

HEAD & SPINE

Severe Traumatic Brain Injury Guidelines

1. Head injury has around a 5% mortality. Early neuroprotective measures can significantly improve outcomes.
2. Early CT brain & skull are indicated in the majority of patients with GCS <14.
3. For a rapid overview of head injury management, please see the separate key points document “Care of Head Injured Patients”
4. Levetiracetam (Keppra) is now the first line anticonvulsant for patients with significant head injury.
5. Patients already taking anticonvulsants who sustain a head injury should have their anticonvulsant therapy discussed with a neurosurgeon.

Head injury is the commonest cause of death and disability in people aged 1–40 years in the UK. Most patients recover without specific or specialist intervention, but others experience long-term disability or even die from the effects of complications that could potentially be minimised or avoided with early detection and appropriate treatment.

The incidence of death from head injury is low, with as few as 0.2% of all patients attending emergency departments with a head injury dying as a result of this injury. The majority of fatal outcomes are in the moderate (GCS 9–12) or severe (GCS 8 or less) head injury groups, which account for 5% of attenders.

Appropriate guidance can enable early detection and treatment of life-threatening brain injury, where present.

This guideline is based on NICE CG176: Head Injury.

Initial Assessment and Management

As with all major trauma, patients with a head injury should be managed according to standard trauma primary survey principles.

Neurological assessment:

The patient should be assessed and monitored using the Glasgow Coma Scale. The individual components of the GCS and the overall score should be described in all communications and documentation

In patients with a GCS of 8 or less, ensure there is early involvement of an anaesthetist or critical care physician to provide appropriate airway management and assist with resuscitation.

Patients considered high risk for clinically important brain injury and/or cervical spine injury:

Conduct a full clinical examination to establish the need to request CT imaging of head, cervical spine and other body areas.

Patients considered low risk for clinically important brain injury and/or cervical spine injury following initial assessment:

An emergency department clinician should re-examine the patient within an hour. The need to request CT imaging of the head and/or cervical spine should be established at this time.

Airway

Intubate and ventilate the patient immediately in the following circumstances:

- GCS ≤ 8
- Loss of protective laryngeal reflexes
- Ventilatory insufficiency as judged by blood gases: hypoxaemia ($\text{PaO}_2 < 13 \text{ kPa}$ on oxygen) or hypercapnia ($\text{PaCO}_2 > 6 \text{ kPa}$)
- Spontaneous hyperventilation causing $\text{PaCO}_2 < 4 \text{ kPa}$
- Irregular respirations

If transferring from a trauma unit to major trauma centre, intubation and ventilation prior to the start of the journey is indicated in the following circumstances:

- Significantly deteriorating conscious level (1 or more points on the motor score), even if GCS not ≤ 8 .
- Unstable fractures of the facial skeleton
- Copious bleeding into the mouth (for example, from skull base fracture)
- Seizures

Ventilate an intubated patient with muscle relaxation and appropriate short-acting sedation and analgesia. Aim for:

- $\text{PaO}_2 > 13 \text{ kPa}$
- $\text{PaCO}_2 4.5 - 5.0$, unless there is clinical or radiological evidence of raised intracranial pressure, in which case more aggressive hyperventilation is justified. If hyperventilation is used, increase the oxygen concentration.
- Maintain the mean arterial pressure at $\geq 80 \text{ mmHg}$ by infusion of fluid and vasopressors as indicated.

Analgesia

Pain can lead to an increase in intracranial pressure and should be managed effectively. Treat significant pain with small doses of intravenous opioids titrated against clinical response and baseline cardiorespiratory measurements. All patients with head injury should receive paracetamol (IV or PO) if not contraindicated.

Imaging

The current primary investigation of choice for the detection of acute clinically important brain injuries is CT imaging of the head.

Do not perform MRI scanning as the primary investigation for clinically important brain injury. However, additional information of importance to the patient's prognosis can sometimes be detected using MRI.

Do not use plain X-rays of the skull to diagnose significant brain injury without prior discussion with a neuroscience unit.

Perform a CT Head Scan Within One Hour:

- GCS less than 13 on initial assessment in the Emergency Department
- GCS less than 15 at 2 hours after the injury on assessment in the Emergency Department
- Suspected open or depressed skull fracture
- Any sign of basal skull fracture (haemotympanum, 'panda' eyes, cerebrospinal fluid leaking from the ear or nose, Battle's sign)
- Post-traumatic seizure
- Focal neurological deficit
- More than 1 episode of vomiting

A provisional written radiology report should be made available within 1 hour of the scan being performed.

Perform a CT Head Scan Within Eight Hours in Patients who:

- Experienced some loss of consciousness or amnesia since the injury

AND any of the following

- Age ≥ 65
- Any history of bleeding or clotting disorder
- Dangerous mechanism of injury e.g pedestrian vs. motor vehicle, cyclist vs. motor vehicle, occupant ejected from a motor vehicle or fall from a height >1 meter / 5 stairs.
- More than 30 minutes of retrograde amnesia of events immediately before the head injury

A provisional written radiology report should be made available within 1 hour of the scan being performed.

Patients on warfarin:

For patients who have sustained a head injury with no other indications for a CT head scan and who have been receiving warfarin treatment, perform a CT head scan within 8 hours of the injury. A provisional written radiology report should be made available within 1 hour of the scan being performed.

Patients with any neurosurgical shunt for CSF diversion in situ:

For patients who have sustained a head injury with no other indications for a CT head scan and who have any neurosurgical shunt for CSF diversion in situ should undergo CT scan within 8 hours of minor head injury. This patient group lies outside of NICE guidance but are at significant risk of major intracranial haemorrhage and must be imaged within this timeframe.

Neurosurgical Involvement

Neurosurgical involvement is indicated if any of the following are present:

- Surgically significant abnormalities on imaging
- Persisting coma (GCS ≤ 8) after initial resuscitation
- Unexplained confusion which persists for more than 4 hours
- Deterioration in GCS score after admission (greater attention should be paid to motor response deterioration)
- Progressive focal neurological signs
- A seizure without full recovery
- Definite or suspected penetrating head injury
- A cerebrospinal fluid leak
- Neurosurgical shunt for CSF diversion

Discuss with a neurosurgeon the care of all patients with new, significant abnormality on imaging.

Transfer

All patients requiring neurosurgical involvement should be discussed with Southmead Hospital. Transfer would benefit all patients with serious head injuries (GCS of 8 or less) irrespective of the need for neurosurgery. If transfer of these patients is not possible, ongoing liaison with Southmead Hospital over clinical management is essential.

Initial resuscitation and stabilisation of the patient must be completed prior to transfer. Do not transport a patient with persistent hypotension despite resuscitation, until the cause of the hypotension has been identified and the patient stabilised.

See page 174 for guidance on when intubation and ventilation is indicated prior to a patient with head injury being transferred.

