr>
<tr>
<td>ii abnormal CT scan</td>
<td></td>
</tr>
<tr>
<td>iii normal CT scan but not clinically improving</td>
<td></td>
</tr>
<tr>
<td>iv CT scan unavailable.</td>
<td></td>
</tr>
<tr>
<td>Patients with mild head injuries (GCS 14-15) if:</td>
<td>Consensus</td>
</tr>
<tr>
<td>i clinical deterioration</td>
<td></td>
</tr>
<tr>
<td>ii abnormal CT scan</td>
<td></td>
</tr>
<tr>
<td>iii normal CT scan but not clinically improving</td>
<td></td>
</tr>
<tr>
<td>iv high risk Mild Head Injury with CT scan unavailable.</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Consult neurosurgical / retrieval service early.

10.1 Discussion

i Patients with closed head injuries should be observed in facilities that can manage any complications that are likely to arise. Clinical judgment regarding risk of deterioration is required and early neurosurgical consultation is advisable.

ii Patients with closed head injuries should be transferred to the nearest appropriate hospital if there is significant risk of intracranial injury. Transfer of patients to a hospital with CT scanning facilities but without neurosurgical services should be avoided.

iii The evidence for which patients are at significant risk is outlined in the preceding text and evidence tables.
### Evidence Table 1. Definitions of Mild Head Injury

<table>
<thead>
<tr>
<th>Author</th>
<th>Source</th>
<th>Terminology</th>
<th>Initial GCS</th>
<th>Inclusion</th>
<th>Exclusion</th>
<th>Sub-classification of risk of intracranial injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabbri et al 2004</td>
<td>Prospective study</td>
<td>Minor HI</td>
<td>14-15</td>
<td>All</td>
<td>Penetrating.</td>
<td>Sub-classification into mild, medium and high risk based on: initial GCS LOC / amnesia risk factors.</td>
</tr>
</tbody>
</table>
### Evidence Table 2. Initial GCS versus abnormal CT / neurosurgery

**Studies showing the relationship between initial GCS and frequency of abnormal CT scans or neurosurgical intervention**

<table>
<thead>
<tr>
<th>Author and Year</th>
<th>Level of evidence</th>
<th>Quality</th>
<th>GCS 13</th>
<th>GCS 14</th>
<th>GCS 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dacey 198615</td>
<td>III-2</td>
<td>B2</td>
<td>18 N/A 33</td>
<td>59 N/A 6.5</td>
<td>533 N/A 1.5</td>
</tr>
<tr>
<td>Teasdale 199017</td>
<td>III-2</td>
<td>B1</td>
<td>– – – – – –</td>
<td>7,838 0.03</td>
<td></td>
</tr>
<tr>
<td>Shackford 199220</td>
<td>III-2</td>
<td>B2</td>
<td>221 33 10.8</td>
<td>646 17.5 3.8</td>
<td>1,699 14.8 3.2</td>
</tr>
<tr>
<td>Stein 199220</td>
<td>IV</td>
<td>B2</td>
<td>120 37.5 –</td>
<td>301 24.2 –</td>
<td>1,117 13.2 –</td>
</tr>
<tr>
<td>Jeret 199322</td>
<td>III-2</td>
<td>B2</td>
<td>– – – – – –</td>
<td>712 9.4 0.30</td>
<td></td>
</tr>
<tr>
<td>Borczuk 199521</td>
<td>III-2</td>
<td>C</td>
<td>40 27.5 7.5</td>
<td>197 18.2 3.6</td>
<td>1,211 5.9 0.10</td>
</tr>
<tr>
<td>Dunham 199624</td>
<td>III-2</td>
<td>B1</td>
<td>1,160 13 25 3.5</td>
<td>435 57 28 0.5</td>
<td>1,481 150 10 –</td>
</tr>
<tr>
<td>Culotta 199625</td>
<td>III-2</td>
<td>B1</td>
<td>173 28 4.5</td>
<td>755 16 1.6</td>
<td>2,179 4 0.40</td>
</tr>
<tr>
<td>Hsiang 199726</td>
<td>III-2</td>
<td>B2</td>
<td>45 57.8 20</td>
<td>138 35.5 5.1</td>
<td>1,177 18.5 2.2</td>
</tr>
<tr>
<td>Miller 199727</td>
<td>III-2</td>
<td>B1</td>
<td>– – – – – –</td>
<td>2,143 6.4 0.20</td>
<td></td>
</tr>
<tr>
<td>Nagy 199928</td>
<td>III-2</td>
<td>B1</td>
<td>– – – – – –</td>
<td>1,170 3.3 0.34</td>
<td></td>
</tr>
<tr>
<td>Haydel 200027</td>
<td>III-2</td>
<td>B1</td>
<td>– – – – – –</td>
<td>1,429 6.5 0.40</td>
<td></td>
</tr>
<tr>
<td>Stiell 200129</td>
<td>III-2</td>
<td>A</td>
<td>110 41 –</td>
<td>522 17 –</td>
<td>2,489 4.8 –</td>
</tr>
</tbody>
</table>
### Evidence Table 3. Risk factors for intracranial injury in Mild Head Injury

