1. Key messages

The Victorian State Trauma System (VSTS) provides support and retrieval services for critically injured patients requiring definitive care, transfer and management. This spinal trauma guideline provides evidence-based advice on the initial management and transfer of major trauma patients who present to Victorian health services with spinal injuries.

This guideline is developed for all clinical staff involved in the care of trauma patients in Victoria. It is intended for use by frontline clinical staff that provide early care for major trauma patients; those working directly at the Major Trauma Service (MTS) as well as those working outside of a MTS. These spinal management guidelines provide up-to-date information for frontline healthcare clinicians.

These guidelines provide the user with accessible resources to effectively and confidently provide early care for critically injured spinal patients. The guideline has been assessed utilising the AGREE II methodology for guideline development and is under the auspice of the Victoria State Trauma Committee (VSTC).\(^1\)

**Clinical emphasis points**

The early management of trauma patients should emphasise the possibility of a spinal injury with a focus on clinical protective mechanisms.

- Protective handling is essential to minimise secondary spinal cord injury in the early management of spinal trauma.
SPINAL TRAUMA GUIDELINE

- Regular neurological assessment should be undertaken to monitor for progressive deterioration in function.
- Deteriorating respiratory function in a spinal trauma patient may indicate the need for intubation. This requires specific planning and intervention.
- Once the patient is identified as suffering from a spinal injury, early activation of the retrieval process is crucial.
- All polytrauma patients are ideally managed at an MTS. Adult trauma patients with an isolated spinal injury should be transferred to the Victorian Spinal Cord Service (VSCS), Austin Health.
- Adult Retrieval Victoria (ARV) is the first point of call to initiate retrieval and transfer in the adult patient.
- The main goal of early care is to ensure optimum resuscitation in the emergency setting as well as activation of the retrieval network, with timely transfer to an appropriate facility.
# Spinal Trauma

Make early contact with ARV/PIPER for advice from the major trauma services and to initiate retrieval.

**Early Activation**
- Gather vital information
- Activate Trauma Team
- Designate roles
- Set up to receive patient
- Ensure safety using PPE

**Primary Survey**

### Airway / C-Spine
- Protect Airway
- Assess risk of aspiration
- Prevent bradycardia during survey manipulation
- Maintain full spinal precautions

### Breathing
- Identify and treat life threats
- Oxygen therapy to maintain SpO2 94-98%
- Assess RR, work of breathing, SpO2, and symmetry
- ETCO2 monitoring if intubated, maintain 35-45 mmHg

### Circulation
- Insert 2 large bore IV canulas
- Access HR/EKG/Cap rell
- Monitor for signs of neurogenic shock
- Identify source of possible hemorrhage & commence cautious fluid resuscitation if required

### Disability
- Assess level of consciousness
- Check pupils
- Check EDL

### Exposure / Environment
- Fully expose patient
- Prevent heat loss
- Log roll

### Adjuncts
- FAST scan
- Analgesia
- X-rays: Chest, Pelvis, Abdomen: PEB X-mat, Ultrasound, LAC, LAC
- 12 lead ECG
- Insert IDC
- Oesophageal tube if intubated
- AMPLE monoramic

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**Key Points**

- **Spinal cord oedema**
  - Ongoing assessment of the patient’s neurological function is indicated to assess for symptoms extending due to ascending spinal cord oedema.
  - Rising oedema may result in progressive loss of diaphragmatic function & inability to breathe.

- **Airway management**
  - High cervical injuries potentiate loss or compromise of both gag and cough responses.
  - Pharyngocutaneous fistulae and high spina bifida patients with stoma are indicated prior to airway management due to uncoordinated vocal cord and the risk of bradycardia during pharyngeal stimulation.

- **Neurogenic shock**
  - Caused by SCI affecting the 8th thoracic vertebra or above, leading to losses of sympathetic nervous system control.
  - Compensatory mechanisms are unable to be controlled. The resulting vasodilation leads to hypotension, warm flushed skin yet may be centrally cool & bradycardic.
  - Avoid fluid to maintain urinary output as an indicator of perfusion and monitor the fluid balance.

- **Cervical collar**
  - At potential major trauma patients suspected of having a SCI should arrive with a hard collar intact.
  - Assess for pressure area risk. Apply an appropriately sized rigid foam collar e.g. Philadelphia, daily within 624.

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**Spinal Trauma considerations**

- **SPEED assessment**
  - Spinal Emergency Evaluation of Deficits (SPEED) is a brief assessment which uses foot motor and sensory function to indicate injury severity and C3 dermatomal sensation, hand grip strength and location of spinal pain to indicate the level of injury.
  - This new approach to early SCI assessment is an important step to undertake the complete ASIA assessment requires significant time and training.

- **Log Roll**
  - Maintain in line stabilization
  - Impact the entire length of the neck and back noting any deformity, bruising and lacerations. Follow for any tenderness or steps between the vertebrae.
  - The cervical spine will be thoroughly assessed after transfer to a major trauma service and specialist assessment, therefore advanced imaging is generally not required in the early stages of SCI.