Admission

The following criteria should be used for admitting patients to hospital following a head injury:

- New, clinically significant abnormalities on imaging
- GCS has not returned to 15 after imaging, regardless of the imaging results
- CT scan is indicated, but cannot be done within the appropriate period
- Continuing worrying signs (e.g. persistent vomiting, severe headache) of concern to the clinician
- Other sources of concern to the clinician (e.g. drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak)

Admit patients with multiple injuries under the care of the team that is trained to deal with their most severe and urgent problem.

Observation of Admitted Patients

For all patients admitted for observation following head injury, the following neurological observations must be documented as a minimum:

- GCS (assess every 30 minutes until GCS equal to 15 has been achieved)
- Pupil size and reactivity
- Limb movements
- Respiratory rate
- Heart rate
- Blood pressure
- Temperature
- SpO₂

The minimum frequency of observations for patients with GCS equal to 15 should be as followed, starting after the initial assessment in the emergency department:

- Half-hourly for 2 hours
- 1 hourly for 4 hours
- 2 hourly thereafter

Should the patient with GCS = 15 deteriorate at any time after the initial 2 hour period, observations should revert to half-hourly and follow the original frequency schedule.

The must be prompt urgent reappraisal by the supervising doctor if any of the following examples of neurological deterioration occur:

- Development of agitation or abnormal behaviour
- A sustained (for at least 30 minutes) drop of 1 point in GCS score (greater weight should be given to a drop of 1 point in the motor response score of the GCS).

- Any drop of 3 or more points in the eye-opening or verbal response scores of the GCS, or 2 or more points in the motor response score.
- Development of severe or increasing headache or persistent vomiting
- New or evolving neurological symptoms or signs such as pupil inequality or asymmetry of limb or facial movement.

A second member of staff competent to perform observation should confirm deterioration before involving the supervising doctor. Where a confirmation cannot be performed immediately, the supervising doctor should be contacted without the confirmation being performed.

If neurological deterioration as listed above is confirmed, an immediate CT scan should be considered, and the patient's clinical condition re-assessed and managed appropriately.

In the case of a patient who has had a normal CT scan, but who has not achieved GCS equal to 15 after 24 hours' observation, a further CT scan or MRI scanning should be considered and discussed with the radiology department.

References

1. NICE Clinical Guideline (CG176) Head Injury: Assessment and Early Management
<https://www.nice.org.uk/guidance/cg176>
2. NICE Quality Standard (QS74) Head Injury
<https://www.nice.org.uk/guidance/qs74>

Anticonvulsants for Traumatic Brain Injury

Patients Not Taking Anticonvulsants Prior to Injury

In patients who were not taking anticonvulsants prior to injury, where no witnessed seizure has occurred since injury:

- Start levetiracetam 1g twice daily
 - ▶ No loading dose needed
 - ▶ Initial dose intravenously
 - ▶ Give subsequent doses via NG/PO if absorbing feed, otherwise continue IV
- Continue treatment for 7 days THEN STOP
 - ▶ May need longer duration and/or increased doses if clinical or EEG evidence of seizures during treatment
 - ▶ Maximum doses 1.5g twice daily

In patients who were not taking anticonvulsants prior to injury, where a witnessed seizure *has* occurred since the injury:

- Give loading dose levetiracetam 20mg/kg
- Start levetiracetam 1g twice daily
 - ▶ Initial dose 12 hours after loading
 - ▶ Give via NG/PO route if absorbing feed, otherwise continue IV
 - ▶ Treatment duration on a case-by-base basis in discussion with the admitting neurosurgical team

Levetiracetam is now the first-line anticonvulsant for TBI, replacing phenytoin. Phenytoin is the second line agent where levetiracetam is contraindicated or unavailable.

Patients Taking Anticonvulsants Prior to Injury

Patients who were taking anticonvulsants prior to a head injury should be discussed with the neurosurgical team regarding their need for additional anticonvulsant agents.

Care of Head Injured Patients

1. Effective analgesia is critical for all major trauma patients. All patients with significant pain should receive IV paracetamol if not otherwise contraindicated. Avoidance of sedating narcotics may have significant potential advantages in head injured patients and should be used with caution and titrated to effect.
2. Sedation (for any reason) makes accurate assessment of the GCS impossible and should be used only in order to gain control of an agitated patient in the pre-oxygenation phase of rapid sequence induction of anaesthesia.
3. RSI technique in head injury maintain oxygen saturations >94%, mitigate and pharyngeal and laryngeal stimulation and avoid unplanned hyperventilation all of which risk worse outcomes.
4. Following RSI, ventilation, volume management and packaging must be carefully considered but rapidly initiated with specific attention to optimisation of cerebral perfusion pressure.
5. Emergency control of clinically suspected raised ICP or impeding herniation can be attempted with boluses of 3ml/kg of 5% saline.

Background

The principles of head injury management are the provision of adequate oxygenation and cerebral perfusion, treatment of other significant injuries and rapid transfer to a neurosurgical service.

Many patients with head injury do not require urgent neurosurgery but, if they do, taking them directly to a neurosurgical centre cuts the time dramatically. Even when surgical intervention is not required, patients with head injury do better when managed in neurosurgical centres.

Indications for emergency anaesthesia in patients with head injury are straightforward:

- Unconsciousness
- Airway compromise
- Ventilatory compromise

We also anaesthetise a number of patients with head injury and a relatively high GCS (9 – 14). Most of these patients have cerebral agitation and we know that patients who have cerebral agitation have a high incidence of intracranial pathology. Anaesthesia in this patient group makes them more manageable and may reduce the severity of secondary injury.

Use of Analgesia and Sedation

Sedation in head injured patients is a high risk procedure and should be performed only in the presence of those with significant experience and/or expertise.

Effective multimodal analgesia is associated with better outcomes in head injured patients. All patients without contraindications should receive paracetamol (IV) and consideration of non-steroidal and opioid analgesia in the usual fashion.

Oral codeine, where appropriate may achieve significant analgesia with minimal sedation, facilitating more accurate assessment of GCS and clinical condition.

If patients are in severe pain from a head injury alone then this could signify intracranial pathology until proved otherwise. However pain primarily from systemic injury may push patients into the 'agitated' category; thus if effective analgesia cannot be achieved without the use of potentially sedating narcotic analgesia, small doses of fentanyl, morphine or oxycodone should be titrated to effect.

Sedation (for any reason) makes accurate assessment of the GCS impossible and should be used only in order to gain control of an agitated patient in the pre-oxygenation phase of rapid sequence induction of anaesthesia.

Ketamine: Concerns relating to its use in un-intubated patients with head injury (due to the possibility that ketamine raises ICP when CO₂ is not controlled) are largely unfounded. Ketamine has the advantage of not impairing respiratory drive and of being haemodynamically stable; its use is increasing in all traumatically injured patient groups.