<table>
<thead>
<tr>
<th>Author &amp; Year</th>
<th>Level of evidence</th>
<th>Study population</th>
<th>Study objectives</th>
<th>Relevant findings</th>
<th>Comment</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masters 1987&lt;sup&gt;17&lt;/sup&gt;</td>
<td>III-2</td>
<td>215 patients with severe head injury. Talk and deteriorate.</td>
<td>Major risk factors include: persistent abnormal mental state focal neurological deficit skull fracture.</td>
<td>Skull x-ray may be useful in identifying higher risk patients if CT scan unavailable although does not exclude intracranial injury.</td>
<td></td>
<td>B1</td>
</tr>
<tr>
<td>Rockswold 1987&lt;sup&gt;19&lt;/sup&gt;</td>
<td>IV</td>
<td>215 patients with severe head injury. Talk and deteriorate.</td>
<td>Patients who talk and deteriorate are high risk.</td>
<td></td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Feuerman 1988&lt;sup&gt;15&lt;/sup&gt;</td>
<td>IV</td>
<td>215 patients with severe head injury. Talk and deteriorate.</td>
<td>Patients who talk and deteriorate are high risk.</td>
<td></td>
<td>B2</td>
<td></td>
</tr>
<tr>
<td>Teasdale 1990&lt;sup&gt;27&lt;/sup&gt;</td>
<td>III-2</td>
<td>Prospective 8406 head injuries adults and children.</td>
<td>Neurosurgical intervention.</td>
<td>Initial GCS &lt;15. Abnormal mental status. Neurological deficits.</td>
<td>History of LOC / amnesia with initial GCS 15 was only a minor absolute risk (1 in 6,663 vs 1 in 31,370 if no LOC / amnesia).</td>
<td>B1</td>
</tr>
<tr>
<td>Lee 1995&lt;sup&gt;28&lt;/sup&gt;</td>
<td>III-2</td>
<td>Prospective 1,812 patients GCS 15 with one of blew to head / LOC / amnesia.</td>
<td>Clinical predictors of deterioration.</td>
<td>Risk factors for deterioration: age &gt;60 years abnormal mental status (drowsiness) focal neurological deficit headache vomiting.</td>
<td>Majority of patients who deteriorated (28 or 1.5%) did so in first 24 hours (57%). Of those who deteriorated 23 patients required neurosurgery.</td>
<td>B2</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>Level of evidence</td>
<td>Study population</td>
<td>Study objectives</td>
<td>Relevant findings</td>
<td>Comment</td>
<td>Quality</td>
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</tr>
<tr>
<td>Lucchi 1995</td>
<td>IV</td>
<td>Retrospective 300 patients &quot;Mild Head Injuries&quot;.</td>
<td>Risk of CT in Mild Head Injuries.</td>
<td>Focal neurological deficit.</td>
<td>Found there was no relationship between LOC and positive CT scans.</td>
<td>B2</td>
</tr>
<tr>
<td>Gomez 1996</td>
<td>II-2</td>
<td>Retrospective 2,484 patients. - GCS 13-15.</td>
<td>Abnormal CT findings.</td>
<td>Initial GCS &lt;15. Skull fracture.</td>
<td>Relatively few CT scans were performed.</td>
<td>B2</td>
</tr>
<tr>
<td>Dunham 1996</td>
<td>II-2</td>
<td>Retrospective 2,587 patients. - GCS 15 with LOC / amnesia. - GCS 14 or GCS 13.</td>
<td>To identify risk factors for abnormal CT.</td>
<td>Risk factors were: - GCS &lt;15 - age &gt;60 - cranial soft tissue injury.</td>
<td>Time since injury average one hour. Noted that initial GCS may suffer interobserver and inter-centre variability.</td>
<td>B1</td>
</tr>
<tr>
<td>Miller 1996</td>
<td>III-2</td>
<td>Prospective 1,382 patients with GCS 15 and LOC or amnesia.</td>
<td>Clinical value of routine CT scans. Neurosurgery required in only 0.2%. Higher risk if nausea / vomiting / headache or skull fracture.</td>
<td>Routine CT scan not recommended for patients with GCS 15 and LOC / amnesia without other clinical signs and symptoms of head injury or skull fracture.</td>
<td>B2</td>
<td></td>
</tr>
<tr>
<td>Miller 1997</td>
<td>III-2</td>
<td>Prospective 2,143 patients. - GCS 15 LDC.</td>
<td>Predictive value of severe headache, nausea, vomiting and skull fracture for abnormal CT scans.</td>
<td>- Severe headache. - Nausea. - Vomiting. - Skull fracture.</td>
<td>Clinical criteria selected shown to be predictive of need for neurosurgery (PPV 100%) but not sensitive for abnormal CT scans (65% sensitivity).</td>
<td>B1</td>
</tr>
<tr>
<td>Hsiang 1997</td>
<td>III-2</td>
<td>Prospective 1,360 patients. - GCS 15-13. LOC present.</td>
<td>Define Mild Head Injury. Initial GCS &lt;15 associated with higher risk abnormal CT, neurosurgery or poor outcome.</td>
<td>Neurosurgical incidence of 4 (0.34%). No patients deteriorated following normal CT scan.</td>
<td>Recommended discharge if initial CT normal. Study had 969 patients with unknown LOC emphasising clinical difficulties in assessment.</td>
<td>B1</td>
</tr>
<tr>
<td>Stiell 1997</td>
<td>III-3</td>
<td>Retrospective 1,699 patients. - GCS 13-15. LDC/amnesia. - Seven Canadian major teaching hospitals.</td>
<td>Assess need for and use of CT scanning for Mild Head Injury.</td>
<td>6.2% with abnormal CT scan and 0.5% with extradural. Significant variability in use of CT scanning. Missed haematoma occurred in those institutions with higher rates of CT scanning.</td>
<td>CT scanning not necessarily useful if use not standardised. Head for clinical decision.</td>
<td>B2</td>
</tr>
<tr>
<td>Nagy 1999</td>
<td>II-2</td>
<td>Prospective 1,170 patients GCS 15. - LDC/amnesia. - All CT. - All 24 hour observation.</td>
<td>Using CT to allow safe discharge. - Positive CT or deterioration.</td>
<td>Neurosurgical incidence of 4 (0.34%). No patients deteriorated following normal CT scan.</td>
<td>Recommended discharge if initial CT normal. Study had 969 patients with unknown LOC emphasising clinical difficulties in assessment.</td>
<td>B1</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>Level of evidence</td>
<td>Study population</td>
<td>Study objectives</td>
<td>Relevant findings</td>
<td>Comment</td>
<td>Quality</td>
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</tr>
<tr>
<td>Vilke 2000[16]</td>
<td>IV</td>
<td>Prospective 58 patients. - GCS 15. - LOC / amnesia.</td>
<td>To determine if intracranial injury could be excluded in initial GCS 15 and normal complete Neuro examination.</td>
<td>Need for CT scanning could not be ruled out by GCS 15 and normal neurological examination on presentation.</td>
<td>B2</td>
<td></td>
</tr>
<tr>
<td>Hofman 2000[17]</td>
<td>I</td>
<td>Meta analysis</td>
<td>Risk of intracranial injury after MHI related to skull fractures.</td>
<td>Assess use of skull fracture in predicting intracranial injury.</td>
<td>– Prevalence of ICH 0.083 (8 in 100). – Skull x-ray sensitivity 0.39 specificity 0.95. – Skull fracture is a significant risk for ICH.</td>
<td>B1</td>
</tr>
<tr>
<td>Haydel 2000[17]</td>
<td>III-2</td>
<td>Prospective. - Phase I 520. - Phase II 909. - GCS 15. - LOC / amnesia. - Age &gt;10. - Exclusion criteria: – neurodeficit – coagulopathy (only one patient).</td>
<td>To identify clinical predictors of patients who do not require CT scan.</td>
<td>All patients with positive CT scan had one of seven criteria (likelihood ratio): – deficit in STM (15.0) (anterograde amnesia) – trauma above clavicle (11.0) (mostly skull fracture) – drug or alcohol intoxication (11.0) – seizure (3.0) – age &gt;60 (3.0) – headache (2.5) – vomiting (2.2).</td>
<td>Clinical decision rule of seven criteria was 100% sensitive (95% CI 95-100) and 25% specific with a negative predictive value of 100%. Application of the criteria would have reduced the number of CT scans by 22%.</td>
<td>B1</td>
</tr>
<tr>
<td>Sharma 2001[18]</td>
<td>II-2</td>
<td>100 patients</td>
<td>Assess importance of history of unconsciousness.</td>
<td>– GCS useful. – Presence of LOC not useful. – Duration of LOC more useful.</td>
<td>A history of brief LOC did not accurately predict risk of intracranial injury in Mild Head Injury.</td>
<td>B1</td>
</tr>
<tr>
<td>Stiell 2001[18]</td>