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**Inter-Hospital Transfer Guidelines (Discuss via ARV/PIPER)**

<table>
<thead>
<tr>
<th>Pediatric Major Trauma Patient (MTP) &amp; SCI</th>
<th>Adult MTP &amp; SCI</th>
<th>Isolated SCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royal Children's Hospital</td>
<td>Major Trauma Service Inter-hospital transfer</td>
<td>Victorian Spinal Cord Service - Austin Health</td>
</tr>
</tbody>
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** ambulancевictoria | 1300 36 86 61 | ARV Adult Retrieval Victoria | 1300 13 76 50 | 17/2/2019 | Contact: Trauma.Victoria@ambulance.vic.gov.au |
3. Introduction

In Victoria, most spinal cord injuries (SCI) result in permanent neurological disability for patients. Australian data collected from 2006–07 indicated that 52% per cent of injuries were related to transport crashes and 29% were as a result of falls. These two mechanisms alone accounted for more than three-quarters of all traumatic SCI. Presentations of SCI have a bimodal distribution. Cases related to trauma in younger adults often involve higher velocity injury in a healthy spine. Injuries to the older adult often appear in later life with other causes, which may be associated with a lower velocity injury in a vulnerable spine. These may be a result of a pathological vertebral fracture, a first sign of malignancy and/or result from seemingly insignificant injury presentation.

Damage to the spinal cord may cause irreversible injury with the outcome of either temporary or permanent neurological deficit. The natural progression of SCI, in particular rising spinal cord oedema, may lead to an exacerbation of symptoms in the hours following an accident. Early care of SCI can have a significant effect on the long-term outcomes for these patients, with safe and appropriate transport to definitive care facilities a vital process. Emergent surgical fixation, where indicated, and stabilisation of the spinal injury may provide the best outcome for patients and is the first stage of recovery.

Injuries to the spinal cord may be classified as: complete (with no neurological connection between the cortex of the brain and the lowest sacral spinal cord segment) and incomplete injury (with some connection maintained). The American Spinal Injury Association (ASIA) Standards for Classification of Neurological Injury include documentation of incomplete and/or motor preservation and identification of unilateral deficits. (Refer to Appendix 1)

Following a traumatic injury, the spinal cord becomes oedematous and, with limited capacity for swelling inside the vertebral column, normal neurological function rapidly becomes compromised. This may affect about two nerve exit levels of the spinal cord above the level of initial injury. As resolution of swelling occurs over time, there may be recovery at the level of SCI but not always recovery in the long tracts below.

Importantly, SCI trauma patients may present with an amalgamation of motor and sensory neurological deficits, which may be unilateral or bilateral, affecting upper and/or lower body regions. Conscious patients may describe various perceptions such as numbness, burning pain or absence of feeling or movement. The emerging and frequently ascending nature of spinal injury signs and symptoms indicate a need for exacting and ongoing assessment, as well as monitoring and management of the SCI trauma patient.

Two important outcomes of a SCI are neurogenic shock and spinal shock.

**Neurogenic shock** is seen in SCI affecting the sixth thoracic vertebrae or above, thus loss of over 50% of sympathetic nervous system control typically occurring within 30 minutes of cord damage and lasting six to eight weeks following injury. It is a result of the loss of vasomotor and sympathetic nervous system tone or function. Its critical features are changed parameters with the triad of hypotension, bradycardia and poikilothermia.

**Spinal shock** is a combination of the immediate loss of sympathetic tone, decreased reflexes and autonomic dysfunction that accompanies SCI. Skeletal and smooth muscles are therefore flaccid from hours to weeks.

All patients with spinal trauma must receive a rapid and systematic primary and secondary survey. The main goals are to ensure understanding of injury mechanisms and pattern, optimum management in the emergency setting, including prevention of secondary insults,
and activation of the retrieval network, with timely transfer to an appropriate trauma facility.

4. Early activation

Emergency medical services should notify the receiving hospital that a trauma patient with suspected SCI is on the way. This information may be crucial to how a severely injured patient is managed and can allow for communication to vital members of the response team as well as time to prepare the department for the patient’s arrival.

*The presence of acute SCI needs to be assumed in a multi-trauma patient, particularly with altered conscious state, until it can be dismissed by appropriate clinical and radiological examination.*

The following sequence of actions should take place upon initial notification:

1. Gather vital information from the notifier using the MIST mnemonic:
   - **M** Mechanism of injury
   - **I** Injuries found or suspected
   - **S** Signs: respiratory rate, pulse, blood pressure, SpO2, GCS or AVPU
   - **T** Treatment given

2. Ensure all staff involved in patient care are wearing gloves, aprons and eye protection. Personal protective equipment is vital in the care of trauma patients.

3. Activate the trauma team and available support departments (medical imaging, pathology). In small health service settings this may only consist of a clinician and a nurse. Additional staff may be gathered from wards or on call. It may be necessary to utilise the skills of all available resources including emergency response personnel in the initial trauma management.

4. Set up the trauma bay to receive the patient, including equipment checks, documentation, medications and resuscitation equipment.

