

CG033 Acute Spinal Cord Injury

1. Key Recommendations for operational use		
1	Initial approach	<ul style="list-style-type: none"> • Assess and treat major trauma patients using a <C>ABCDE structure in accordance with CG006 Major Trauma. • Screen, immobilise and package patients at risk of spinal cord injury (due to mechanism) in accordance with CG031 Spinal Immobilisation and Primary Packaging. • This guideline describes additional measures to be considered in patients with neurological or radiological signs of Acute Spinal Cord Injury (SCI) such as: <ul style="list-style-type: none"> - weakness. - reduced or absent sensation. - hyperaesthesia. - priapism (in males). - inability to pass urine. - radiological evidence of cord injury.
2	Breathing assessment	<ul style="list-style-type: none"> • Assess adequacy of oxygenation and ventilation. <ul style="list-style-type: none"> - observe respiratory pattern and depth - look for diaphragmatic breathing, hypoventilation or fatigue. - measure oxygen saturations. - consider ETCO₂ monitoring. - consider arterial blood gas analysis. • Consider hypersecretion and bronchospasm (due to loss of sympathetic activity).
3	Circulation assessment	<ul style="list-style-type: none"> • Assess the adequacy of circulation. <ul style="list-style-type: none"> - assess for peripheral and central signs of shock (skin colour, capillary refill, pulse and blood pressure). - do not automatically attribute hypotension to neurogenic shock. - maintain a high index of suspicion for other causes of traumatic shock. - autonomic dysfunction can mask the usual signs of hypovolemia and sensory loss can mask the pain of injuries. - consider use of ultrasound (e.g. FAST) to augment examination. • Neurogenic shock can occur with injuries above T8: <ul style="list-style-type: none"> - patients may be flushed, warm peripherally, hypotensive with good volume pulses and a bradycardia.
4	Pre-hospital neurological assessment	<ul style="list-style-type: none"> • In the pre-hospital phase, do not delay transfer to hospital to complete a full neurological examination. • A limited examination to determine the approximate neurological level of the injury may aid with anticipating respiratory and cardiovascular compromise.

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		Myotome	Dermatome
	Pre-hospital neurological assessment	C4 - Shrug shoulder C5 - Elbow Flexor C6 - Wrist Extensors C7 - Elbow Extensors C8 - Finger Flexors T1 - Finger Abductors L2 - Hip flexor L3 - Knee Extensors L4 - Ankle Dorsiflexion L5 - Long Toe Extensors S1 - Ankle Plantar Flexors	C4 - Shoulder C6 - Thumb T10 - Umbilicus L3 - Knee L5 - Big toe S1 - Little toe
5	In-hospital neurological assessment	<ul style="list-style-type: none"> • The neurological level is the lowest level with both normal sensory (light touch and pin prick) and motor (normal power) function. • In hospital, aim to determine the neurological level of the injury. <ul style="list-style-type: none"> - a full neurological examination is usually deferred to day 7 following the injury. - the American Spinal Injury Association ISNCSCI assessment is the gold standard but full completion is not appropriate for all retrievals. - further examination, including PR and sacral dermatome testing, should be guided by the receiving centre. • Reassess the patient every 1-2 hours. <ul style="list-style-type: none"> - gradual deterioration can occur over the first 72 hours. - this may present with a rising neurological level or worsening respiratory compromise. 	
6	Indications for respiratory support	<ul style="list-style-type: none"> • Administer oxygen if required to maintain SpO₂ 94-98%. • Consider intubation and ventilation if there is significant respiratory compromise: <ul style="list-style-type: none"> - apnoea. - fatigue with progressively shallower breathing. - hypoventilation - PaCO₂ > 6kPa. - hypoxia despite oxygen supplementation. - those at risk of deterioration requiring prolonged transfer, especially by air where there is limited room for in-flight intervention. 	