If being used for induction of anaesthesia, then common practice is to use 10-20% of the intended induction dose as a sedative premedication to facilitate patient positioning and preoxygenation. The subsequent induction dose of ketamine should be reduced.

Midazolam: If the patient is agitated or combative, sedate with 1-2mg aliquots of midazolam until control is achieved and then proceed to rapid sequence induction. This also enables effective pre-oxygenation.

Propofol: This should be used in caution due to significant risk of apnoea, hypoventilation and loss of systemic vascular resistance. Its only use would be in the context of achieving preoxygenation prior to RSI where propofol is being used as the induction agent (usually, isolated head injury with significant hypertension).

Rapid Sequence Induction

RSI technique in head injury should minimise CO₂ increases and pharyngeal and laryngeal stimulation in an attempt to minimise ICP rises. Meticulous attention to oxygenation is also important as is prevention of hyper and hypoventilation (which has been associated with poor outcomes).

This may be achieved by:

Adequate induction agent

- Use of adequate dose of Fentanyl and Ketamine where allowed by the patient's cardiovascular status.

Adequate paralysis:

- Use 1mg/kg of Rocuronium
- Reparalyse frequently

Gentle and minimal laryngoscopy:

- Avoid touching the posterior pharyngeal wall during intubation

Minimal tube movement. Hold the tube when the patient is moved.

Ventilation

Ventilate to low normocapnia (end-tidal CO₂ of 30 mmHg/4.0KPa). This equates to a PaCO₂ of approximately 4.5KPa in normal individuals. This minimises the risk of cerebral vasodilation (high PaCO₂) and cerebral vasoconstriction (low PaCO₂).

High levels of PEEP can increase ICP. Use of more than 5 cmH₂O of PEEP without well founded clinical reason should be avoided.

Use of IV Fluids

After significant head trauma, the brain may lose the ability to autoregulate cerebral blood flow. A fall in mean arterial pressure may therefore result in a reduction in cerebral oxygen delivery even if the ICP is normal.

When effective splinting of limbs / pelvis has been maximised, then fluids should be administered to achieve a systolic blood pressure of 100mmHg. This can be increased to 120mmHg in isolated head injury.

Packaging

Compression of the jugular veins will reduce venous return from the head and neck. This can increase ICP. The cervical collar, if used, should therefore be left slightly loose. Cervical spine immobilisation will be maintained with head blocks and tape on the scoop stretcher. The neck veins can also be constricted by a tight tracheal tube tie – this should be checked and loosened. Tube tapes are a sensible alternative. The patient should be managed in a 20-30 degree head up position to maximise venous drainage. Tilt the whole trolley to achieve this, in adequately resuscitated patients.

Control of ICP / Impending Herniation

Hypertonic Saline (HTS):

HTS has been shown to lower ICP in severe head injuries and may have other beneficial effects such as increasing circulating volume, minimal alteration to coagulation and anti-inflammatory properties. It is used extensively in ICU to lower refractory ICPs. North Bristol uses sodium chloride 5%. There is no evidence that one formulation of hypertonic saline offers advantages over another. It is available as a 250ml or 500ml infusion bag.

Administration Policy:

3ml / kg (to a maximum of 200ml) of 5% hypertonic saline should be delivered by well secured large bore peripheral (>18 gauge) cannula over 10 minutes in patients with signs of actual or impending herniation resultant from severe head injury:

- Unilateral or bilateral pupil dilation / GCS < 8 (usually 3)
- Progressive hypertensive (SBP over 160mmHg) and bradycardia (pulse below 60) / GCS <8 (usually 3).

This dose is given once and given regardless of blood pressure.

In patients with blunt trauma, hypotension and head injury a bolus of HTS as above will help restore circulating volume and may protect against cerebral hypoperfusion and reduce oedema.

References

NICE CG 44: Management of Head Injury

Patel HC, Bouamra O, Woodford M, King AT, Yates DW, Lecky FE; Trauma Audit and Research Network. Trends in head injury outcome from 1989 to 2003 and the effect of neurosurgical care: an observational study. *Lancet*. 2005 Oct 29-Nov 4;366(9496):1538-44.

Fuller G, Bouamra O, Woodford M, Jenks T, Patel H, Coats TJ, Oakley P, Mendelow AD, Pigott T, Hutchinson PJ, Lecky F. The effect of specialist neurosciences care on outcome in adult severe head injury: a cohort study. *J Neurosurg Anesthesiol*. 2011 Jul;23(3):198-205.

Pre-hospital Anaesthesia. AAGBI Safety Guideline. February 2009. AAGBI London.

Torre-Healy A, Marko NF, Weil RJ. Hyperosmolar therapy for intracranial hypertension. *Neurocrit Care*. 2012 Aug;17(1):117-30

Spinal Cord Injury Care Pathway

1. Thorough examination of the spinal column should always be methodically performed; inadequate immobilisation and unprotected movement of the spine may lead to additional neural injury and may worsen the outcome.
2. In all patients, cervical collars should be removed as soon as practically possible. Blocks & tape for immobilisation of the c-spine should still be applied until injury can be ruled out.
3. In the conscious, co-operative patient, the cervical spine can be safely cleared using the Canadian Cervical Spine rules. "Clearing" the cervical spine should involve further clinical assessment of the patient as well as discussion of the patient with a clinician experienced in the management of neck injuries where appropriate.
4. In the obtunded patient, imaging will usually be required. CT is the imaging modality of choice; there is no role for plain x-rays of the spine in the unconscious trauma patient.

