



SPINAL TRAUMA GUIDELINE



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1. Key messages

The Victorian State Trauma System 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 methodology for guideline development and is auspiced by the Victoria State Trauma Committee.

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.
- 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.
- 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.

DRAFT

Spinal Trauma



Make early contact with ARV for advice and to initiate retrieval where required.

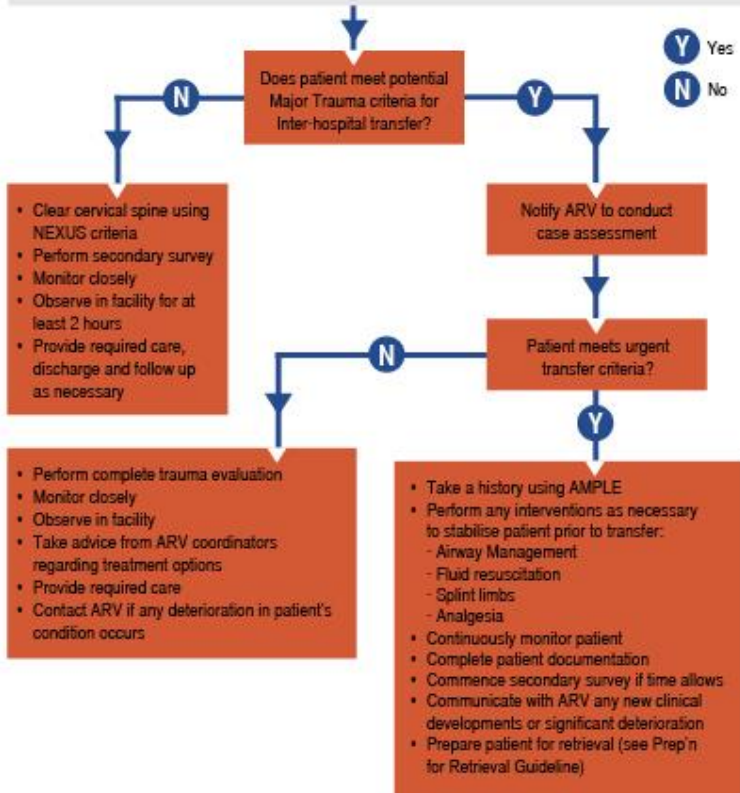
- Ascending spinal cord injury
- Aspiration
- Neurogenic Shock

Early Activation

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

Primary Survey

<p>AIRWAY / C SPINE:</p> <ul style="list-style-type: none"> • Protect Airway • Airway adjuncts as available • Secure the airway using available means • Maintain full spinal precautions 	<p>BREATHING:</p> <ul style="list-style-type: none"> • Identify and treat any life threats (i.e: pneumo) • Apply oxygen • Ventilate as necessary • SpO₂ monitoring • ETCO₂ monitoring 	<p>CIRCULATION:</p> <ul style="list-style-type: none"> • Control life threatening haemorrhage • Insert x 2 large bore IV cannulas • Assess HR/BP/Shock Index • Take bloods • Identify source of haemorrhage • Continuous ECG monitoring 	<p>DISABILITY:</p> <ul style="list-style-type: none"> • Assess level of consciousness • Check pupils • Check BSL <p>BASIC SCI ASSESSMENT:</p> <p>NO hand grip = C8 injury or above -> quadriplegia</p> <p>NORMAL hand grip = C8-T1 injury -> paraplegia</p> <p>DETAILED SCI ASSESSMENT:</p> <p>ASIA assessment and examination</p>	<p>EXPOSURE / ENVIRONMENT:</p> <ul style="list-style-type: none"> • Fully expose patient • Ensure normothermia 	<p>ADJUNCTS:</p> <ul style="list-style-type: none"> • FAST scan • X rays: Lat c spine, Chest, Pelvis • 12 lead ECG
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Early Management