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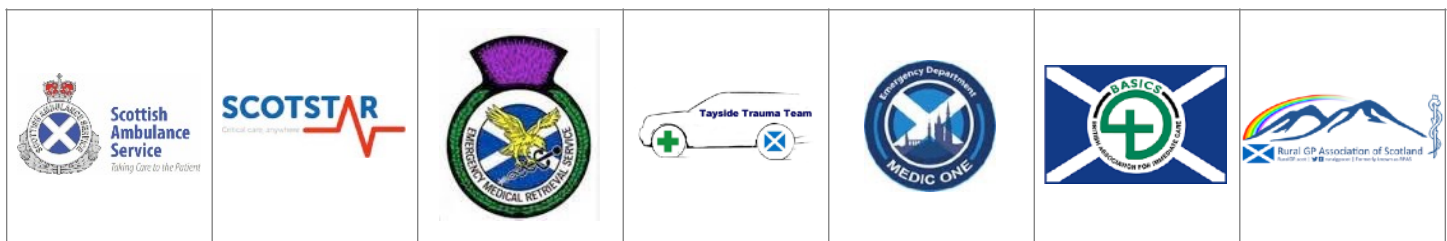
7	Cardiovascular support	<ul style="list-style-type: none"> • Avoid hypotension (SBP <90mmHg). • Treat hypotension with fluids initially. <ul style="list-style-type: none"> - use blood products if haemorrhage is suspected. - consider crystalloids if there is a low suspicion of haemorrhage (suggested maximum of 2000ml in adults). • Do not routinely use permissive hypotension except with active non-compressible bleeding where targeting a normal blood pressure may be detrimental or unachievable. • Consider inserting an arterial line. • In isolated spinal cord injury, consider targeting a MAP of 85-90mmHg. <ul style="list-style-type: none"> - this should only be considered in patients without significant bleeding e.g. where the clinician is confident of an isolated spinal injury or where other injuries have been ruled out by CT scan. • Consider using vasopressors and inotropes in isolated spinal cord injury following fluid resuscitation: <ul style="list-style-type: none"> - noradrenaline and adrenaline infusions are both suitable first line agents. - be aware that pure vasopressors (e.g. metaraminol) may cause significant bradycardia. • Treat severe (<40 bpm) or symptomatic bradycardia with antimuscarinics (e.g. atropine 0.3-0.6mg). • Consider antimuscarinics prophylactically in vagally stimulating procedures e.g. laryngoscopy.
8	Anaesthetic induction	<ul style="list-style-type: none"> • Anticipate worsening hypotension or bradycardia during induction. <ul style="list-style-type: none"> - consider establishing vasopressor support before induction. • During induction and intubation: <ul style="list-style-type: none"> - remove collars and blocks. - allocate manual in-line stabilisation. - use a rapid sequence induction (RSI) technique. - minimise cervical movement where possible through laryngoscopy technique and the use of adjuncts, e.g. a video laryngoscope and bougie or stylet. - do not use suxamethonium if >72 hours has elapsed since the time of injury. • Target normocapnia in ventilated patients.

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9	Other management	<ul style="list-style-type: none"> • Keep the patient flat with neutral spinal alignment. • Minimise movement. • If rolling is required, perform a full log-roll. • Immobilise and package the patient as per CG031 Spinal Immobilisation and Primary Packaging. • Use a vacuum mattress when available. • Meticulously ensure pressure areas care and the patient is not lying on clothing/objects. • Mitigate for temperature loss aggressively: <ul style="list-style-type: none"> - SCI patients have impaired thermoregulation and are prone to hypothermia. • Prevent hypoglycemia. • Treat pain initially with IV morphine or fentanyl; use ketamine as a second line agent. • Do not routinely give steroids. • For inter-hospital transfers: <ul style="list-style-type: none"> - insert a urinary catheter and monitor fluid balance. - insert a NG/OG tube and leave on free drainage.
10	Triage	<ul style="list-style-type: none"> • For patients in the pre-hospital phase, triage suspected spinal cord injury to the nearest Major Trauma Centre (MTC) as per the trauma triage tool. • For patients being transferred from a hospital setting, consider referring directly to the Queen Elizabeth University Hospital in Glasgow (where the National Spinal Injuries Unit is located). <ul style="list-style-type: none"> - patients who have not had a CT scan should usually be taken to the emergency department for further assessment. - most patients will initially be nursed in a general ward, HDU or ICU and not directly admitted to the National Spinal Injuries Unit.

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2. Document History				
Reference Number	CG033			
Version	1			
Writing group (Lead author in bold)	Paul Edgar	Consultant	Institute Neurological Sciences, Glasgow	
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	ScotSTAR	Air Ambulance		✓
		EMRS West		✓
		EMRS North		✓
		Paediatric		X
		Neonatal		X
Tayside Trauma Team		✓		



3. Scope and purpose

- Overall objectives:

The intent of this guideline is to provide clinical guidance to clinicians treating and transferring patients with Spinal Cord Injury (SCI). It is designed to be used in a subset of trauma patients with overt neurological signs of SCI.