<td>II-2</td>
<td>Prospective multi-centre 3,121 patients GCS 13-15 one of LOC / amnesia / disorientation Exclusion: – neurodeficit – seizure – coagulopathy – nausea or vomiting unstable multi-system.</td>
<td>To develop clinical decision rule for use of CT scan in mild head injury to identify clinically important brain injury.</td>
<td>Developed seven risk factors. High risk (OR): – GCS &lt;15 at 2 hr post-injury (7.3) – skull fracture (base) (5.2) – skull fracture (non-base) (3.6) – age &gt;65 (4.1) – vomiting (3.8) Medium risk: – dangerous mechanism (2.8) – retrograde amnesia &gt;30 min(1.4).</td>
<td>High risk factors alone were 100% sensitive and 69% specific for predicting neurosurgical intervention and require only 12% of patients to undergo CT scan. High risk and medium risk factors together were 98.4% sensitive and 49.6% specific for clinically important brain injury and would require 34% of patients to have CT scan.</td>
<td>A</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>Level of evidence</td>
<td>Study population</td>
<td>Study objectives</td>
<td>Relevant findings</td>
<td>Comment</td>
<td>Quality</td>
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</tr>
<tr>
<td>Mina 2002!&lt;sup&gt;72&lt;/sup&gt;</td>
<td>II-2</td>
<td>Retrospective inception cohort, 380 patients.</td>
<td>Any injury with pre-injury anticoagulation.</td>
<td>Effect of anticoagulation on incidence of intracranial lesion.</td>
<td>Preinjury anticoagulation and intracranial injury has a four- to five-fold higher risk of death than the non-anticoagulated patient.</td>
<td>B1</td>
</tr>
<tr>
<td>Falmirski 2003!&lt;sup&gt;39&lt;/sup&gt;</td>
<td>II-2</td>
<td>Prospective 331 patients.</td>
<td>GCS 14-15. LOC.</td>
<td>To identify significance of constitutional signs and symptoms in predicting need for CT scan.</td>
<td>Constitutional signs and symptoms predicted presence of abnormalities on CT scan requiring a change in management.</td>
<td>B1</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>Level of evidence</td>
<td>Study population</td>
<td>Study objectives</td>
<td>Relevant findings</td>
<td>Comment</td>
<td>Quality</td>
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</tr>
<tr>
<td>Fabbri 2004¹</td>
<td>III-2</td>
<td>Prospective 5,578.</td>
<td>GCS 14-15.</td>
<td>Validation of mild head injury guideline.</td>
<td>Best predictors of post traumatic injury and neurological injury were abnormal GCS, skull fracture and to a lesser extent clinical findings.</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Excluded blunt trauma.</td>
<td>– Excluded penetrating multi-system injury.</td>
<td>Outcomes of post traumatic lesion on CT, neurosurgical intervention, outcome at 6/12.</td>
<td>Unfavourable outcome was most related to abnormal GCS skull fracture and not surprisingly risk factors or neurological deficits.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>High risk GCS 14 or GCS 15 with any of:</td>
<td>Sensitivity and specificity of high vs. medium / low risk were:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Neurodeficit</td>
<td>– Skull fracture</td>
<td>– Post traumatic 92%</td>
<td>– post traumatic 92%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Risk factors</td>
<td>– Age &gt;60</td>
<td>– sensitive 54%</td>
<td>– sensitive 54%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Coagulopathy</td>
<td>– Previous neurological symptoms</td>
<td>– Specificity</td>
<td>– Specificity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Epilepsy</td>
<td>– Alcohol / drug intoxication.</td>
<td>– 63% specificity</td>
<td>– Unfavourable outcome</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Amnesia</td>
<td>– Vomiting</td>
<td>– 100% sensitive</td>
<td>– 52% specificity.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Diffuse headache.</td>
<td>– Severe headaches</td>
<td>– 100% sensitive</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low risk GCS 15 with none of above.</td>
<td>– Aged &gt;65 years</td>
<td>– 52% specificity.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium risk GCS 15 with clinical findings:</td>
<td>– Significant extracranial lesions</td>
<td>– Neurosurgical intervention occurred in 71 patients. None from low risk, five (0.4%) from medium risk and 66 (5.4%) from the high risk group.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>– LOC</td>
<td>– Vomiting</td>
<td>– Only 67% of the high risk group had CT scans due to cost and local resource issues.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Amnesia</td>
<td>– Diffuse headache.</td>
<td>– Age alone was not used as a risk factor due to cost and resource issues. Only one patient (1 of 705) with age &gt;60 as the sole high risk factor had an undiagnosed ICH. Suggests age alone need not be used as a risk factor.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>– Severe headaches</td>
<td>– Vomiting</td>
<td>– Only 67% of the high risk group had CT scans due to cost and local resource issues.</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Coagulopathy</td>
<td>– Aged &gt;65 years</td>
<td>– Only 67% of the high risk group had CT scans due to cost and local resource issues.</td>
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<tr>
<td></td>
<td></td>
<td>– Skull fracture</td>
<td>– Significant extracranial lesions</td>
<td>– Neurosurgical intervention occurred in 71 patients. None from low risk, five (0.4%) from medium risk and 66 (5.4%) from the high risk group.</td>
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<tr>
<td></td>
<td></td>
<td>– Vomiting</td>
<td>– Diffuse headache.</td>
<td>– Age alone was not used as a risk factor due to cost and resource issues. Only one patient (1 of 705) with age &gt;60 as the sole high risk factor had an undiagnosed ICH. Suggests age alone need not be used as a risk factor.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ibanez 2004²</td>
<td>II-2</td>
<td>Prospective 1,101 patients.</td>
<td>GCS 14-15.</td>
<td>Identify risk factors.</td>
<td>Risks of post concussive symptoms were similar in all groups, while rates of intracranial injury were much higher in the high risk group.</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Identify risk factors.</td>
<td>– Evaluate guidelines</td>
<td>Acute intracranial lesions 7.5%.</td>
<td>Neurosurgical intervention occurred in 71 patients. None from low risk, five (0.4%) from medium risk and 66 (5.4%) from the high risk group.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Evaluate guidelines</td>
<td></td>
<td>Risk factors identified</td>
<td>Only 67% of the high risk group had CT scans due to cost and local resource issues.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– GCS 14</td>
<td>– Only one patient (1 of 705) with age &gt;60 as the sole high risk factor had an undiagnosed ICH. Suggests age alone need not be used as a risk factor.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– LOC</td>
<td>– Neurological deficit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– Skull fracture</td>
<td>– Vomiting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– Severe headaches</td>
<td>– Coagulopathy</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– Aged &gt;65 years</td>
<td>– Significant extracranial lesions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– Hydrocephalus with shunt.</td>
<td>Guidelines</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– Miss some abnormal CT scans</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– Identify clinically important lesions.</td>
<td></td>
</tr>
</tbody>
</table>
### Evidence Table 4. Safe discharge of Mild Head Injury