5. Designate roles and specific tasks to staff and maintain an approach based on teamwork. Ensure good communication between all parties involved in managing the trauma. Use closed-loop communication, which ensures accuracy in information shared between response staff. Repeat instructions, make eye contact and provide feedback. Misinterpreted information may lead to adverse events.

If there is no prior notification of the patient, then rapid activation of the trauma team request must take place and any additional resources notified. If it is anticipated that transfer to an MTS will be required, early retrieval activation is essential (phone ARV on 1300 368 661).

- Early retrieval activation ensures access to critical care advice and a more effective retrieval response.
- Early activation and timely critical care transfer improves clinical outcomes for the patient.

Even if you are unsure, call the ARV coordinator, who can provide expert guidance and advice over the phone or via tele- or videoconference, and link to an MTS as required.
5. Early rapid neurological assessment

A rapid assessment to be used in the prehospital and emergency settings is currently being trialled and is showing excellent results. A brief assessment called the SPinal Emergency Evaluation of Deficits (SPEED) uses foot motor and sensory function to indicate injury severity and C3 dermatome sensation, handgrip strength and location of spinal pain to indicate the level of injury. This new approach to early SCI assessment is an important step as to undertake the complete American Spinal Injury Association (ASIA) assessment requires significant training and given the time and complexity cannot be undertaken in the field. The SPEED assessment appears capable of accurately determining the severity and level of cervical SCI in the first hours post-injury. A neurological assessment that can be performed rapidly after injury is important for clinical trials of early therapy and to identify patients most likely to benefit from intervention10.

### SPEED

**SPinal Emergency Evaluation of Deficits**

<table>
<thead>
<tr>
<th>Motor Scoring</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle or toe movement (please record)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No movement</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flicker movement at toe or ankle</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Definite movement at toe or ankle</td>
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<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sensory Scoring</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light touch C3 (please record)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Altered</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Normal</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exclusion high cervical injury</th>
<th>Midline (angular notch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light touch C3 (please record)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Altered</td>
<td>1</td>
</tr>
<tr>
<td>Normal</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Confirmation of cervical SCI</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand grip (please record)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Can you squeeze my hand?”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No movement</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Weak</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Strong</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Approximate location of spinal pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>If applicable: Please record the region as indicated and/or approximate verteboreal level</td>
</tr>
<tr>
<td>Upper cervical (UC): C1-2 (or iter and above)</td>
</tr>
<tr>
<td>Cervical (C): C3-C7 (below ear to clavicle)</td>
</tr>
<tr>
<td>Upper thoracic (UT): T1-T8 (below clavicle to end of sternum)</td>
</tr>
<tr>
<td>Lower thoracic/lumbar (LT): T9-T12 (below end of sternum to sacrum)</td>
</tr>
</tbody>
</table>

SPEED score
0 = nothing = complete
1 = something = incomplete
2 = normal

**DATE AND TIME OF ASSESSMENT (please record):**
6. Primary survey

Use a systematic approach based on the ABCDE survey to assess and treat acutely ill patients. The goal is to manage any life-threatening conditions and identify any emergent concerns, especially in an SCI patient who may present with other complications of trauma.

All patients with a mechanism of injury likely to have induced SCI must have an appropriately fitted and sized collar placed and inline immobilisation implemented. Regular assessment is crucial in SCI trauma patients as developing cord oedema may cause significant changes in neurological function.

**Airway with cervical spine protection**

Early and safe airway management in the SCI patient can make a crucial impact to long-term patient outcomes and functional deficits.

*Assess for airway stability*

Attempt to elicit a response from the patient.

Look for signs of airway obstruction (use of accessory muscles, paradoxical chest movements and see-saw respiration).

Listen for any upper-airway noises and breath sounds. Are they absent, diminished or noisy?

Spinal patients are at particular risk of passive regurgitation and subsequent aspiration. High cervical injuries potentiate loss or compromise of both gag and cough responses. (Nasogastric tube insertion is highly recommended although consideration of intubation and inherent airway protection should be considered prior to insertion.)

*Attempt simple airway manoeuvres if required*

Open the airway using a chin lift or jaw thrust.

Suction the airway if excessive secretions are noted or if the patient is unable to clear it themselves.

Insert an oropharyngeal airway (OPA)/nasopharyngeal airway (NPA) if required.

*Secure the airway if necessary (treat airway obstruction as a medical emergency)*

Consider early intubation if there are any signs of:

- Decreased level of consciousness, unprotected airway, an uncooperative/combative patient leading to distress and further risk of injury.
- Pending airway obstruction: stridor, hoarse voice.
- Apnoea or respiratory failure due to paralysis.

Intubation of the patient while maintaining full spinal precautions requires skill and a high level of teamwork.

Manoeuvres to open the airway that mobilise the cervical spine, such as a neck tilt are contraindicated. Only jaw thrust and chin lift should be utilised.

Manual in-line cervical stabilisation must be maintained while the cervical collar is removed to facilitate intubation. A second assistant may apply cricoid pressure over the cricoid cartilage ring while intubation is performed. The use of external laryngeal
Manipulation may be an effective procedure to mobilise the airway and to facilitate vocal cord identification. Prophylactic, pre-treatment of quadriplegic and high-paraplegic patients with atropine is indicated prior to airway management due to unopposed vagal tone and the risk of bradycardia during pharyngeal stimulation.