- Statement of intent:

This guideline is not intended to be construed or to serve as a standard of care. Adherence to guideline recommendations will not ensure a successful outcome in every case, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgement must be made by the appropriate healthcare professional(s) responsible for clinical decisions regarding a particular clinical procedure or treatment plan.

- Feedback:

Comments on this guideline can be sent to: sas.cpg@nhs.scot

- Equality Impact Assessment:

Applied to the ScotSTAR Clinical Standards group processes.

4. Explanatory Statements		
4.1 Initial approach	Authors' recommendation	Level [Reference]
<ul style="list-style-type: none"> Asses and treat major trauma patients using a <C>ABCDE structure in accordance with CG006 Major Trauma <p>The identification and management of life-threatening injuries should be prioritised.</p>	Strong	1,2
<ul style="list-style-type: none"> Screen, immobilise and package patients at risk of spinal cord injury (due to mechanism) in accordance with CG031 Spinal Immobilisation and Primary Packaging. <p>CG031 Spinal Immobilisation and Primary Packaging is a complimentary guideline which describes extrication, selective immobilisation and packaging principles. It is applicable to all trauma patients.</p>	GPP	
<ul style="list-style-type: none"> This guideline describes additional measures to be considered in patients with neurological or radiological signs of Spinal Cord Injury (SCI) such as: <ul style="list-style-type: none"> weakness. reduced or absent sensation. hyperaesthesia. priapism (in males). inability to pass urine. radiological evidence of cord injury. <p>This guideline described additional measure to be used in those with overt signs of spinal cord injury. It is not applicable to all trauma patients.</p>	Information	
4.2 Breathing assessment		
<ul style="list-style-type: none"> Assess adequacy of oxygenation and ventilation. <ul style="list-style-type: none"> observe respiratory pattern and depth – look for diaphragmatic breathing, hypoventilation or fatigue. measure oxygen saturations. consider ETCO₂ monitoring. consider arterial blood gas analysis. if available, consider serial vital capacity measurements. Consider hypersecretion and bronchospasm (due to loss of sympathetic activity). <p>In cervical and high thoracic injuries the nerves to the intercostals are paralysed, reducing the ability to breathe effectively. Patient will have diaphragmatic breathing and an impaired cough. In high cervical lesions the diaphragm may also be affected (C3,4,5) causing apnoea. Adequate ventilation can quickly deteriorate due to muscle fatigue, retained secretions, developing V/Q mismatch, diaphragmatic splinting due to ileus, opioid adverse effects or ascending spinal lesions.</p>	Strong	3,7

4.3 Circulation assessment	Authors' recommendation	Level [Reference]
<ul style="list-style-type: none"> • <i>Assess the adequacy of circulation.</i> <ul style="list-style-type: none"> - <i>assess for peripheral and central signs of shock (skin colour, capillary refill, pulse and blood pressure).</i> - <i>do not automatically attribute hypotension to neurogenic shock.</i> - <i>maintain a high index of suspicion for other causes of traumatic shock.</i> - <i>autonomic dysfunction can mask the usual signs of hypovolemia and sensory loss can mask the pain of injuries.</i> - <i>consider use of ultrasound (e.g. FAST) to augment examination.</i> • <i>Neurogenic shock can occur with injuries above T8:</i> <ul style="list-style-type: none"> - <i>patients may be flushed, warm peripherally, hypotensive with good volume pulses and bradycardic.</i> <p>Neurogenic shock occurs due to sudden loss of efferent sympathetic supply to the vasculature and heart. It can occur with lesions above T8. Patients are vasodilated and flushed. Unopposed vagal supply to the heart leads to bradycardia. It is critical to maintain a high index of suspicion for other injuries. Not only will SCI mask the pain of other injuries but other types of shock can be difficult to detect with autonomic dysfunction. It is usually safer to assume that other injuries co-exist than treat as isolated neurogenic shock.</p>	Strong	3,7
4.4 Pre-hospital neurological assessment		
<ul style="list-style-type: none"> • <i>In the pre-hospital phase, do not delay transfer to hospital to complete a full neurological examination.</i> • <i>A limited examination to determine the approximate neurological level of the injury may aid with anticipating respiratory and cardiovascular compromise.</i> <p>Only life-saving interventions should be undertaken on scene. Full neurological examination at scene is not beneficial and will delay transfer.</p>	Strong	1,6