Spinal Clearance

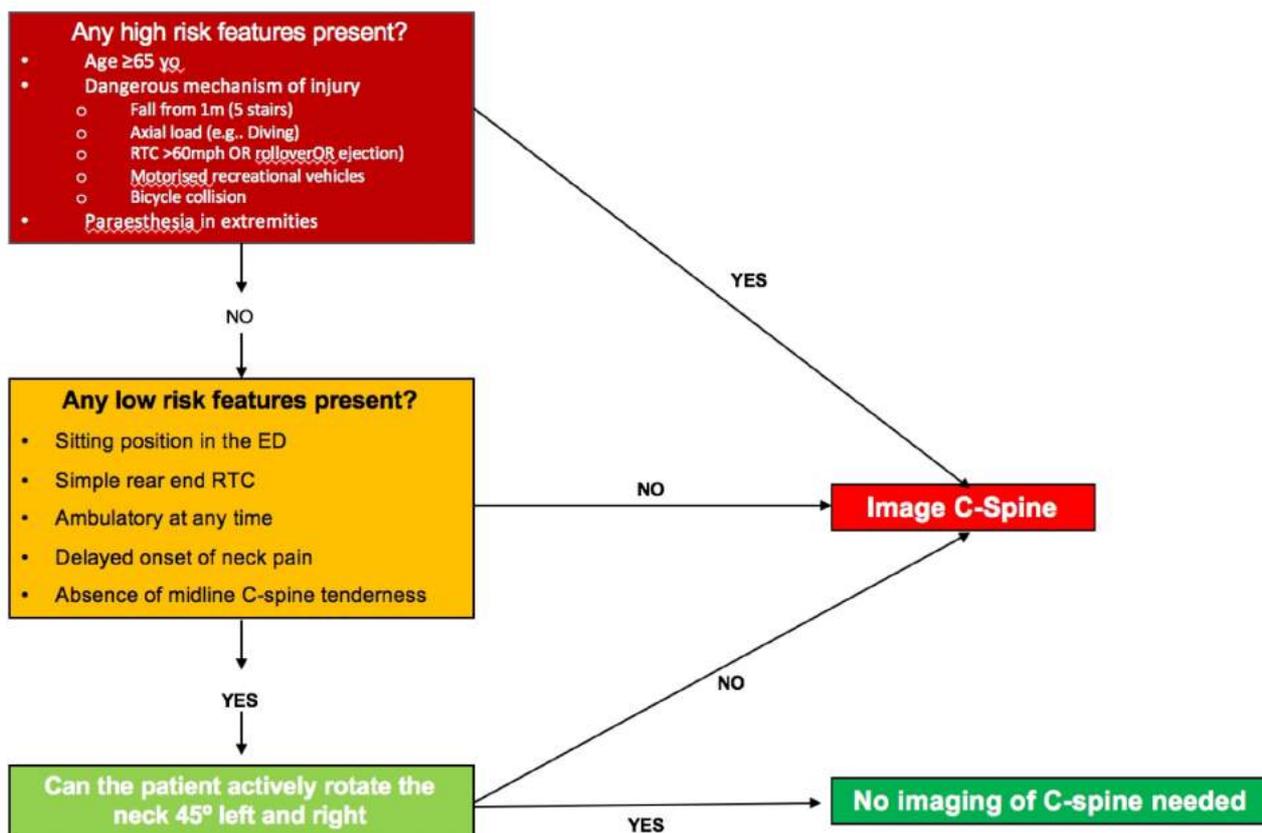
C-spine injuries occur in 2.0-6.6% of blunt trauma patients. Co-existing head injury increases the incidence of C-spine injury to 10%. Injury to the cervical spinal cord in the absence of fracture occurs in 0.07-0.7% of trauma admissions.

Thorough examination of the spinal column should always be methodically performed; inadequate immobilisation or unnecessary movement of the spine may lead to additional neural injury and worsen the outcome.

CT imaging is largely replacing plain x-rays in the assessment of spinal injuries, but clinical clearance remains standard in awake, alert patients with no neurologic deficit, distracting injury, neck pain or tenderness.

Conscious, Cooperative Patient

In the conscious, co-operative patient: the Canada C-spine rule can be used to exclude the need for imaging. High index of suspicion should be maintained where imaging not used until clinical examination + discussion with a clinician experienced in the management of neck injuries have occurred and fracture has been excluded.



Stiell, I. *et al.* The Canadian C-spine rule for radiography in alert and stable trauma patients. *JAMA* 2001;286:1841-1848

Removal of Cervical Spine Collars

In all patients, cervical collars should be removed as soon as practically possible (Grade III evidence). Early removal is associated with decreased collar related pressure ulcers, lower intracranial pressure, fewer ventilator days, fewer ICU and hospital days, decreased incidence of delirium and pneumonia.

In the conscious, co-operative patient, cervical spine collars do not need to be applied prior to imaging if they have not been applied pre-hospital.

Obtunded Patient

If collar is removed in the obtunded / sedated / unconscious patient, blocks and tape should remain in place until CT of the neck +/- spinal column have occurred.

Clear verbal and written handover must occur between all staff caring for the patient stating that:

- The cervical spine and spinal column have not been clinically cleared of injury
- The patient should be nursed in a neutral position with head and neck maintained in the midline if possible while obtunded / unconscious / sedated.
- Consideration of and assessment for spinal injury must be undertaken once the patient regains an adequate level of consciousness.
- Individual clinical judgement must be used to determine the level of cervical and thoracolumbar spinal protection required as the patient regains consciousness.

Imaging

Patients with a GCS<13 following trauma: CT imaging of the cervical spine should be performed in all cases.

Unconscious patient following multi-system trauma: The whole of the spine should be imaged.

Acute fracture found anywhere in spinal column: The rest of the spinal column should be imaged

Patient presenting with neurology: CT imaging of the spine should be undertaken, followed by MRI – *CT has a higher sensitivity for bony injury than MRI*

If the patient complained of neurology MRI is required to clear the spine.

Patient not presenting with neurology: Isolated unstable ligamentous injury is uncommon, but where it does occur is a common reason for missed instability.

However, ongoing spinal immobilisation of an unconscious patient is not a benign procedure. Therefore, in patients without (self) reported neurological symptoms prior to anaesthesia (whether pre- or in-hospital), the spine can safely be considered cleared following CT of the whole spine reported as "normal" by a consultant radiologist or clinician with advanced training in interpretation of neuraxial imaging modalities.

In the presence of a mechanism of injury that could cause instability e.g. flexion / extension , rotation of head or spinal column, consideration should be given to use of MRI for exclusion of unstable non-bony injury.

On emergence from anaesthesia or sedation, consideration of occult injury should occur and assessment for signs and symptoms of occult spinal injury should be undertaken where clinical suspicion or concern remains.

Flexion / Extension View: Should NOT be undertaken in unconscious patients at all. They have a questionable role in the conscious patient, except in the context of planning for operative intervention after trauma (interventions that are unlikely to be undertaken in the acute phase).

Plain radiographs: Have NO role in the assessment of the unconscious trauma patient.

Fracture Exclusion

Exclusion of a fracture on imaging should be based on report from or approved by a consultant radiologist. Discussion with and assessment by a spinal or neuro- surgeons a clinician with experience of managing spinal injury should occur in any patient with suspected injury to the spinal column.

Spinal Fracture Present

If a significant fracture is noted in the spine: The region of the spine with the injury should be assumed to be unstable until reviewed by an orthopaedic or neurosurgical consultant with training in spinal injury management.

Stable cervical spine fracture for conservative management:

- Miami or Philadelphia collar will be applied in Emergency Department.
- A named spinal consultant will be responsible for the ongoing management of the spinal injury.

'Insignificant' cervical spine injuries:

These include:

- Spinous-process fracture
- Simple wedge-compression fracture without loss of 25 percent or more of vertebral body height
- Isolated avulsion without associated ligamentous injury
- Type I (Anderson–D'Alonzo) odontoid fracture
- End-plate fracture
- Osteophyte fracture, not including corner fracture or teardrop fracture
- Injury to trabecular bone
- Transverse-process fracture

These injuries do not need specialist involvement at the major trauma centre unless the patient complains of neurological symptoms or has additional significant traumatic injuries.