**Breathing and ventilation**

Patients with a spinal injury may have respiratory compromise relative to the level of injury and spinal cord compromise, remembering that the diaphragm is innervated by cervical nerves 3, 4 and 5. Breathing and ventilation may be compromised by direct pulmonary injury or aspiration. They may present with an inadequate cough reflex, hypoventilation and apnoea. Rising spinal cord oedema may result in progressive loss of diaphragmatic function.

Paradoxical breathing, a sign of high spinal injury, results from activation of the diaphragm while thoracic muscles remain paralysed, causing the thorax to cave in (respiratory movements in which the chest wall moves in on inspiration and out on expiration, in reverse of the normal movements).

**Assess the chest**

Assess the patient’s ventilation by monitoring their respiratory rate and oxygen saturation. Auscultate to identify abnormal breath sounds and assess their bilateral air entry.

**Circulation with haemorrhage control**

Intravenous access should be obtained early to permit fluid administration. Management of volume resuscitation is important in spinal patients and hypotension should be avoided; a general guide is to maintain a systolic blood pressure of above 90 mmHg. It is important not to assume that hypotension in a patient with SCI is solely as a result of their cord injury without excluding other causes such as haemorrhage.

Inspect for any signs of haemorrhage and apply direct pressure to any external wounds. Consider the potential for significant intrathoracic bleeding related to the mechanism of injury, which may lead to signs and symptoms of shock.

Expect hypotension and bradycardia associated with spinal shock in those with lesions above the sixth thoracic vertebrae.

Additionally, neurogenic shock may cause a bradycardia, contributing to hypotension, and may require treatment with medication such as atropine. Pulse commonly falls to 55 bpm or less.

*A heart rate less than 45 bpm and blood pressure under 90 mmHg require treatment in consultation with ARV and the receiving unit. If necessary, perform a FAST scan.*

Consider the need for FAST (Focused Assessment with Sonography in Trauma) if available and if staff are trained in its use. FAST is used primarily to detect pericardial and intraperitoneal blood, and it is more accurate than any physical examination finding for detecting an intra-abdominal injury.

If the patient is haemodynamically stable and there are no signs of significant internal bleeding then FAST may be delayed until the secondary survey.
Disability: neurological status
Perform an initial AVPU assessment (Alert, responds to Voice, responds to Pain, Unresponsive); check the patient’s pupillary response.
Until ruled out by appropriately qualified clinical personnel (and where necessary with supportive radiological examination), major trauma patients should be considered at risk of spinal injury.
Identifying a cervical spinal injury in primary assessment is important. Priapism, diaphragmatic breathing and loss of anal tone are key signs of high spinal cord compromise.
Combative patients should not be physically restrained due to the increase in leverage and potential for further injury. Sedation, intubation and ventilation may be indicated to manage severe agitation.

Exposure/environmental control
Remove the patient’s clothing to allow a complete examination.
An SCI patient can become hypothermic due to the loss of autonomic regulation, so it is important to monitor their temperature and keep them in a warm environment.

7. Secondary survey
The secondary survey is only to be commenced once the primary survey has been completed and any life-threatening injuries have been treated. If during the examination any deterioration is detected, go back and reassess the primary survey.

History
Taking an adequate history from the patient, bystanders and emergency personnel of the events surrounding the injury can assist with understanding the extent of the injury, and any possible other injuries.
Use the AMPLE acronym to assist with gathering pertinent information\(^4\):
A    Allergies
M    Medication
P    Past medical history including tetanus status
L    Last meal
E    Events leading to injury

Head-to-toe examination
A thorough examination of motor, sensory and reflex capacity is crucial and systems should be assessed independently and systematically. A head-to-toe assessment is an established approach in assessing neurological function. Where transfer to a MTS or the Victorian Spinal Cord Service at the Austin is imminent, a full ASIA assessment can be delayed while preparing the patient for transfer if the SPEED assessment has been completed.
Motor: Muscle groups should be assessed. It is often difficult to test some segments due to traumatic injuries, therefore upper limbs are often most easily assessed. Strength rated 1/5 to 5/5 should be documented in addition to any deficits of left or right responses.

Sensory: Sensation should be assessed systematically with initial tests using light touch. If no response then increase to sharp stimulation. The trigeminal nerve, exiting above the spinal cord, is a useful reference point for assessing primary SCI where intact facial sensation is expected.

Reflexes: Reflex responses should be obtained by usual assessment practice.

Head and face

This examination should be conducted with the patient remaining supine. Inspect the face and scalp. Look for any lacerations and bruising including mastoid or periorbital bruising, which is indicative of a base of skull fracture. Gently palpate for any depressions or irregularities in the skull.

Look in the eyes for any foreign body, subconjunctival haemorrhage, hyphaema, irregular iris, penetrating injury or contact lenses.

Assess the ears for any signs of cerebrospinal fluid leak, bleeding or blood behind the tympanic membrane. Check the nose for any deformities, bleeding, septal haematoma or cerebrospinal fluid leak.