4.5 In-hospital neurological assessment	Authors' recommendation	Level [Reference]
<ul style="list-style-type: none"> <i>The neurological level is defined as the lowest level with both normal sensory (light touch and pin prick) and motor (normal power) function.</i> 	Strong	5
<ul style="list-style-type: none"> <i>In hospital, aim to determine the neurological level of the injury.</i> <ul style="list-style-type: none"> <i>a full neurological examination is usually deferred to day 7 following the injury.</i> <i>the American Spinal Injury Association ISNCSCI assessment is the gold standard but full completion is not appropriate for all retrievals.</i> <i>further examination, including PR and sacral dermatome testing, should be guided by the receiving centre.</i> <i>Reassess the patient every 1-2 hours.</i> <ul style="list-style-type: none"> <i>gradual deterioration can occur over the first 72 hours.</i> <i>this may present with a rising neurological level or worsening respiratory compromise.</i> <p>The International Standard Neurological Classification of Spinal Cord Injury (ISNCSCI) is the gold standard for the assessment and prognostication of SCI. NICE guidance suggests it should be completed as soon as possible after admission to the Emergency Department. The chart and explanatory notes are available at: https://www.iscos.org.uk/sitefiles/International%20Standards%20Worksheet.pdf</p> <p>Completion of the full assessment is likely to be inappropriate in many rural retrieval situations. As a minimum, the neurological level should be determined as accurately as possible and further examination guided by the receiving centre.</p>	Strong	1,3,5,7
<ul style="list-style-type: none"> <i>Reassess the patient every 1-2 hours.</i> <ul style="list-style-type: none"> <i>gradual deterioration can occur over the first 72 hours.</i> <i>this may present with a rising neurological level or worsening respiratory compromise.</i> <p>Secondary injury can occur due to oedema of the cord, hypoxia and hypoperfusion. This can lead to an ascending neurological level of worsening compromise below the level of injury.</p>	Strong	3

4.6 Indications for respiratory support	Authors' recommendation	Level [Reference]
<ul style="list-style-type: none"> Administer oxygen if required to maintain an SpO₂ 94-98%. <p>Hypoxia can lead to secondary injury to critical areas of the cord.</p>	Strong	3,7
<ul style="list-style-type: none"> Consider intubation and ventilation if there is significant respiratory compromise: <ul style="list-style-type: none"> apnoea. fatigue with progressively shallower breathing. hypoventilation - PaCO₂ > 6kPa. hypoxia despite oxygen supplementation. those at risk of deterioration requiring prolonged transfer, especially by air where there is limited room for in-flight intervention. <p>Hypoxia, hypercarbia and acidosis can lead to hypoperfusion and hypoxia of the cord worsening secondary injury. Patients can deteriorate quickly and the decision to intubate should take into account the patient's current state, previous state and the trajectory of the injury.</p>	Conditional	3,7
<h3>4.7 Cardiovascular support</h3>		
<ul style="list-style-type: none"> Avoid hypotension (SBP <90mmHg). Treat hypotension with fluids initially. <ul style="list-style-type: none"> use blood products if haemorrhage is suspected. consider crystalloids if there is a low suspicion of haemorrhage (suggested maximum of 2000ml in adults). <p>Hypoperfusion worsens secondary injury and should be treated. Vasodilation due to the spinal cord injury leads to a relative hypovolemia and fluids should be first line. In the major trauma patient, bleeding can be difficult to rule out and blood products should be considered. In isolated spinal injuries then crystalloids should be considered but fluid overload should be avoided (suggested maximum of 2000ml of crystalloid).</p>	Strong	2,3
<ul style="list-style-type: none"> Do not routinely use permissive hypotension except with active non-compressible bleeding where targeting a normal blood pressure may be detrimental or unachievable. <p>As per NICE Major Trauma Guidelines - if bleeding is suspected to be the bigger issue then a permissive hypotension approach can be utilised.</p>	Conditional	2
<ul style="list-style-type: none"> Consider inserting an arterial line. 	GPP	