Traumatic Spinal Cord Injury

ASIA Score: Patients with traumatic spinal cord injury must have ASIA score performed, ideally within 1st four hours, if patient is clinically assessable.

Surgery: Patients with traumatic spinal cord injury requiring surgery should have surgery within 4 hours of injury in MTC.

Actions on Confirmation of Spinal Cord Injury

At Trauma Unit: The trauma team leader should contact the specialist Neurosurgical or Spinal Surgeon on call at North Bristol NHS Trust.

At Major Trauma Centre: The trauma team leader should contact the specialist neurosurgical or spinal surgeon on call.

Specialist Neurosurgical / Spinal Surgeon: Should contact the on call consultant or registrar at the Duke of Cornwall Spinal Treatment Centre, Salisbury District Hospital (also colloquially known as "Odstock") ideally within 4 hours of diagnosis to establish a partnership of care. Salisbury switchboard can be reached on 01722 336262.

The appropriate location for best medical management and the immediate management plan for SCI must be agreed, taking into account other injuries and pre-existing medical conditions.

Odstock will be responsible for providing ongoing advice, guidance and appropriate support via its outreach system until such time as the patient is transferred.

All patients with SCI should normally be transferred from the MTC to Odstock once a bed becomes available, unless it has been agreed that the interests of the individual patient would be best served by planning a different model of care.

Initial Assessment and Management of Spinal Cord Injury

Initial resuscitation should be according to standard trauma principles.

The management of a spinal cord injury should be agreed between spinal surgeons and the spinal cord injury centre. See page 193 for further information on contacting the spinal cord injury centre.

Airway and Cervical Spine Control

As soon as possible, the patient should be placed into the neutral supine position. Protect the cervical spine with manual in-line spinal immobilisation or blocks and tape. Avoid moving the remainder of the spine. Any turning must be through use of a coordinated "log-roll" using a minimum of 4 clinicians familiar with the principles of coordinated controlled movement of spinal cord injured patients.

Breathing

In high spinal cord injury, innervation to the intercostal muscles and diaphragm may be affected leading to hypoventilation. Many patients with spinal cord injury also have reduced or absent ability to cough. They are therefore at significant risk of impaired respiratory function.

Management:

- Continuous monitoring of SaO₂ - maintain at ≥85%
- Regular monitoring of respiratory rate, blood gases and vital capacity (by spirometry)
- If the vital capacity is reduced to <1 litre, secure the airway via endotracheal intubation and careful intermittent positive pressure ventilation
- Turn the patient 2 hourly to optimise V/Q match
- Early, regular and frequent physiotherapy, including assisted cough techniques, are the mainstay of treatment

Circulation

Neurogenic Shock:

Patients with a spinal cord injury at the level of T6 or above are at risk of neurogenic shock. Impairment of the descending sympathetic pathways results in loss of vasomotor tone and sympathetic innervation to the heart.

Vasodilatation of the lower-extremity and visceral blood vessels causes significant hypotension, whilst unopposed effects of the vagus nerve on the heart results in bradycardia. The blood pressure is often unresponsive to fluid resuscitation and vasopressors may be required.

This is of particular importance in the acute phase, when impaired perfusion to the spinal cord may extend the spinal cord lesion and worsen neurological deficits.

Management of Hypotension:

- Patients with acute spinal cord injury **must** be nursed flat
- Maintain a systolic BP of 90-100mmHg and MAP of >70mmHg. Discuss on referral to Odstock.
- Maintain a urine output of ≥ 0.5 mls/kg/hour.
- Prescribe IV crystalloid to maintain blood pressure and urine output targets.
- Monitoring of fluid balance is essential, especially in older patients and those with pre-existing cardiac and/or renal disease.
- In rare instances, inotropes may be required to maintain a stable BP.
- Prior to trial of patient sitting out for the first time, ephedrine (30-60mg orally/via nasogastric tube, once/day) may be given to prevent postural drop.

Management of Bradycardia:

An abnormal vaso-vagal response can occur through stimulation such as rapid changes in body positioning e.g. log rolling and procedures such as tracheal suctioning and NG tube insertion. This can result in significant bradycardia, hypoxia and in severe cases cardiac syncope.

- ECG monitoring is required
- If heart rate persistently ≤ 40 BPM and the patient is cardiovascularly unwell or unstable, administer Atropine 0.3-0.6mg as an IV bolus
- In patients with thoracic injuries, consider the possibility of cardiac contusion and potential resulting arrhythmias.

Assessment of Pain and Analgesia

Assess pain regularly. In the acute phase of injury, use an IV opioid as the first-line analgesic and adjust the dose as needed to achieve adequate pain relief. If intravenous access has not been established, consider the intranasal route with diamorphine or ketamine.

Consider ketamine in analgesic doses as a second-line agent.

Neurological Assessment of Spinal Cord Injury

Neurological Observations: Initial observations should be recorded every two hours.

Neurological Examination: The standardised American Spinal Injuries Association neurological examination recording chart (ASIA Chart, Appendix V, page 283), should be completed:

- Within 4 hours of admission
- After 24 & 72 hours of admission
- Following any further neurological changes
- Pre- and post-operatively if surgery is undertaken

Test pin prick sensation on the anterior surface of the body and the perineum –patients alteration in pin prick easier to report than light touch.

Perianal sensation, deep anal pressure, tone and voluntary contraction should be examined. These can be significant for bowel and bladder management.

Mark the sensory level on the patient to more easily identify changes when conducting later examinations.

There should also be an assessment of the patient's vital capacity and ability to cough.

Careful documentation of findings is important as the neurological level may change in the days following the injury.

Worsening neurological features may indicate extension of the spinal cord injury secondary to inadequate oxygenation, hypoperfusion or complications such as epidural haematoma. Neurological examination allows early identification and may prevent avoidable deterioration of neurological deficit.

Spinal Shock: This refers to flaccidity and areflexia and occurs in the acute phase of spinal cord injury. The injured cord may appear completely non-functional, although spinal cord injury is not necessarily complete. The duration of spinal shock is variable, but typically around 48 hours.

In the period of spinal shock, formal classification of the injury is not possible.

The end of spinal shock is defined by the onset of spasticity below the level of the spinal cord injury. No recovery by this time suggests complete cord injury and poor prognosis.

Spinal Cord Injury Centre

Contacting the Spinal Cord Injury Centre

The Severn Trauma Network is linked with Duke of Cornwall Spinal Treatment Centre, Salisbury District Hospital, Odstock, Salisbury

Tel: 01722 336 262

Referral to the Spinal Cord Injury Centre

The Neurosurgical / Spinal Surgeon is responsible for contacting Odstock within 4 hours of initial assessment.