<table>
<thead>
<tr>
<th>Author &amp; Year</th>
<th>Level of evidence</th>
<th>Study population</th>
<th>Study objectives</th>
<th>Relevant findings</th>
<th>Comment</th>
<th>Quality</th>
</tr>
</thead>
</table>
| Stein 1990(79) | III-2             | Retrospective 658 patients.  
GCS 13-15. | Detect abnormal CT scan or deterioration in mild head injury patients. | None of 542 patients with initial normal CT scan deteriorated. | Safe to discharge Mild Head Injury if normal CT and neurological examination. | B2 |
| Stein 1992(78) | IV                | Retrospective 1,538.  
GCS 13-15.  
LOC / amnesia  
“normal” neurology.  
All CT scanned and admitted. | Detect abnormal CT scan or deterioration in mild head injury patients. | None of 1,339 patients with initial normal CT scan deteriorated. | Safe to discharge mild head injury if normal CT scan and normal neurological examination. | B2 |
66 patients.  
GCS 13-15.  
Isolated head injuries. | To prove that a patient with normal neurological examination and normal CT scan would have negligible risk of neurosurgical lesion.  
Distinguished abnormal, positive and relevant positive scans.  
Normal neurological examination included abnormal mental states or focal neurological deficit. | None of 1,170 patients with normal CT scan deteriorated.  
None of 933 patients with normal CT scan and normal neurological deteriorated.  
Identified significant risk factors as GCS 13 or focal neurological deficit. | “Reliable patients with a mild head injury with normal neurological examination and negative CT scan can be safely discharged.”  
The utility of abnormal CT scan or abnormal neurological examination in detecting neurosurgical lesions was:  
sensitivity 100%  
specifically 51%  
NPV 100%. | B2 |
| Taheri 1993(77) | IV                | Retrospective 310 patients.  
GCS 15. | Assess safe discharge for Mild Head Injury. | Patients who required neurosurgical intervention with initial GCS 15 had either:  
\( i \) skull fracture  
\( ii \) neurological deficit. | Safe discharge required:  
\( i \) initial GCS 15  
\( ii \) no skull fracture clinically or radiologically  
\( iii \) no neurological deficit. | B2 |
| Teasdale 1990(27) | III-2             | Prospective 8,406 patients.  
All head injuries. | Assess risk of intracranial haematoma.  
Best predictors of injury:  
\( i \) abnormal LOC  
\( ii \) focal neurology  
\( iii \) skull fractures. | Safe discharge if:  
\( i \) initial GCS 15  
\( ii \) no focal neurological deficit  
\( iii \) no skull fracture. | B1 |
| Lee 1995(28) | II-2              | Prospective 1,812 patients.  
GCS 15. | Clinical predictors of deterioration. | Risk of deterioration associated with:  
\( i \) age >60  
\( ii \) abnormal mental states  
\( iii \) focal deficit  
\( iv \) headache  
\( v \) vomiting. | Deterioration most common in first 24 hours due to extradural.  
Delayed deterioration due to subdural occurred up to a week later. Initial CT scan may not rule out risk of deterioration due to subdural SAH or seizure. | B2 |
<table>
<thead>
<tr>
<th>Author &amp; Year</th>
<th>Level of evidence</th>
<th>Study population</th>
<th>Study objectives</th>
<th>Relevant findings</th>
<th>Comment</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunham 1996</td>
<td>III-2</td>
<td>Prospective 2,587 patients. GCS 13-15.</td>
<td>To identify risk factors for abnormal CT scan.</td>
<td>No patients required neurosurgical intervention if initial CT scan was normal.</td>
<td>Safe discharge implied after observation if:</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- initial GCS 15:</td>
<td>1. age &lt;60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. no evidence of skull fracture</td>
<td>3. no neurodeficit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4. no headache</td>
<td>5. no vomiting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6. initial GCS 13-14:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7. age &lt;60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8. normal CT scan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9. no persistent neurodeficit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10. no persistent headache</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11. no persistent vomiting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hsiang 1997</td>
<td>III-2</td>
<td>Prospective 1,360 patients. GCS 13-15. Good follow up at 6/12.</td>
<td>Define high risk Mild Head Injury.</td>
<td>GCS 15 with normal CT scan or skull x-ray associated with good outcome.</td>
<td>Safe discharge if initial GCS 15 with normal CT scan or skull x-ray.</td>
<td>B2</td>
</tr>
<tr>
<td>Nagy 1999</td>
<td>IV</td>
<td>Prospective 1,170 patients. GCS 15. LOC / amnesia. All CT. All 24 hour admissions.</td>
<td>Assess role of CT scanning in identifying lesions and risk of deterioration.</td>
<td>No patients with a normal initial CT scan deteriorated.</td>
<td>Safe discharge if initial GCS 15 and normal CT scan.</td>
<td>B1</td>
</tr>
<tr>
<td>Livingston 2000</td>
<td>III-2</td>
<td>Prospective. GCS 14-15. LOC / amnesia.</td>
<td>Discharge after normal CT scan.</td>
<td>One of 1,788 patients with initial negative CT scan deteriorated requiring neurosurgery.</td>
<td>Safe to discharge if normal CT scan and clinical improvement.</td>
<td>B2</td>
</tr>
<tr>
<td>Jagoda 2002</td>
<td>III-2</td>
<td>Systematic review</td>
<td>Can a patient with MTBI be safely discharged from ED if a non contrast head CT scan shows no acute injuries?</td>
<td>Exclusion criteria.</td>
<td>Safe discharge if:</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- GCS &lt;15.</td>
<td>1. normal examination</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. normal CT scan</td>
<td>3. six hours observation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. responsible observer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>Level of evidence</td>
<td>Study population</td>
<td>Study objectives</td>
<td>Relevant findings</td>
<td>Comment</td>
<td>Quality</td>
</tr>
<tr>
<td>--------------</td>
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<td>------------------</td>
<td>-----------------</td>
<td>------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Fabbri 2004&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>III-2</td>
<td>Prospective, multi-centre.</td>
<td>5,578 patients.</td>
<td>GCS 14-15.</td>
<td>Blunt trauma.</td>
<td>Excluded penetrating multi-system injury.</td>
</tr>
<tr>
<td>Fabbri 2004&lt;sup&gt;3,4&lt;/sup&gt;</td>
<td>III-2</td>
<td>Prospective</td>
<td>1,480 patients.</td>
<td>Safety discharging ‘high risk’ Mild Head Injury after normal CT scan.</td>
<td>No significant difference in outcome between in hospital and home monitoring.</td>
<td>Early home discharge ‘safe’.</td>
</tr>
</tbody>
</table>
**Evidence Table 5. Post concussive symptoms and Mild Head Injury**