<p>Airway management</p> <ul style="list-style-type: none"> • If there is potential that the patient's airway may deteriorate then intubation should be considered. • Always have emergency airway equipment available. • Prevent bradycardia during airway manipulation. <p>Fluid resuscitation</p> <ul style="list-style-type: none"> • <i>Crystalloid fluids:</i> Initial treatment of hypovolaemia with normal saline is recommended, up to 20 - 30 mL/kg. • Avoid excess fluid administration-treat bradycardia and hypotension caused by neurogenic shock. • <i>Blood products:</i> if minimal response to fluids, administration of packed red blood cells (PRBC) is advised if available. 	<p>Prevent hypothermia</p> <ul style="list-style-type: none"> • Use warmed IV fluids; cover the patient with warm blankets as well as keeping the room warm, use a forced air warming machine if available. <p>In-dwelling catheter / Naso or orogastric tube</p> <ul style="list-style-type: none"> • Ensure the above are placed if necessary and time allows. <p>Glasgow Coma Scale</p> <ul style="list-style-type: none"> • Assess the patient's level of consciousness as well as pupillary size and reactivity, gross motor function and sensation. <p>Reassess</p> <ul style="list-style-type: none"> • Patients should be re-evaluated at regular intervals as deterioration in a patient's clinical condition can be swift • If in doubt, repeat ABCDE.
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Secondary Survey

History

- Take an adequate history from the patient, bystanders or emergency personnel of the surrounding events
- Use AMPLE to assist with gathering relevant information.

Head-to-toe examination

- A thorough exam of all body regions should take place.
- Consider using ASIA charts for assessment and communication.
- Assess for pressure area risk. Soft, rigid collar if available

Log Roll

- Document any findings and treat accordingly.
- Maintain in-line stabilisation. Inspect the entire length of the neck and back noting any deformity, bruising and lacerations. Palpate for any tenderness or steps between the vertebrae.
- The cervical spine will generally be cleared after transfer to a major trauma service and specialist assessment.

Interhospital Transfer Guidelines (Discuss via ARV)

Paediatric MTP AND SCI	Adult MTP with SCI	Isolated SCI patient
Royal Children's Hospital	Major Trauma Service Interhospital transfer	Victorian Spinal Cord Service at Austin Health

3. Introduction

In Victoria, most spinal cord injuries (SCI) result in permanent neurological disability for patientsⁱ. Australian data collected from 2006–07 indicated that 52% per cent of injuries were related to transport accidents and 29% were as a result of falls. These two mechanisms alone accounted for more than three-quarters of all traumatic SCIⁱ.

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 presentationⁱⁱ.

Damage to the spinal cord may cause irreversible injury with the outcome of either temporary or permanent neurological deficitⁱⁱⁱ. 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^{iii,iv,v}. 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^{vi}. (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, 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 hypotension, bradycardia and poikilothermia.

Spinal shock is a combination of loss of and decreased reflexes and autonomic dysfunction that accompanies SCI. Skeletal and smooth muscles are therefore flaccid from hours to weeks^{vii}.

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:^{viii}
 - M** Mechanism of injury
 - I** Injuries found or suspected
 - S** Signs: respiratory rate, pulse, blood pressure, SpO₂, GCS or AVPU
 - T** Treatment given
2. Personal protective equipment is vital in the care of trauma patients. Ensure all staff involved in patient care are wearing gloves, aprons and eye protection.
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. 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 gather a response from the patient.

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

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/combatative 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^{ix}.

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^x.

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 nerve 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 internal 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^{xi}.

If the patient is haemodynamically stable and there are no signs of significant internal bleeding then it 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 with supportive radiological examination, all trauma patients should be assumed to have a spinal injury until proven otherwise.

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.

6. 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: ^{xii}

- 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.

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 major trauma patients suspected of having a cervical spine injury will arrive in the Emergency department with a rigid collar applied by the ambulance crew. Assessment and imaging will occur while the patient has the rigid collar insitu. 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 45degree 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.

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^{xiii}. 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.



7. 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^{xiv}. 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 major trauma transfer criteria or may have sustained injuries beyond the clinical skill set of the hospital 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 clinical resources and an 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 procedures performed and imaging obtained).