- The appropriate location for medical management (including surgery) should be discussed.
- Immediate management plan should be discussed and documented
- Complete the referral paperwork (Appendix X Part 1 and 2, page 287)
- Following the telephone referral process, online registration should be completed by the person making the referral.
 - ▶ www.spinalcordinjury.nhs.uk
 - ▶ Print the confirmation email
 - ▶ Sign the SCI pathway documentation (Appendix W)
- Ensure additional required assessments are completed, including anaesthetic assessments

The SCIC outreach team should be contacted for all ongoing care management enquiries.

The patient should be reviewed by a member of the SCIC outreach team within 5 days if appropriate.

Transfer to the Spinal Cord Injury Centre

When the patient is appropriate for transfer to the SCIC the referral is prioritised and bed availability notified. Weekly updates will be sent to relevant NBT team members.

Decisions to transfer and planning for it should take place between senior staff in the transferring and receiving units. Transfer to the SCIC or local hospital repatriation should be organised using the major trauma network guidelines.

For transfer checklist, see Appendix Y

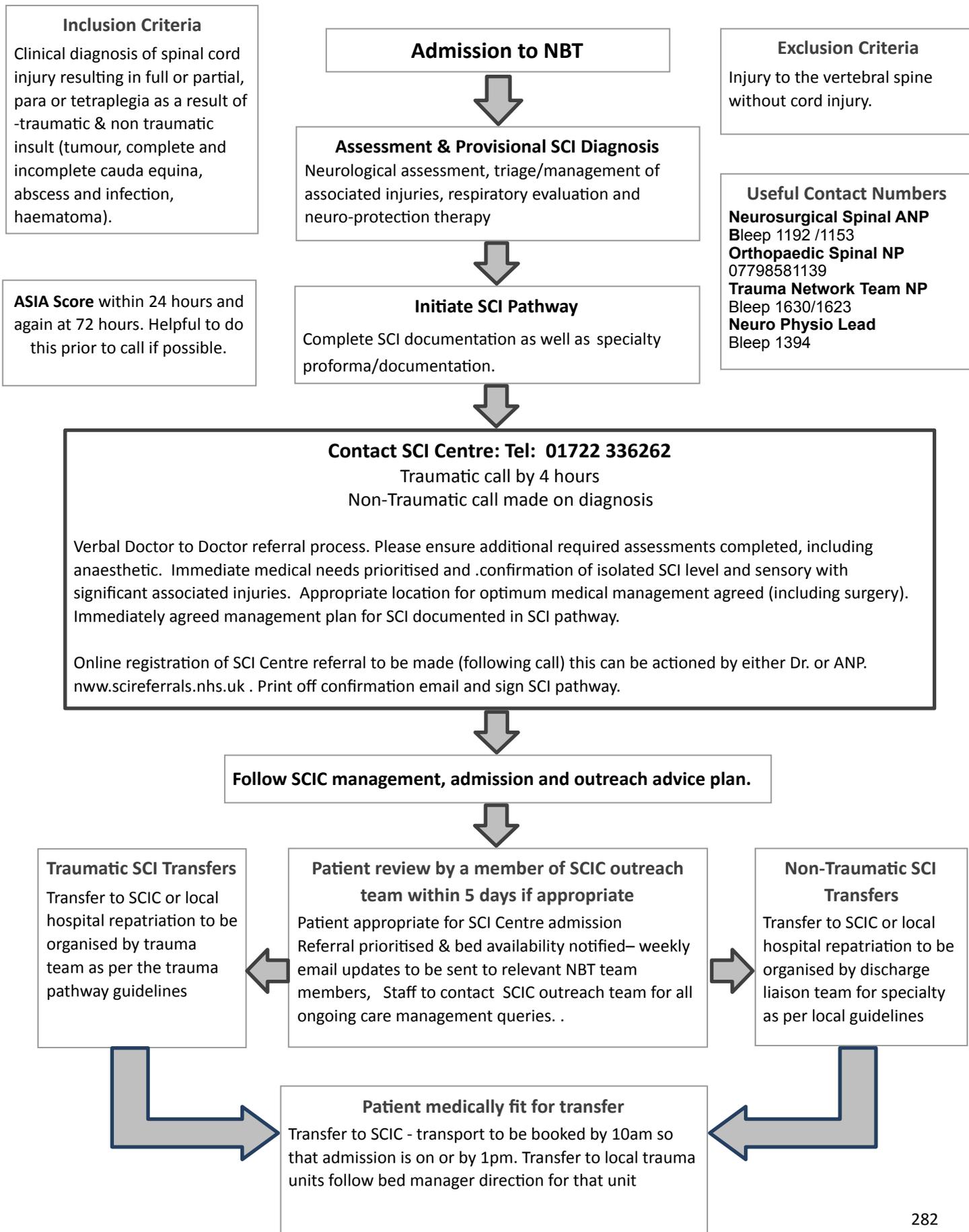
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Spinal Cord Injury Pathway

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Appendix U - Spinal Cord Injury Algorithm



Appendix V - ASIA Classification

Patient Name _____ Date/Time of Exam _____

Examiner Name _____ Signature _____

RIGHT

MOTOR KEY MUSCLES
Light Touch (LTR) Pin Prick (PPR)

SENSORY KEY SENSORY POINTS

MOTOR KEY MUSCLES

LEFT

SENSORY KEY SENSORY POINTS
Light Touch (LT) Pin Prick (PP)

MOTOR KEY MUSCLES

UER
(Upper Extremity Right)

C2	
C3	
C4	
C5	
C6	
C7	
C8	
T1	

Comments (Non-Key Muscles? Reason for NT? Pain?)

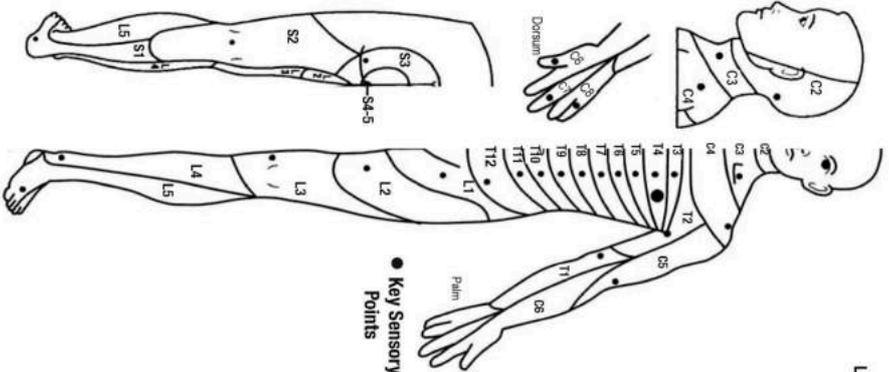
LER
(Lower Extremity Right)

L2	
L3	
L4	
L5	
S1	
S2	
S3	
S4-5	

(VAC) Voluntary Anal Contraction (Yes/No)

RIGHT TOTALS
(MAXIMUM) (50)