Look in the mouth for any lacerations to the gums, lips, tongue or palate. Note any swelling, which may indicate further injury. Inspect the teeth, noting if any are loose, fractured or missing.

Test eye movements, pupillary reflexes, vision and hearing.

Palpate the bony margins of the orbit, maxilla, nose and jaw. Inspect the jaw for any pain or trismus.

Neck

NEXUS criteria

All potential major trauma patients suspected of having a cervical spine injury will arrive in the Emergency department with a rigid collar applied by ambulance crew. Assessment and imaging will occur while the patient has the rigid collar in situ. Clinical examination using the NEXUS low risk criteria should be performed, however this can only occur four hours after the last administration of narcotics.

The NEXUS low risk criteria constitute a decision tool for use in the initial assessment of conscious patients to indicate those at very low risk of cervical spine injury following blunt trauma who may not need radiographic imaging.

Patients are considered to be at extremely low risk of cervical spine injury if ALL of the following criteria are fulfilled:

1. No midline cervical spine tenderness
2. No focal neurologic deficit
3. No evidence of intoxication
4. No painful distracting injury
5. No altered mental status
If all of the above criteria are satisfied, clinical examination may then proceed. If there is no evidence of any bruising, deformity or tenderness on examination, and if a full range of active movement can be performed without pain (including 45 degree rotation to left and right), the cervical spine can be cleared without radiographic imaging and the cervical collar be removed.

Should the patient exhibit any of the criteria, however, clinical examination is unreliable and radiographic assessment of the cervical spine is advised.

For further details on the NEXUS criteria, refer to Appendix 2.

**Neck Examination**

To ensure adequate access have another colleague maintain manual in-line stabilisation while the collar is removed for palpation and throughout the examination.

Gently palpate the cervical vertebrae. Note any cervical spine pain, tenderness or deformity. The point of maximum tenderness should be noted. Deformity may be felt in significant vertebral disruption or dislocation.

Check the soft tissues for bruising, pain and tenderness.

Complete the neck examination by observing the neck veins for distension and palpating the trachea and the carotid pulse. Note any tracheal deviation or crepitus.

The patient will need to be log rolled to complete the full examination. This should be combined with the back examination.

**Chest**

Inspect the chest, observing movements. Look for any bruising, lacerations or penetrating injury.

Palpate for clavicle or rib tenderness. Look for bilateral chest expansion.

Auscultate the lung fields; note any changes to percussion, lack of breath sounds, wheezing or crepitations.

Check the heart sounds: apex beat and presence and quality of heart sounds.

**Abdomen**

Inspect the abdomen. Look for any distension or swelling, bruising, lacerations or penetrating injuries.

Palpate for areas of tenderness, especially over the liver, spleen, kidneys and bladder.

Check the pelvis. Gently palpate for any tenderness. **Do not spring the pelvis.** Any additional manipulation may exacerbate haemorrhage\(^{15}\). Apply a binder if a pelvic fracture is suspected.

Auscultate bowel sounds.

Inspect the perineum and external genitalia.

**Limbs**

Inspect all the limbs and joints. Note any bruising or lacerations and muscle, nerve or tendon damage. Look for any deformities, penetrating injuries or open fractures. Palpate for bony and soft-tissue tenderness and check joint movements, stability and muscular power.
Examine the sensory and motor function of any nerve roots or peripheral nerves that may have been injured. Assess distal perfusion for capillary refill, pulse and warmth.

Refer to Appendix 1: American Spinal Association: International Standards for Neurological Classification of Spinal Cord Injury

**Back**
Log roll the patient. Maintain in-line stabilisation throughout. Inspect the entire length of the back and buttocks noting any bruising and lacerations. Palpate the spine for any tenderness or steps between the vertebrae. Include a cervical examination at this stage. Many patients with SCI have vertebral injury at more than one level. Do not sit the patient up. Digital examination should be performed in suspected SCI. Note any loss of tone or sensation.

**Buttocks and perineum**
Look for any soft-tissue injury such as bruising or lacerations.

**Genitalia**
Inspect for soft-tissue injury such as bruising or lacerations. Note any priapism that may indicate spinal injury.

**8. Planning and communication**
For a trauma team to run effectively there must be an identifiable leader who will direct the resuscitation, assess the priorities and make critical decisions. Good communication between the trauma team members is vital, as is ensuring that local senior staff are aware and can provide additional support if required. Once the initial assessment and resuscitation is underway, it is important to plan the next steps in immediate management. Priorities for care must be based on sound clinical judgement, patient presentation and response to therapies. Awareness of limitations in resources as well as training in the emergency field is vital. If escalation of care to senior staff is warranted, then do so early in the patient care episode. Do not wait until the patient deteriorates to ask for assistance.