4.7 Cardiovascular support, cont	Authors' recommendation	Level [Reference]
<ul style="list-style-type: none"> • <i>In isolated spinal cord injury, consider targeting a MAP of 85-90mmHg.</i> <ul style="list-style-type: none"> - <i>this should only be considered in patients without significant bleeding e.g. where the clinician is confident of an isolated spinal injury or where other injuries have been ruled out by CT scan.</i> <p>There is evidence that targeting a high MAP for 5-7 days can improve outcome. This should be considered on a case-by-case basis and can be guided by the receiving centre for delayed or prolonged retrievals.</p>	Conditional	8
<ul style="list-style-type: none"> • <i>Consider using vasopressors and inotropes in isolated spinal cord injury following fluid resuscitation:</i> <ul style="list-style-type: none"> - <i>noradrenaline and adrenaline infusions are both suitable first line agents.</i> - <i>be aware that pure vasopressors (e.g. metaraminol) may cause significant bradycardia.</i> <p>Targeting a high MAP will often require vasopressor/inotropic support. We suggest a maximum of 2000ml of fluid resuscitation prior to starting inotropic support. Use caution with pure vasopressors (e.g. metaraminol) which may cause severe bradycardia due to the unopposed baroreceptor reflex.</p>	Conditional	3,7
<ul style="list-style-type: none"> • <i>Treat severe (<40 bpm) or symptomatic bradycardia with antimuscarinics (e.g. atropine 0.3-0.6mg).</i> • <i>Consider antimuscarinics prophylactically in vagally stimulating procedures e.g. laryngoscopy.</i> <p>Bradycardia can occur due to the unopposed vagal innervation of the heart in high thoracic and cervical cord injuries. Vagally stimulating procedures (e.g. ET suctioning, laryngoscopy) can precipitate an exaggerated vasovagal response and the prophylactic treatment of bradycardia prior to these procedures should be considered.</p>	Strong	3

4.8 Anaesthetic induction	Authors' recommendation	Level [Reference]
<ul style="list-style-type: none"> • <i>Anticipate worsening hypotension or bradycardia during induction.</i> <ul style="list-style-type: none"> - <i>consider establishing vasopressor support before induction.</i> 	GPP	
<ul style="list-style-type: none"> • <i>During induction and intubation:</i> <ul style="list-style-type: none"> - <i>remove collars and blocks</i> - <i>allocate manual in-line stabilisation.</i> - <i>use a rapid sequence induction (RSI) technique.</i> - <i>minimise cervical movement where possible through laryngoscopy technique and the use of adjuncts, e.g. a video laryngoscope and bougie/stylet.</i> - <i>do not use suxamethonium if >72 hours has elapsed since the time of injury.</i> <p>Collars make intubation more difficult and prevent quick access to the neck - they should be removed.</p> <p>These patients are at increased risk of aspiration due to gastroparesis so an RSI technique should be used.</p> <p>During intubation, flexions and extension of the spine should be minimised. A technique the operator is comfortable with should be used. Operators could consider using a video-laryngoscope, bougie, stylet and/or BURP.</p> <p>Suxamethonium is contraindicated from 72 hours after the point of injury as the proliferation of extra-junctional acetyl-choline receptors leads to an exaggerated hyperkalemic response.</p>	Strong	3,9
<ul style="list-style-type: none"> • <i>Target normocapnia in ventilated patients.</i> <p>Hypercarbia leads to vasodilation of spinal vessels, increased blood volume and therefore pressure in the spine. This can worsen hypoperfusion and secondary injury.</p>	Strong	6
<h3>4.9 Other management</h3>		
<ul style="list-style-type: none"> • <i>Keep the patient flat with neutral spinal alignment.</i> • <i>Minimise movement.</i> • <i>If rolling is required, perform a full log-roll.</i> <p>The patients should be moved once to a neutral position of comfort. In patients with spinal deformities, they should not be forced into a position that is not comfortable or which elicits neurology. They should only be moved when necessary, for interventions and to relieve pressure areas. If rolling is required then a full log roll with 4 people controlling the head, shoulders, pelvis and legs.</p>	Strong	1,3,7