ISBAR is an acronym for facilitating health professional communication ensuring clarity and completeness of information in verbal communication: ^{xv}

- I** Identify: Who are you and what is your role? Patient identifiers (at least three)
- S** Situation: What is going on with the patient?
- B** Background: What is the clinical background/context?
- A** Assessment: What do you think the problem is?
- R** Recommendation: What would you recommend? Identify risks – patient and occupational health and safety. Assign and accept responsibility/accountability.

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.

8. Early management

Airway management	Prevent hypothermia
Fluid resuscitation	Glasgow Coma Scale
Monitoring	Pathology tests
X-ray	In-dwelling catheter
Wound care	Nasogastric tube
Pressure area care	Antibiotic
Analgesia	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.

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

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.^{viii} 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.

9. 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.

The use of a transfer checklist can help to ensure that important information is not omitted and the patient is packaged accordingly.

10. Guideline Implementation

These guidelines are designed to push for quality improvement using evidence-based practice across the entire care pathway. They aim to achieve consistent advancement in people's health and lead to access of good-quality care.

Putting these guidelines into practice benefits everyone; this includes the staff directly involved in patient care, those involved in managing the health facility, local healthcare organisations and members of the public. It can help to monitor service improvements, demonstrate that high-quality care is being provided and also highlight areas for improvement.

One of the most difficult aspects of working with guidelines is how best to implement them into routine daily practice. Many of us provide patient care according to usual routines ('how it's always been done') instead of looking at developments and change in practice to reflect the latest evidence-based research. Barriers to implementation can include organisational constraints, such as a lack of time, obstructive opinions of key people who may not agree with

the evidence or do not want to change their practice, and lack of leadership to effect change. Additionally, there may be a perceived poor sense of competence by staff who question their skills.

In order for change to be effective there must be an identified need, a willingness to adapt and promote current practices, a driving force behind it and acceptance from all levels, be it individual, team or organisational^{xvii}. For these guidelines to be successfully implemented, the following is recommended.

High-level support and clear leadership

Successful implementation plans have a person on the board, such as a medical director, who drives the implementation agenda forward as well as a clear implementation policy approved at the highest level.

A nominated lead for the organisation

One person should be identified who is responsible for driving the education and development of these guidelines into practice. They should be involved in coordinating, disseminating and monitoring of the implementation as well as for arranging educational events to promote the use of these guidelines in the workplace. The responsibility for this could be included into an existing role such as that of the clinical governance manager or anyone involved in quality assurance.

A multidisciplinary forum

The multidisciplinary forum should have decision-making powers and report to the chief executive or senior managers of the organisation. New guidelines should be reviewed shortly after they are published and their relevance to the organisation assessed. A lead for each guideline should be identified and steps taken to disseminate to the appropriate people. Implementation is most effective if a wide range of disciplines are involved in the forum.

A local policy

Organisations should have a clear, structured policy in place for implementing new guidelines. This policy should be endorsed at the highest level and be available for all.



What can you do as an individual?

Become a project champion. One way to begin implementation in your workplace is to take the initiative and volunteer to represent your department. Review these guidelines and compare them with the current ones you have in place. Note any changes to practice that need to be addressed in order to standardise your organisation with current best practice.

In staff meetings, bring up the idea of implementation and seek feedback from other staff members on the best way to do this. Collaborate with colleagues across all boards and emphasise the importance of team communication and cohesion. Print handouts, send out links to workmates and arrange for flowchart posters to be placed in relevant areas.

If you have a clinical educator at your site, inform them of the current updates and discuss ways they can influence training and provide moulage-based simulation scenarios. Often training with the staff you work with on a regular basis can help to foster communication and a real sense of teamwork.

Speak with your organisation about placing access to the Victorian trauma guidelines on your intranet to allow easy access to the site.

As always, your feedback is encouraged. If you have any comments or suggestions, or would like to share how you have adopted these guidelines into your practice, we would appreciate your thoughts.