Frontline clinical staff should initiate contact with ARV early in the patient care pathway or, more importantly, as soon as it is identified that the patient meets the inter-hospital trauma transfer criteria or may have sustained injuries beyond the clinical skill set of the emergency department or urgent care centre. ARV can be contacted at any time throughout the patient care episode to offer or coordinate clinical advice and consultation. ARV coordinators can facilitate a three-way conversation between the referral health service, specialist burn resources and the ARV consultant to discuss the best, timely management of the patient.
The decision of when to transfer an unstable patient should ideally be made by the transferring and receiving clinicians in collaboration with the retrieval service. Clear communication is crucial: the transmission of vital information allows receiving clinicians to mobilise needed resources while the inadvertent omission of such information can delay definitive care. Information should be conveyed in both verbal and written (via the patient record) form and should include the patient’s identifying information, relevant medical history, pre-hospital management and emergency department evaluation and treatment (including any procedures performed and imaging obtained).

It is important that additional communication with the ARV coordinator is initiated when there is:

1. Significant deterioration in:
   - conscious state
   - blood pressure
   - heart rate
   - respiratory status
   - oxygenation

2. Major clinical developments such as significantly abnormal diagnostic tests or new clinical signs.

3. The need for major interventions prior to the retrieval team arriving (for example, intubation or surgery). This will ensure the retrieval team is prepared, the patient receives the appropriate care en route and the patient is referred to the correct facility.

9. Early management

Airway management
Fluid resuscitation
Monitoring
X-ray
Analgesia
Prevent hypothermia
Glasgow Coma Scale
Pressure area care

Wound care
Pathology tests
In-dwelling catheter
Nasogastric tube
Antibiotic
Reassess
Airway management
If there is potential that the patient’s airway may deteriorate due to injuries or respiratory insufficiency, intubation prior to retrieval should be discussed with the ARV consultants. Assess adequacy of oxygenation and ventilation. Frequent reassessment of the patient must take place as injury sequelae may cause further airway compromise. In an intubated patient, end-tidal carbon dioxide (ETCO₂) monitoring (if available) should be used to assess respiratory status and the adequacy of ventilation. Always have emergency airway equipment by the bedside.

Fluid resuscitation
Order intravenous (IV) fluids, usually normal saline initially (until other trauma is excluded) then transfer to maintenance fluids.
Avoid fluid overload in the presence of neurogenic shock – use urinary output as the indicator and monitor fluid balance.
It is important to maintain an accurate fluid balance chart from the early stages of treatment to assess the effectiveness of fluid resuscitation. This will also assist retrieval staff with further management during transfer.

Monitoring
Monitoring the heart rate, respiration rate, blood pressure and oxygen saturation should take place at 15-minute intervals or more frequently if indicated. Monitor continuously via electronic monitoring if the facilities are available. All monitoring should be maintained until the retrieval team arrives.
Expect hypotension and bradycardia associated with spinal shock in those with lesions above 6th thoracic vertebrae. The pulse commonly falls to 55 bpm or less. Blood pressure often falls to 90 mmHg systolic. A heart rate less than 45 bpm and blood pressure less than 90 mmHg require treatment in consultation with ARV and the receiving spinal unit or trauma service. A baseline ECG should be taken prior to transfer if time permits and facilities exist.
Ongoing assessment of the patient’s neurological function is indicated to assess for symptom extension due to ascending spinal cord oedema.

Medical imaging
Radiological examination is crucial in the diagnosis of SCI. Plain x-rays may provide initial information on spinal injury, however, are not used to clear the trauma patient of injury. The patient should be cared for as a possible cervical vertebral injury.
A CT scan/MRI should be undertaken if the NEXUS criteria for cervical spine clearance has not been met, or the patient is unconscious. Should the patient exhibit any of the criteria as mentioned previously, then clinical examination is unreliable and radiographic assessment is advised. Where facilities do not have CT imaging available, then consultation with ARV and the MTS regarding retrieval and transfer should take place. X-ray imaging of the cervical spine is not suitable to clear the neck of the trauma patient. It may be appropriate to delay exhaustive imaging investigations if they are not going to alter management. Definitive imaging may be performed at the receiving specialist unit.
**Wound care**
All wounds should be covered with a suitable and secure occlusive or dry dressing.

**Pressure area care**
Special attention should be paid to pressure area care and surveillance in consideration of the extended time that spinal patients may remain supine with an extrication/hard collar in situ. Importantly if equipment is available, an appropriately sized, rigid foam, soft collar should ideally be fitted as soon as possible or within 6 hours of injury.

**Analgesia**
Morphine is a drug of choice in the acute SCI management phase. IV administration is the most effective route due to its rapid absorption, for both adults and children. Administer as per local protocols and titrate to effect.
Consider anti-emetics at this stage, especially if transfer and retrieval is anticipated.

**Prevent hypothermia**
It is important to maintain normothermia. Patients with high SCI present with poikilothermia, where normal thermoregulation is compromised and hypothermia becomes a concern.
If available, the use of a forced air-warming machine is encouraged. Ensure wound care is attended to before commencing. Re-assess the room temperature at regular intervals while awaiting the retrieval team.

**Glasgow Coma Scale**
A focused neurological assessment using the Glasgow Coma Scale should be performed. This should include a description of the patient’s level of consciousness as well as assessments of pupillary size and reactivity, gross motor function and sensation. Document the findings and reassess at frequent intervals.