Selected studies and guidelines looking at post concussive symptoms follow up and outcome for Mild Head Injury

<table>
<thead>
<tr>
<th>Author &amp; Year</th>
<th>Level of evidence</th>
<th>Study population</th>
<th>Study objectives</th>
<th>Relevant findings</th>
<th>Comment</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams 1990[7]</td>
<td>III-2</td>
<td>Compared neurobehavioural outcome over six months for: uncomplicated mild head injury (GCS 13-15) complicated mild head injury (GCS 13-15) with brain injury or skull fracture moderate head injury (GCS 9-12);</td>
<td>Assessed relationship of neurobehavioural complications to initial injury.</td>
<td>Outcome for uncomplicated mild head injury was better than complicated mild head injury or moderate head injury which were similar. Age was associated with poor outcome. An abnormal intracranial lesion was more predictive of poor outcome than an isolated skull fracture.</td>
<td>Uncomplicated mild head injury had a good outcome in 97% of patients. However complicated mild head injury or moderate head injury had a good outcome in only 70-80%. Patients with complications need follow up.</td>
<td>A</td>
</tr>
<tr>
<td>Lee 199[3]</td>
<td>III-2</td>
<td>1,812 patients.</td>
<td>Outcome follow up for three months.</td>
<td>At three months post injury nearly all had good outcome. Delayed deterioration may occur with mild head injury.</td>
<td>Outcome is generally good.</td>
<td>B2</td>
</tr>
<tr>
<td>Author &amp; Year</td>
<td>Level of evidence</td>
<td>Study population</td>
<td>Study objectives</td>
<td>Relevant findings</td>
<td>Comment</td>
<td>Quality</td>
</tr>
<tr>
<td>---------------</td>
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<td>------------------</td>
<td>------------------</td>
<td>------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Chambers 1996</td>
<td>III-2</td>
<td>Follow up of mild head injury patients.</td>
<td>Assessment of complications.</td>
<td>– Post concussive symptoms are common and gradually reduce with time. – Headache or memory problems most common.</td>
<td>Post concussive symptoms common.</td>
<td>B2</td>
</tr>
<tr>
<td>Thornhill 2000</td>
<td>II-2</td>
<td>2,962 patients with head injury (362 with mild head injury analysed).</td>
<td>To determine outcome at one year.</td>
<td>Among patients with no pre-existing problems about 1/3 failed to achieve good outcome significant problems included cognitive, behavioural and employment dysfunction.</td>
<td>Significant disability may occur in the undifferentiated GCS 13-15 ‘mild’ head injury group.</td>
<td>B2</td>
</tr>
<tr>
<td>Cushman 2001</td>
<td>III-2</td>
<td>EAST guidelines.</td>
<td>Recommendations (paraphrased).</td>
<td>– Mild cognitive impairment is common and usually resolved by one month post injury (level II). – Patients with post concussive symptoms that persist for more than 6/52 should have formal neuropsychological testing (level II).</td>
<td>Persistent post concussive symptoms may identify a subgroup at risk of prolonged cognitive deficits.</td>
<td>N/A</td>
</tr>
<tr>
<td>Vos 2003</td>
<td>II-2</td>
<td>European (EFNS) guidelines.</td>
<td>Recommendations (paraphrased).</td>
<td>– Patients with high risk head injury admitted to hospital should have outpatient follow up. – Post concussive symptoms are common but usually resolve by 3-6 months.</td>
<td>Post concussive symptoms persisting after six months may benefit from neuropsychological testing.</td>
<td>N/A</td>
</tr>
<tr>
<td>Savola 2003</td>
<td>III-2</td>
<td>172 patients with mild head injury GCS 13-15.</td>
<td>Early predictors of post concussive symptoms.</td>
<td>Best beside predictors of post concussive symptoms were: – skull fracture – dizziness on admission – headache on admission. Serum protein S-100 B was also found to be a good predictor of post concussive symptoms.</td>
<td>Initial GCS and duration of PTA were not found to be good predictors.</td>
<td>B1</td>
</tr>
</tbody>
</table>
### Evidence Table 6. Management of Severe Head Injury