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

ASIA
AMERICAN SPINAL INJURY ASSOCIATION

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

ISCOS
INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

Patient Name _____ Date/Time of Exam _____
 Examiner Name _____ Signature _____

RIGHT

UER
(Upper Extremity Right)

Elbow flexors C5
 Wrist extensors C6
 Elbow extensors C7
 Finger flexors C8
 Finger abductors (little finger) T1

LER
(Lower Extremity Right)

Hip flexors L2
 Knee extensors L3
 Ankle dorsiflexors L4
 Long toe extensors L5
 Ankle plantar flexors S1

(MAC) Voluntary anal contraction (Yes/No)

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

RIGHT TOTALS (MAXIMUM)
 (50)

LEFT

UEL
(Upper Extremity Left)

Elbow flexors C5
 Wrist extensors C6
 Elbow extensors C7
 Finger flexors C8
 Finger abductors (little finger) T1

LEL
(Lower Extremity Left)

Hip flexors L2
 Knee extensors L3
 Ankle dorsiflexors L4
 Long toe extensors L5
 Ankle plantar flexors S1

(DAP) Deep anal pressure (Yes/No)

MOTOR SUBSCORES
 UEL + UEL = PPL TOTAL (56)
 PPR + PPL = PP TOTAL (112)
 MAX (56) MAX (112)

LEFT TOTALS (MAXIMUM)
 (56) (112)

SENSORY KEY POINTS
 Light Touch (LT) Pain/Prick (PP)

C2		
C3		
C4		
C5		
C6		
C7		
C8		
T1		
T2		
T3		
T4		
T5		
T6		
T7		
T8		
T9		
T10		
T11		
T12		
L1		
L2		
L3		
L4		
L5		
S1		
S2		
S3		
S4-5		

SENSORY SUBSCORES
 LTR + LTL = LT TOTAL (56)
 PPR + PPL = PPTOTAL (112)
 MAX (56) MAX (112)

NEUROLOGICAL LEVELS
 Steps 1-5 for classification as on reverse

1. SENSORY LEVELS R L

2. MOTOR LEVELS R L

3. NEUROLOGICAL LEVEL OF INJURY (NLI)

4. COMPLETE OR INCOMPLETE?
 Incomplete = Any sensory or motor function in S4-S5

5. ASIA IMPAIRMENT SCALE (AIS)

6. ZONE OF PARTIAL PRESERVATION
 Most caudal level with any innervation

COMMENTS (Non-key Muscle? Reason for NT? Pain?):

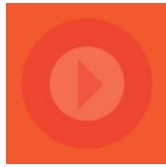
SCORING ON REVERSE SIDE

0 = absent
 1 = altered
 2 = normal
 NT = not testable

KEY POINTS
 1 = long nailbed
 2 = palpable or visible contraction
 3 = active movement, gravity eliminated
 4 = active movement, against gravity
 5 = active movement, against some resistance
 6 = active movement, against full resistance
 8 = normal, corrected for pain/tissue
 NT = not testable

Diagram: Anatomical diagrams of the human body showing key sensory points (LT, PP) and motor levels (C2-C8, T1-T12, L1-L5, S1-S5) for the right and left sides.

REV 02/13
 This form may be copied freely but should not be altered without permission from the American Spinal Injury Association.



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 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 range of motion)

Sensory Grading

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

Non Key Muscle Functions (optional)

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

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

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 below the neurological level*, and more than half of key muscle functions below the neurological level of injury (NLI) have a muscle grade less than 3 (Grades 0-2).

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 ≥ 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.

** For an individual to receive a grade of C or D, i.e. motor incomplete status, they must have either (1) voluntary anal sphincter contraction or (2) sacral sensory sparing with sparing of motor function more than three levels below the motor level for that side of the body. The International Standards at this time allow seven non-key muscle function more than 3 levels below the motor level to be used in determining motor incomplete status (AIS B versus C).