MOTOR SUBSCORES
UER + UEL = UEMS TOTAL (50)
MAX (25) (25)



MOTOR KEY MUSCLES
(Upper Extremity Left)

C2	
C3	
C4	
C5	
C6	
C7	
C8	
T1	

(SCORING ON REVERSE SIDE)
0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
5* = normal corrected for pain/disease
NT = not testable

SENSORY KEY SENSORY POINTS
(Lower Extremity Left)

L2	
L3	
L4	
L5	
S1	
S2	
S3	
S4-5	

(SCORING ON REVERSE SIDE)
0 = absent
1 = altered
2 = normal
NI = not testable

LEFT TOTALS
(MAXIMUM) (50)

SENSORY SUBSCORES
LTR + LTL = LT TOTAL (56)
MAX (56) (56)

NEUROLOGICAL LEVELS
1. SENSORY R L
2. MOTOR R L

3. NEUROLOGICAL LEVEL OF INJURY (NLI)

4. COMPLETE OR INCOMPLETE?
Incomplete = Any sensory or motor function in S4-5

5. ASIA IMPAIRMENT SCALE (AIS)

(In complete injuries only)
ZONE OF PARTIAL PRESERVATION Most caudal level with any innervation
SENSORY MOTOR R L

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REV 04/15

Muscle Function Grading

- 0 = total paralysis
 - 1 = palpable or visible contraction
 - 2 = active movement, full range of motion (ROM) with gravity eliminated
 - 3 = active movement, full ROM against gravity
 - 4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position
 - 5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
 - 5* = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disuse) were not present
- NT = not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal ROM)

Sensory Grading

- 0 = Absent
- 1 = Altered, either decreased/impaired sensation or hypersensitivity
- 2 = Normal
- NT = Not testable

When to Test Non-Key Muscles:

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

Movement

Movement	Root level
Shoulder: Flexion, extension, abduction, adduction, internal and external rotation	C5
Elbow: Supination	C6
Elbow: Pronation	C7
Wrist: Flexion	C8
Finger: Flexion at proximal joint, extension.	T1
Thumb: Flexion, extension and abduction in plane of thumb	L2
Finger: Flexion at MCP joint	L3
Thumb: Opposition, abduction and abduction perpendicular to palm	L4
Finger: Abduction of the index finger	L5
Hip: Adduction	S1
Hip: External rotation	
Hip: Extension, abduction, internal rotation	
Knee: Flexion	
Ankle: Inversion and eversion	
Toe: MP and IP extension	
Hallux and Toe: DIP and PIP flexion and abduction	
Hallux: Adduction	

ASIA Impairment Scale (AIS)

A = Complete. No sensory or motor function is preserved in the sacral segments S4-5.

B = Sensory Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

C = Motor Incomplete. Motor function is preserved at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments (S4-S5) by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body.

(This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLI have a muscle grade ≥ 3 .

D = Motor Incomplete. Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLI having a muscle grade ≥ 3 .

E = Normal. If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

Using ND: To document the sensory, motor and NLI levels, the ASIA Impairment Scale grade, and/or the zone of partial preservation (ZPP) when they are unable to be determined based on the examination results.

Steps in Classification

The following order is recommended for determining the classification of individuals with SCI.

1. **Determine sensory levels for right and left sides.**
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.
2. **Determine motor levels for right and left sides.**
Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).
Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.
3. **Determine the neurological level of injury (NLI)**
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.
The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.

4. Determine whether the injury is Complete or Incomplete.

(i.e. absence or presence of sacral sparing)
If voluntary anal contraction = **No AND** all S4-5 sensory scores = **0 AND** deep anal pressure = **No**, then injury is **Complete**.
Otherwise, injury is **Incomplete**.

5. Determine ASIA Impairment Scale (AIS) Grade:

Is injury **Complete?** If YES, AIS=A and can record ZPP (lowest dermatome or myotome on each side with some preservation)

Is injury Motor Complete? If YES, AIS=B

NO → (No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)

Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?

NO → AIS=C
YES → AIS=D

If sensation and motor function is normal in all segments, AIS=E

Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply.



Appendix W - Spinal Cord Injury Care Pathway

Part 1: Patient Information					
Patient Name:					
Date of Birth:					
Hospital Number:					
Address:					
Consultant Neurosurgeon / Orthopaedic Surgeon / Other Responsible for SCI Care:					
Part 2: Admission Details					
Date and Time of Injury					
Mechanism of Injury	Traumatic SCI		Non Traumatic SCI		
Date	Provisional / Actual Spinal Cord Injury Diagnosis				
Part 3: Spinal Injury Neurological Assessment Record:					
<i>ASIA Score must be completed once diagnosis, within 24 hours, 72 hours and following any clinical changes. If spinal surgery is undertaken the ASIA Chart must be carefully completed both pre and post-operatively. NB: This is however less reliable in the presence of spinal shock</i>					
1 st	Within 4hrs of admission by assessing Dr	ASIA Completed		Date	Sign
2 nd	Within 24hrs of admission	ASIA Completed		Date	Sign
3 rd	Within 72hrs of admission	ASIA Completed		Date	Sign
4 th	Further neurological changes	ASIA Completed		Date	Sign
5 th	Further neurological changes	ASIA Completed		Date	Sign
6 th	Further neurological changes	ASIA Completed		Date	Sign
7 th	Further neurological changes	ASIA Completed		Date	Sign

Part 4: Current Management of Injury

Spine Precautions / Orthotics / Patient Handling etc.