<table>
<thead>
<tr>
<th>Author &amp; Year</th>
<th>Level of evidence</th>
<th>Quality</th>
<th>Study objectives</th>
<th>Relevant findings</th>
</tr>
</thead>
</table>
| Brain Trauma Foundation | I | B1 | Systematic review of the management and prognosis of severe traumatic brain injury. | Recommendations: Overall management strategies:  
- Organised trauma systems.  
- Initial systemic ABCDE resuscitation fundamental to successful neurological outcome.  
- Prevention of secondary brain injury from hypoxaemia or hypotension crucial to outcome.  
- Specific therapy directed at raised intracranial pressure should not interfere with systemic resuscitation.  
**Hypoxaemia and hypotension:**  
- Systemic hypoxaemia (SaO2<90) and hypotension (systolic BP <90) following head injury are both associated with poor outcome.  
- Adequate oxygenation and fluid resuscitation should be the priority in multiply injured patients.  
**ICP Monitoring:**  
- ICP monitoring should be used as a guide to optimise cerebral perfusion pressure.  
- Specific indications for ICP monitoring include:  
  i. GCS 3-8 abnormal CT scan.  
  ii. GCS 3-8 normal CT scan if two of:  
    - age >40  
    - motor posturing  
    - systolic BP <90.  
**Supportive care ABCDE’s:**  
- Supportive care with attention to stabilising ABCDE’s, adequate nutrition, appropriate posturing (30° head up), basic nursing care and prevention of complications is more effective than most other interventions.  
**Anticonvulsants:**  
- Anticonvulsants such as phenytoin are effective at preventing early post traumatic seizures but do not prevent late post traumatic seizures.  
**Hyperventilation:**  
- Routine hyperventilation (PaCO2<35mmHg) should be avoided in head injury patients as it is associated with poor outcome.  
- Acute hyperventilation (PaCO2<35-30mmHg) is proven effective for short term reduction of raised ICP associated with acute neurological deterioration.  
**Mannitol:**  
- Mannitol (0.5g-1g/kg) is effective at reducing raised ICP.  
- Care should be used to avoid hypovolaemia and serum osmolarity >320.  
- It should be largely reserved for patients with acute neurological deterioration.  
**Therapies not shown to be effective:**  
- Barbiturates.  
- Steroids.  
**Factors clearly associated with poor prognosis:**  
- GCS lower GCS = worse outcome with motor component most predictive.  
- Age >60 (gradual trend with age most significant at age >60).  
- Absent pupillary reflexes (when systemic ABCDE causes eliminated).  
- Hypotension (systolic BP <90mmHg).  
- Hypoxaemia (O2 sat <90%).
<table>
<thead>
<tr>
<th>Author &amp; Year</th>
<th>Level of evidence</th>
<th>Quality</th>
<th>Study objectives</th>
<th>Relevant findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forsyth 2003</td>
<td>I</td>
<td>A</td>
<td>To determine if routine ICP monitoring in acute coma is beneficial.</td>
<td>Insufficient evidence to clarify role.</td>
</tr>
<tr>
<td>Roberts et al 2003</td>
<td>I</td>
<td>A</td>
<td>To determine role of hyperventilation in head injury.</td>
<td>Insufficient evidence to clarify role.</td>
</tr>
<tr>
<td>Roberts et al 2003</td>
<td>I</td>
<td>A</td>
<td>To determine role of mannitol for acute traumatic brain injury.</td>
<td>Mannitol beneficial for pre-operative management of raised ICP.</td>
</tr>
<tr>
<td>Alderson et al 2003</td>
<td>I</td>
<td>A</td>
<td>To determine role of corticosteroids for acute TBI.</td>
<td>Insufficient evidence.</td>
</tr>
<tr>
<td>Roberts 2003</td>
<td>I</td>
<td>A</td>
<td>To determine role of barbiturates for acute TBI.</td>
<td>No evidence that barbiturates improve outcome.</td>
</tr>
<tr>
<td>Langham 2003</td>
<td>I</td>
<td>A</td>
<td>To determine role of calcium channel blockers for acute TBI.</td>
<td>Insufficient evidence.</td>
</tr>
<tr>
<td>Gadkary 2003</td>
<td>I</td>
<td>A</td>
<td>To determine role of therapeutic hypothermia for acute TBI.</td>
<td>No evidence that hypothermia is beneficial.</td>
</tr>
<tr>
<td>Fleminger 2003</td>
<td>I</td>
<td>A</td>
<td>To determine role of pharmacological management for agitation and aggression following acquired brain injury.</td>
<td>B blockers (especially propranolol) may be effective in reducing aggression and agitation in the long term.</td>
</tr>
</tbody>
</table>
The Westmead Post Traumatic Amnesia (PTA) Scale, developed by NEV Marosszeky, L Ryan, EA Shores, J Batchelor and JE Marosszeky, was published in 1986. The Westmead PTA Scale consists of seven orientation questions and five memory items designed to objectively measure the period of PTA. The Westmead PTA Scale is a standardised and prospective measure of PTA. A person is said to be out of PTA if they can achieve a perfect score on the Westmead PTA Scale for three consecutive days.