<table>
<thead>
<tr>
<th>Best response</th>
<th>Eye opening</th>
<th>Verbal response</th>
<th>Motor response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Does not open eyes</td>
<td>Makes no sounds</td>
<td>Makes no movements</td>
</tr>
<tr>
<td>2</td>
<td>Opens eyes in response to painful stimuli</td>
<td>Incomprehensible sounds</td>
<td>Extension to painful stimuli (decerebrate response)</td>
</tr>
<tr>
<td>3</td>
<td>Opens eyes in response to voice</td>
<td>Utters inappropriate words</td>
<td>Abnormal flexion to painful stimuli (decorticate response)</td>
</tr>
<tr>
<td>4</td>
<td>Opens eyes spontaneously</td>
<td>Confused, disoriented</td>
<td>Flexion or withdrawal to painful stimuli</td>
</tr>
<tr>
<td>5</td>
<td>N/A</td>
<td>Oriented, converses normally</td>
<td>Localises painful stimuli</td>
</tr>
<tr>
<td>6</td>
<td>N/A</td>
<td>N/A</td>
<td>Obeys commands</td>
</tr>
</tbody>
</table>
**SPINAL TRAUMA GUIDELINE**

**Pathology**
Pathology tests should be taken for FBC (full blood count), UEC (urea electrolytes and creatinine) and glucose as well as a blood gases if available. Consider taking a group and cross-match if the patient is involved in a trauma presentation with a high index of suspicion for further injuries.

**In-dwelling catheter**
A urinary catheter should be inserted and urine output measured hourly. The desired urine output for adults is 0.5–1.0 mL/kg/hr (American College of Surgeons, 2012). A urinalysis should be performed also to check for blood.

**Nasogastric tube**
All patients should be kept nil orally in the initial post-resuscitation phase of injury. NGT insertion should be considered for managing paralytic ileus in spinal-injured patients, and must be placed for all SCI retrieval/transfers. Skull fractures in poly-trauma should be considered in the decision to insert an NGT.

**Antibiotics**
Routine antibiotic administration is not recommended in the initial phase of trauma injury management.

**Reassess**
The importance of frequent reassessment cannot be overemphasised. Patients should be re-evaluated at regular intervals as deterioration in a patient’s clinical condition can be swift. This will be evident in their vital signs and level of consciousness. If in doubt, repeat ABCDE.

**Other**
Steroids are not routinely recommended in SCI.

10. **Retrieval and transfer**
ARV is the initial point of contact for transferring or retrieving all adult major trauma patients (phone ARV on 1300 36 86 61).
In all cases, the decision regarding the timing of the transfer and the retrieval destination will be coordinated by ARV clinicians in consultation with the receiving facility.

**Isolated spinal cord injury**
Patients with an isolated SCI and neurological deficit should be transferred to the Victorian Spinal Cord Injury Service at Austin Health at the earliest possible time and ideally in less than six hours.
Potential multi-trauma

Patients in whom it is unlikely that other significant trauma can be confidently excluded will be referred to an MTS. A significant proportion of SCI patients have coexistent multisystem injuries, in particular upper thoracic and intracranial injuries.

The transfer and retrieval response will be managed according to patient need after clinical consultation.

It is important to note that an exhaustive clinical workup and interventions is not always necessary or appropriate prior to transfer. Stabilisation and ensuring life-threatening problems are addressed, as well as taking measures to prevent deterioration en route are essential aspects of early care. Delaying transfer to obtain laboratory results or imaging studies may simply delay access to definitive treatment. Often such studies must be repeated at the receiving facility.

In liaison with ARV clinicians, interventions to stabilise the patient prior to retrieval personnel arriving should be commenced. ARV will coordinate the retrieval and will evaluate the practicality and clinical needs involved in transferring the patient from the source hospital. Once retrieval staff arrives on scene, be prepared to give a thorough handover. Retrieval staff will assess the patient prior to transfer and may make changes to care in order to ensure the patient is safe during transfer.

Adult Retrieval Victoria recommends the IRMIST-AMBO method of handover for facilitating health professional communication and ensuring clarity and completeness.
**Muscle Function Grading**

0 = Total paralysis
1 = Partial or variable 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 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


**Sensory Grading**

0 = Absent
1 = Altered, either decreased/paired sensation or hyperesthesia
2 = Normal
3 = Not tested

**Non Key Muscle Functions (optional)**

May be used to assign a motor level to differentiate AIS B vs. C.

**Movements**

- Shoulder: Extension, abduction, adduction, internal and external rotation
- Elbow: Flexion
- Trunk: Flexion, extension, adduction and abduction
- Finger: Flexion of proximal, metacarpo-phalangeal and interphalangeal joints
- Thumb: Extension and adduction

**Root level**

C6
C7
C8
T1
L2
L3
L4
L5
S1

**ASIA Impairment Scale (AIS)**

A = Complete. No sensory or motor function is preserved in the spinal segments S4-S5.
B = Sensory Incomplete. sensory but motor function is preserved below the neurological level and includes the spinal segments S4-S5 (light touch at all sites of S4-S5 or deep and pressure at ASIA level). More than half of key muscle functions below the neurological level of injury (NLI) have a muscle grade of 3 (average 3’s).
C = Motor Incomplete. Motor function is preserved below the neurological level, and more than one half of key muscle functions below the neurological level are of grade 3 (average 3’s).
D = Motor Incomplete. Motor function is preserved below the neurological level, and at least half (half or more) of key muscle functions below the NLI have a muscle grade of 2 (average 2.5’s).
E = Normal. No sensation or motor function is affected, and the patient has no signs of spinal cord injury.