Date	Logroll Y <input type="checkbox"/> N <input type="checkbox"/> Sit up Y <input type="checkbox"/> N <input type="checkbox"/> Full mobilisation Y <input type="checkbox"/> N <input type="checkbox"/> TLSO Y <input type="checkbox"/> N <input type="checkbox"/> JTO Y <input type="checkbox"/> N <input type="checkbox"/> Traction Y <input type="checkbox"/> N <input type="checkbox"/> Halo Y <input type="checkbox"/> N <input type="checkbox"/> Hard collar Y <input type="checkbox"/> N <input type="checkbox"/> Orthotic referral Y <input type="checkbox"/> N <input type="checkbox"/>	Sign
Date	Logroll Y <input type="checkbox"/> N <input type="checkbox"/> Sit up Y <input type="checkbox"/> N <input type="checkbox"/> Full mobilisation Y <input type="checkbox"/> N <input type="checkbox"/> TLSO Y <input type="checkbox"/> N <input type="checkbox"/> JTO Y <input type="checkbox"/> N <input type="checkbox"/> Traction Y <input type="checkbox"/> N <input type="checkbox"/> Halo Y <input type="checkbox"/> N <input type="checkbox"/> Hard collar Y <input type="checkbox"/> N <input type="checkbox"/> Orthotic referral Y <input type="checkbox"/> N <input type="checkbox"/>	Sign
Date	Logroll Y <input type="checkbox"/> N <input type="checkbox"/> Sit up Y <input type="checkbox"/> N <input type="checkbox"/> Full mobilisation Y <input type="checkbox"/> N <input type="checkbox"/> TLSO Y <input type="checkbox"/> N <input type="checkbox"/> JTO Y <input type="checkbox"/> N <input type="checkbox"/> Traction Y <input type="checkbox"/> N <input type="checkbox"/> Halo Y <input type="checkbox"/> N <input type="checkbox"/> Hard collar Y <input type="checkbox"/> N <input type="checkbox"/> Orthotic referral Y <input type="checkbox"/> N <input type="checkbox"/>	Sign
Date	Logroll Y <input type="checkbox"/> N <input type="checkbox"/> Sit up Y <input type="checkbox"/> N <input type="checkbox"/> Full mobilisation Y <input type="checkbox"/> N <input type="checkbox"/> TLSO Y <input type="checkbox"/> N <input type="checkbox"/> JTO Y <input type="checkbox"/> N <input type="checkbox"/> Traction Y <input type="checkbox"/> N <input type="checkbox"/> Halo Y <input type="checkbox"/> N <input type="checkbox"/> Hard collar Y <input type="checkbox"/> N <input type="checkbox"/> Orthotic referral Y <input type="checkbox"/> N <input type="checkbox"/>	Sign
Date	Logroll Y <input type="checkbox"/> N <input type="checkbox"/> Sit up Y <input type="checkbox"/> N <input type="checkbox"/> Full mobilisation Y <input type="checkbox"/> N <input type="checkbox"/> TLSO Y <input type="checkbox"/> N <input type="checkbox"/> JTO Y <input type="checkbox"/> N <input type="checkbox"/> Traction Y <input type="checkbox"/> N <input type="checkbox"/> Halo Y <input type="checkbox"/> N <input type="checkbox"/> Hard collar Y <input type="checkbox"/> N <input type="checkbox"/> Orthotic referral Y <input type="checkbox"/> N <input type="checkbox"/>	Sign
Date	Logroll Y <input type="checkbox"/> N <input type="checkbox"/> Sit up Y <input type="checkbox"/> N <input type="checkbox"/> Full mobilisation Y <input type="checkbox"/> N <input type="checkbox"/> TLSO Y <input type="checkbox"/> N <input type="checkbox"/> JTO Y <input type="checkbox"/> N <input type="checkbox"/> Traction Y <input type="checkbox"/> N <input type="checkbox"/> Halo Y <input type="checkbox"/> N <input type="checkbox"/> Hard collar Y <input type="checkbox"/> N <input type="checkbox"/> Orthotic referral Y <input type="checkbox"/> N <input type="checkbox"/>	Sign

Appendix X - Referral to Spinal Cord Injury Centre

Part 1: Referral to Spinal Cord Injury Centre

Parts a and b are both mandatory

Spinal Cord Injury Centre	<input type="checkbox"/> Duke of Cornwall Spinal Treatment Centre, Salisbury District Hospital, Salisbury (01722 336262) <input type="checkbox"/> Other:
----------------------------------	---

a) Verbal referral and management plan discussed with Consultant/SPR at SCIC

<input type="checkbox"/>	Within 4 hours of injury/ diagnosis	Discussion with Cons/SPR:.....		
--------------------------	--	--------------------------------	--	--

Call Made By	Name	Date	Time	Signature
---------------------	------	------	------	-----------

<input type="checkbox"/>	Within 24 hours of injury/ diagnosis	Discussion with Cons/SPR:.....		
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Call Made By	Name	Date	Time	Signature
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b) Online referral form (after call)

Form completed by:	Name	Date	Time	Signature
---------------------------	------	------	------	-----------

Part 2: Please Record the Plan from SCIC

	Deviation from SCIC plan:
Ventilation	Y <input type="checkbox"/> N <input type="checkbox"/>

Circulation	MAP Target: Duration:	Y <input type="checkbox"/> N <input type="checkbox"/>
Position:		Y <input type="checkbox"/> N <input type="checkbox"/>
DVT		Y <input type="checkbox"/> N <input type="checkbox"/>
Skin		Y <input type="checkbox"/> N <input type="checkbox"/>
Gastric Protection	<input type="checkbox"/> NBM/ <input type="checkbox"/> NG Free drainage/ <input type="checkbox"/> NG feed	Y <input type="checkbox"/> N <input type="checkbox"/>
Bladder	<input type="checkbox"/> Indwelling catheter/ <input type="checkbox"/> Suprapubic catheter <input type="checkbox"/> Self-Intermittent catheterisation	Y <input type="checkbox"/> N <input type="checkbox"/>
Bowel	Commence NBT neurogenic bowel pathway: <input type="checkbox"/> Reflexic pathway / <input type="checkbox"/> Areflexic pathway	Y <input type="checkbox"/> N <input type="checkbox"/>
Autonomic Dysreflexia	At risk of AD? Y <input type="checkbox"/> (if SCI at or above T6) / N <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>
Mental Health	Mental health referral advised? Yes <input type="checkbox"/> / No <input type="checkbox"/>	Y <input type="checkbox"/> N <input type="checkbox"/>

Document any deviation from SCIC plan and reasoning:

Section 2. SCIC Outreach visits – visits by specialist spine practitioners

Date	Advice given	Sign

Appendix Y - Transfer to Spinal Cord Injury Centre Checklist

Transfer to SCIC Checklist	Yes	No	NA
Does this patient need a HDU or ITU bed?			
Immobilisation of the spine is adequate and secure			
Long bone fracture immobilisation			
Airway is clear and can be maintained during transfer Intubate if PaCO ₂ is >5.5 KPa or if respiratory failure is likely to develop during a prolonged transfer			
Supplemental O ₂ is being administered and ventilation is adequate whether spontaneous or assisted. Voluntary vital capacity should exceed > 15 ml/kg: elective ventilation if incipient or frank respiratory failure			
Chest drainage if pneumothorax or haemothorax before transfer			
IV is patent and infusing at desired rate			
Naso-gastric tube is in situ, draining freely.			
Indwelling urinary catheter is in situ and draining freely			
Skin is protected from injury and apparatus or debris which may cause pressure ulcers is cleared away			
Level of Spinal Cord Injury is documented			
Other injuries – thorax, abdomen, pelvis etc. are documented and stabilised			
Any head injury documented and monitored			
Copy of Medical records, drug charts and test results			
X-rays or radiology images have been transferred using: Image Exchange Portal □ Decrypted CD □			
Nurse to Nurse handover			
Family/relatives aware of transfer			
Repatriation to another Hospital:			
Copy of Medical records, drug charts and test results including SCI care documents.			
Nurse to Nurse handover			
Transfer letter			

Outpatients Appointment? Date_____ Time_____			
Planning for home			
TTA completed and dispensed			
Family aware of discharge			
Transport Booked			
Package of Care set up			