The Westmead PTA Scale form (as seen by the example on the following page) and nine picture cards are required to perform the test. As the test was designed to measure PTA in a standard fashion to enable comparison of patients from different hospitals, the supplied picture cards must be used. They are available for purchase with instruction on their use from the Department of Rehabilitation Medicine, Westmead Hospital, Westmead NSW 2145 for a minimal fee.

More information is available on the Westmead PTA Scale at:
email. Arthur.Shores@mq.edu.au
### P.T.A. Scale

**P.T.A. may be deemed to be over on the first of 3 consecutive days of a recall of 12**

<table>
<thead>
<tr>
<th>A = Answer</th>
<th>S = Score (1 or 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How old are you?</td>
<td>A</td>
</tr>
<tr>
<td>2. What is your date of birth?</td>
<td>A</td>
</tr>
<tr>
<td>3. What month are we in?</td>
<td>A</td>
</tr>
<tr>
<td>4. What time of day is it?  (morning, afternoon or night)</td>
<td>A</td>
</tr>
<tr>
<td>5. What day of the week is it?</td>
<td>A</td>
</tr>
<tr>
<td>6. What year are we in?</td>
<td>A</td>
</tr>
<tr>
<td>7. What is the name of this place?</td>
<td>A</td>
</tr>
<tr>
<td>8. Face</td>
<td>A</td>
</tr>
<tr>
<td>9. Name</td>
<td>A</td>
</tr>
<tr>
<td>10. Picture I</td>
<td>A</td>
</tr>
<tr>
<td>11. Picture II</td>
<td>A</td>
</tr>
<tr>
<td>12. Picture III</td>
<td>A</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>****</td>
</tr>
</tbody>
</table>

**Head Injury Guideline**
### Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Eye Opening (E)</th>
<th>Verbal Response (V)</th>
<th>Motor Response (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 = Spontaneous</td>
<td>5 = Normal conversation</td>
<td>6 = Normal</td>
</tr>
<tr>
<td>3 = To voice</td>
<td>4 = Disoriented conversation</td>
<td>5 = Localizes to pain</td>
</tr>
<tr>
<td>2 = To pain</td>
<td>3 = Words, but not coherent</td>
<td>4 = Withdraws to pain</td>
</tr>
<tr>
<td>1 = None</td>
<td>2 = No words... only sounds</td>
<td>3 = Decorticate posture</td>
</tr>
<tr>
<td>1 = None</td>
<td>2 = None</td>
<td>2 = Decerebrate</td>
</tr>
</tbody>
</table>

**Total (Glasgow Coma Score) = E+V+M**
Mild Head Injury discharge advice

Important points about Mild Head Injury

- You have been assessed as having a Mild Head Injury. This means that the doctor has not found any evidence to suggest a serious underlying brain injury and feels you are suitable for observation at home.
- Due to the small risk of you developing a serious complication after discharge from hospital, it is important that a responsible adult observes you for the next 24 hours and returns you to hospital if necessary.
- Although you do not have evidence of a serious underlying brain injury, it is common to have some mild post concussion symptoms for up to several weeks.
- If you still have significant post concussion symptoms that are not improving after a few days you should see your local doctor. Your local doctor may refer you for specialist review if your symptoms persist.