**Steps in Classification**

The following criteria are recommended for the classification of individuals with SCI:

1. Determine sensory levels for right and left sides.
   - The sensory level is the most caudal level of dermatome for both light touch and light touch sensation.

2. Determine motor levels for right and left sides.
   - Defined by the lowest key muscle function to have a grade of at least 3 (on 5-point scale) among the key muscle function(s) innervated by segments above that level are judged to be intact (perceived as at least a 3). A Note: In regions where there is no sympathetic innervation, the motor level is determined by the same as the sensory level. If intact motor functions above that level are also normal, that level is also normal.

3. Determine the neurological level of injury (NLI)
   - This refers to the most caudal spinal segment of the cord with intact sensation and antigravity (2 or more) muscle function strength, provided that there is normal (intact) sensory and motor function nascently, respectively.
   - The NLI is the most caudal of the sensory and motor levels determined in steps 1 and 2.

4. Determine whether the injury is complete or incomplete.
   - Complete: No sensation or motor function is affected.
   - Incomplete:
     - S1-S5 sensory loss and lack of intact motor function.
     - ASIA A, B, or C.
     - ASIA D.

5. Determine ASIA Impairment Scale (AIS).
   - AIS A = Complete
   - AIS B = Incomplete
   - AIS C = Incomplete
   - AIS D = Incomplete

**Claw Deformity?**

- YES: AIS=A
- NO: AIS=B

**Spinal Stability?**

- NO: AIS=A
- YES: AIS=B

**AIS=C**

**AIS=D**
12. Appendix 2: NEXUS criteria

1. Midline cervical spine tenderness
Present if the patient indicates the existence of neck pain on palpation of the posterior midline neck region from the nuchal ridge to the third thoracic prominence, or palpation of any cervical spinous process.

2. Focal neurologic deficit
Motor or sensory examination indicates the presence of a focal neurologic deficit e.g. segmental weakness, numbness or paraesthesia.

3. Intoxication
The patient is considered to be intoxicated if:
- The patient or an observer reports a recent history of intoxication or consumption of intoxicating substances.
- Evidence exists of intoxication on physical examination e.g. odour of alcoholic beverage, ataxia, slurred speech, dysmetria, other cerebellar signs or any behaviour suggestive of intoxication.
- Tests of bodily fluids are positive for drugs or alcohol which affect mental alertness.

4. Painful distracting injury
Any non-spinal related condition causing sufficient pain to distract the patient from a possible cervical spine injury. Suggestions include:
- Any long bone fracture.
- A visceral injury requiring surgical consultation.
- Extensive laceration, crush or degloving injury.
- Considerable burns.
- Any other injury producing functional impairment.
- Any other injury thought to impair the patient’s ability to appreciate cervical spine pain.

5. Altered mental status
An altered state of mental alertness can be demonstrated by:
- GCS < 15.
- Disorientation to time, place, person or event.
- Inability to recall 3 objects at 5 minutes.
- Delayed or inappropriate response to stimulus.

Clinical spinal clearance
If all of the NEXUS criteria are negative, there is no evidence of bruising or deformity, and if a full range of active neck movement (including 45° rotation to left and right) can be performed without pain, the cervical spine can be clinically cleared without radiographic
imaging and the cervical collar can be removed. Documentation must be made on the electronic Spinal Assessment and Clearance Form.

**Cervical spine imaging**
Should the patient exhibit any signs of cervical spine tenderness, focal neurologic deficit, evidence of intoxication, painful distracting injury or altered mental status, however, *clinical examination is unreliable* and radiographic assessment of the cervical spine is advised. Assessment tools:

- Cervical Multi Segmental CT.
- MRI may be required if CT images are abnormal or if abnormal neurology is present.

13. **Appendix 3: AGREEII Score Sheet – Spinal Trauma guideline**
<table>
<thead>
<tr>
<th>Domain</th>
<th>Item</th>
<th>AGREE II Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Applicability</td>
<td>18. The guideline describes facilitators and barriers to its application.</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>19. The guideline provides advice and/or tools on how the recommendations can be put into practice.</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>20. The potential resource implications of applying the recommendations have been considered.</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>21. The guideline presents monitoring and/or auditing criteria.</td>
<td>X</td>
</tr>
<tr>
<td>Editorial independence</td>
<td>22. The views of the funding body have not influenced the content of the guideline.</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>23. Competing interests of guideline development group members have been recorded and addressed.</td>
<td>X</td>
</tr>
<tr>
<td>Overall Guideline Assessment</td>
<td>1. Rate the overall quality of this guideline.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2. I would recommend this guideline for use.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
14. References