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<ul style="list-style-type: none"> • Immobilise and package the patient as per CG031 Spinal Immobilisation and Primary Packaging. • <i>Use a vacuum mattress when available.</i> <p>CG031 Spinal Immobilisation and Primary Packaging describes how adults and children should be immobilised using collars, blocks, tape, scoop stretchers and vacuum mattresses. Vacuum mattresses are strongly encouraged for prolonged primary transfers and all secondary transfers.</p>	Strong	3,7
<ul style="list-style-type: none"> • <i>Meticulously ensure pressure areas care and the patient is not lying on clothing/ objects.</i> <p>Clothing should be removed and particular care taken to make sure the patient is not lying on any objects or bunched sheets. For prolonged or delayed transfers the referring center may need to turn the patient every 2 hours to relive pressure areas.</p>	Strong	3
<ul style="list-style-type: none"> • <i>Mitigate for temperature loss aggressively:</i> <ul style="list-style-type: none"> - <i>SCI patients have impaired thermoregulation and are prone to hypothermia.</i> • <i>Prevent hypoglycemia.</i> <p>Poor glycemic control and hyperthermia can worsen secondary cord injury and should be prevented.</p>	Strong	2
<ul style="list-style-type: none"> • <i>Treat pain initially with IV morphine or fentanyl; use ketamine as a second line agent.</i> <p>Use opioids with caution so not to worsen any respiratory compromise.</p>	Conditional	1
<ul style="list-style-type: none"> • <i>Do not routinely give steroids.</i> <p>Although there is some evidence of benefit in some patients the routine use in all SCI is not supported by national and international bodies.</p>	Strong	3
<ul style="list-style-type: none"> • <i>For inter-hospital transfers:</i> <ul style="list-style-type: none"> - <i>insert a urinary catheter and monitor fluid balance.</i> - <i>insert a NG/OG tube and leave on free drainage.</i> <p>Patients with severe injuries will have flaccid paralysis of the bladder and will be unable to pass urine. Over-distention can lead to permanent damage. Paralytic ileus can also occur leading to abdominal and gastric distention. Patients are at increased risk of aspiration and splinting of the diaphragm can occur worsening ventilation.</p>	Strong	3

4.10 Triage	Authors' recommendation	Level [Reference]
<ul style="list-style-type: none"> • <i>For patients in the pre-hospital phase, triage suspected spinal cord injury to the nearest Major Trauma Centre (MTC) as per the trauma triage tool.</i> <p>Patients should be transferred to the nearest MTC. This allows rapid access to life-saving interventions and critical care. Primary patients should not routinely be transported directly to the QEUH unless it is the nearest centre.</p>	Strong	4
<ul style="list-style-type: none"> • <i>For patients being transferred from a hospital setting, consider referring directly to the Queen Elizabeth University Hospital in Glasgow (where the National Spinal Injuries Unit is located).</i> <ul style="list-style-type: none"> - <i>patients who have not had a CT scan should usually be taken to the emergency department for further assessment.</i> - <i>most patients will initially be nursed in a general ward, HDU or ITU and not directly admitted to the National Spinal Injuries Unit.</i> <p>Patients with Spinal Cord Injury will often be managed in the National Spinal Injuries Unit at some point in their acute illness or rehabilitation. For those with severe injury transfer directly to the QEUH may be beneficial and should be considered. Direct admission to the National Spinal Injuries Unit is generally not appropriate in the immediate phase of their illness.</p>	Conditional	7

5. References

1. NICE Guideline NG 41 – Spinal Injury: Assessment and Initial Management – February 2016
2. NICE Guideline NG39 – Major Trauma: Assessment and Initial Management – February 2016
3. The initial management of adults with spinal cord injuries (Advice for Major Trauma Networks) – National Spinal Cord Injury Strategy Board (May 2012)
4. Scottish Trauma Network Adult and Paediatric Trauma Triage Tools
5. American Spinal Injury Association (ASIA) International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) Chart. (<https://www.iscos.org.uk/sitefiles/International%20Standards%20Worksheet.pdf>)
6. Anaesthesia, Trauma and Critical Care Course Manual 2014. (<https://www.ataccgroup.com/wp-content/uploads/2017/04/ATACC-Manual-version-8-low-resolution-v2.pdf>)
7. Queen Elizabeth National Spinal Injury Unit, Scotland Transfer Checklist (<https://www.spinalunit.scot.nhs.uk/wp-content/uploads/2015/05/24622-Transfer-Checklist.pdf>).
8. Ploumis A et al. A systematic review of the evidence supporting a role for vasopressor support in acute SCI. *Spinal Cord* 2010; 48: 356–62
9. Heath KJ. The effect on laryngoscopy of different cervical spine immobilisation techniques. *Anaesthesia* 1994; 49: 843–845