NOTE: When assessing the extent of motor sparing below the level for distinguishing between AIS B and C, the **motor level** on each side is used, whereas to differentiate between AIS C and D (based on proportion of key muscle functions with strength grade 3 or greater) the **neurological level of injury** is used.



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 myelome to last, 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 anligavity (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/ at 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 myelome on each side with some preservation)



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



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.

Available from:

<http://www.asia-spinalinjury.org/elearning/ISNCSCI Exam Sheet r4.pdf>



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 eg. 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 eg. 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.

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

Adapted from The Alfred Spinal Clearance Management Protocol (November 2009). Developed by Helen Ackland. Accessed August 25 2014, available from http://www.alfredhealth.org.au/Assets/Files/SpinalClearanceManagementProtocol_External.pdf

Trauma Victoria

The Victorian State Trauma System (VSTS) facilitates the management and treatment of major trauma patients in Victoria. The VSTS aims to reduce preventable death and permanent disability and improve patient outcomes by matching the needs of injured patients to an appropriate level of treatment in a safe and timely manner.

The system works to have the right patient delivered to the right hospital in the shortest time.

One of the best ways to facilitate this is to provide an education resource to all clinicians.

Trauma Victoria is a statewide education initiative directed towards clinical staff (doctors, nurses, allied health, paramedics) who provide early patient care for major trauma outside of a MTS.

Guidelines are in place to support awareness of **key aspects of the trauma system** and early trauma care and include **specialist trauma transfer** guidelines.

A web-based learning management system provides modules to support each of the principle guideline areas. Skills tutorials on key trauma procedural interventions will also be accessible.

Moderated remote tutorials will be offered in the future. Clinicians will join a multisite, multiparty videoconferenced meeting room for tutorials and discussions on relevant trauma subjects. It will allow local practitioners to tap into specialised clinical knowledge and to develop their learning to the fullest extent.

Regional simulation and team training will also be supported via a remote expert facilitator and will involve regional and subregional simulation trainers. It will build capacity among simulation trainers to enhance local trauma team training programs.

Facilitated visits will also be arranged whereby medical, nursing and allied health staff may be placed for brief rotations with a MTS in order to increase their experience and familiarity in major trauma management. The aim is also to promote the development of clinical relationships between organisations.



Created by Adult Retrieval Victoria on behalf of the Victorian State Trauma System.

To receive this document in an accessible format phone Acute Programs on 9096 7741.

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AGREE II score sheet – spinal trauma guideline

Domain	Item	AGREE II Rating						
		1 Strongly Disagree				7 Strongly Agree		
		1	2	3	4	5	6	7
Scope and purpose	The overall objective(s) of the guideline is (are) specifically described.							X
	The health question(s) covered by the guideline is (are) specifically described.						X	
	The population (patients, public, etc.) to whom the guideline is meant to apply is specifically described.						X	
Stakeholder involvement	The guideline development group includes individuals from all the relevant professional groups.						X	
	The views and preferences of the target population (patients, public, etc.) have been sought.						X	
	The target users of the guideline are clearly defined.							X
Rigor of development	Systematic methods were used to search for evidence.						X	
	The criteria for selecting the evidence are clearly described.						X	
	The strengths and limitations of the body of evidence are clearly described.						X	
	The methods for formulating the recommendations are clearly described.						X	
	The health benefits, side effects and risks have been considered in formulating the recommendations.						X	
	There is an explicit link between the recommendations and the supporting evidence.							X
	The guideline has been externally reviewed by experts prior to its publication.							X
A procedure for updating the guideline is provided.							X	



Domain	Item	AGREE II Rating						
		1 Strongly Disagree				7 Strongly Agree		
		1	2	3	4	5	6	7
Clarity of presentation	The recommendations are specific and unambiguous.							X
	The different options for management of the condition or health issue are clearly presented.						X	
	Key recommendations are easily identifiable.							X
Applicability	The guideline describes facilitators and barriers to its application.							X
	The guideline provides advice and/or tools on how the recommendations can be put into practice.							X
	The potential resource implications of applying the recommendations have been considered.							X
	The guideline presents monitoring and/ or auditing criteria.						X	
Editorial independence	The views of the funding body have not influenced the content of the guideline.						X	
	Competing interests of guideline development group members have been recorded and addressed.							X
Overall Guideline Assessment	Rate the overall quality of this guideline. 1- Lowest possible quality 7- Highest possible quality						X	
Overall Guideline Assessment	I would recommend this guideline for use.	Yes		Yes, with modifications			No	
		X						