Please read the following fact sheet that details what you should expect while you recover from your head injury.

WARNING SIGNS!

Return to HOSPITAL IMMEDIATELY if you deteriorate and develop any of the following:

- excessive drowsiness or lethargy
- confusion or disorientation
- abnormal behaviour or irritability
- fitting or seizures
- blurred vision or slurred speech
- severe headache
- persistent vomiting
- abnormal clumsiness

FIRST 24–48 HOURS

Warning signs

You should be observed and returned to hospital if you develop any of the above warning signs.

Rest / Sleeping

Rest and avoid strenuous activity for at least 24 hours. It is alright for you to sleep tonight but you should be woken every four hours by someone to make sure you are alright.

Driving

Do not drive for at least 24 hours, as you may be unable to concentrate properly. This is a legal requirement.

Drinking / Drugs

Do not drink alcohol, take sedatives or use recreational drugs in the next 48 hours, as they may make you feel worse and or mask symptoms of deterioration.

Pain relief

Use paracetamol or paracetamol/codeine for headaches. Do not use aspirin or an anti-inflammatory pain reliever such as ibuprofen or naproxen (NSAIDs) which may increase the risk of bleeding.
THE FIRST FOUR WEEKS

Post concussion symptoms
The following symptoms are common after a Mild Head Injury and usually resolve within a few weeks:

- fatigue
- poor concentration
- mood swings
- dizziness
- mild headache
- forgetfulness
- mild nausea
- mild behavioural change

Rest / Sleeping
It is important to get adequate amounts of sleep as you may feel more tired than normal.

Relationships
Sometimes your post concussion symptoms will affect your relationship with family and friends, as you may suffer irritability and mood swings. See your local doctor if you or your family are worried.

Driving
Do not drive until you feel much better and can concentrate properly.

Drinking / Drugs
Do not drink alcohol or use recreational drugs until you are fully recovered – they will make you feel much worse.

Work / Study
Most people return to work or study within a few days following a Mild Head Injury. Some people find it difficult to concentrate properly when returning to work or study following a Mild Head Injury. See your doctor and notify your employer or teachers if you are having problems at work or with study. You may need to take on reduced work or study duties for a short period.

Sport / Lifestyle
It is important to avoid another head injury. You should avoid contact sports and other activities where you may suffer another head injury for at least four weeks – ‘if in doubt – sit it out’.

Recovery
You should start to feel better within a few days and be ‘back to normal’ within about four weeks. See your local doctor if you are not starting to feel better within a few days of your head injury.

PERSISTENT POST CONCUSSION SYMPTOMS
The majority of people recover rapidly following a Mild Head Injury. However, a minority of people may suffer from persistent post concussion symptoms. If you still have post concussion symptoms a few days after a Mild Head Injury, you should see your local doctor. Your local doctor will monitor these symptoms, which would normally improve within four weeks. Your local doctor may refer you to a Traumatic Brain Injury Clinic or a Neurologist for specialist review if your symptoms persist.

SUMMARY

- Return to hospital immediately if you develop any of the warning signs
- Most people recover rapidly from mild head injuries and have no significant problems
- Mild post concussion symptoms are common but usually resolve within a few weeks
- See your local doctor if you still have post concussion symptoms a few days after your head injury

Dr. Duncan Reed, Director of Trauma, Gosford Hospital
List of search terms to identify studies

**The following search phrases were used in Medline:**
1. exp Head Injuries, Closed/
2. exp *tomography, x-ray/
3. Patient Discharge/
4. Patient Transfer/
5. intubation/ or exp intubation, intratracheal/
6. *Intracranial Pressure/
7. Drainage/
8. (7 and (ventricular or intra?ventricular or extra?ventricular).mp.) or ((ventricular or intra?ventricular or extra?ventricular) adj drain)).mp.
9. (icp monitor$ or intracranial pressure monitor$).mp.
10. exp Aggression/
11. exp Mannitol/
12. exp Hyperventilation/
13. Adrenal Cortex Hormones/
14. Craniotomy/
15. Trephining/
16. exp emergency treatment/
17. exp *head injuries, closed/su, th or (exp head injuries, closed/ and management.mp.)
18. (or/2-6) or (or/8-16)
19. (1 and 18) or 17

**The following search phrases were used in Embase:**
(head injury/ and closed$.mp.) or (closed head injury or closed head trauma$).mp.
[mp=title, abstract, subject headings, drug trade name, original title, device manufacturer, drug manufacturer name]
2. exp computer assisted tomography/
3. patient transport/ or discharg$..mp.
4. exp RESPIRATORY TRACT INTUBATION/ or INTUBATION/
5. Intracranial Hypertension/
6. cerebrospinal fluid drainage/
7. [(ventricular or intra?ventricular or extra?ventricular) adj drain]).mp.
8. (icp monitor$ or intracranial pressure monitor$).mp.
9. exp aggression/
10. Mannitol/
11. exp Hyperventilation/
12. exp Corticosteroid/
13. craniotomy/
14. (trephin$ or burr hole$).mp.
15. exp emergency treatment/
16. (su or th).fs. or management.mp.
17. 1 and (or/2-16)
18. limit 17 to human
References


2. NSW Institute of Trauma & Injury Management 2002, NSW Trauma Minimum Data Set 2002 Annual Report.


75 NSW Institute of Trauma & Injury Management, *Trauma Death Review Committee 2003/2004*.