References

- [i] Cripps R. 2009. Spinal cord injury, Australia, 2006-07, Injury research and statistics series no. 48. Cat. no. INJCAT 119, AIHW, Canberra. [2014 March 28]. Available from: <<http://www.aihw.gov.au/publication-detail/?id=6442468201>>
- [ii] Norton L 2010, Spinal cord injury, Australia 2007–08, Injury research and statistics series no. 52. Cat. no. INJCAT 128, AIHW, Canberra.
- [iii] Hauswald M. 2013. A re-conceptualisation of acute spinal care, *Emergency Medicine Journal*. Vol. 30, no. 9, p. 720–7233
- [iv] Ahn H, Singh J, Nathens A, MacDonald R, Travers A, Tallon J, et al. 2011. Pre-hospital care management of a potential spinal cord injured patient: a systematic review of the literature and evidence-based guidelines. *Journal of Neurotrauma*. Vol. 28, p. 1341–1361
- [v] Moss R, Porter K, Greaves I 2013. Minimal patient handling: a faculty of pre-hospital care consensus statement. *Emergency Medicine Journal*. Vol. 30, no. 12, p. 1065–1066
- [vi] American Spinal Injury Association 2014, Injury scoring, scaling and classification. [2014 March 27] Available from: <<http://content.learnshare.com/courses/120/440012/story.html>>
- [vii] Cortez R, Levi A. 2007. Acute spinal cord injury. *Current Treatment Options in Neurology*. Vol. 9, no. 2, p. 115–125
- [viii] Ministry of Defence. 2012. Clinical guidelines for operations. Joint Services Publication 999. Change 3, p. 41. [2014 April 14]. Available from: <<https://www.gov.uk/government/publications/jsp-999-clinical-guidelines-for-operations>>
- [ix] Ambulance Victoria. 2013. Clinical practice guidelines for ambulance and MICA paramedics. 2014. revised edition. Ambulance Victoria, Doncaster
- [x] Consortium for Spinal Cord Medicine. Paralyzed Veterans of America. 2008. Early acute management in adults with spinal cord injury: a clinical practice guideline for health-care professionals [2014 March 25] Available from: <http://www.pva.org/site/c.ajIRK9NjLcJ2E/b.6431479/k.3D9E/Consortium_for_Spinal_Cord_Medicine.htm>.
- [xi] Nishijima D, Simel D, Wisner D, Holmes J. 2012. Does this patient have a blunt intra-abdominal injury? *JAMA*, vol. 307, no. 14, p. 1517
- [xii] Gumm K 2011. Major trauma initial assessment and management. In: Curtis K, Ramsden C, Lord B. *Emergency and trauma care for nurses and paramedics*. Elsevier. Sydney, p. 1160



[xiii] Lee C, Porter K. 2007. The pre-hospital management of pelvic fractures. *Emergency Medicine Journal*. Vol.24, no. 2, p 130–133

[xiv] Hodgetts T, Turner L. 2006. *Trauma rules: incorporating military trauma rules*. Blackwell. Sydney, p. 17

[xv] Government of South Australia 2014, SA Health.[cited 2014 April 2] Available from: <<http://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/clinical+resources/safety+and+quality/clinical+handover/isbar+-+identify+situation+background+assessment+and+recommendation>>

[xvi] Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. *The Lancet*. 2003. Vol. 362. Oct 11

[xvii] National institute for health and care excellence. Using NICE guidance and quality standards to improve practice. Available at: <http://publications.nice.org.uk/using-nice-guidance-and-quality-standards-to-improve-practice-pg1/introduction> (Accessed April 2 2014).