INTRODUCTION

Spinal cord injury (SCI) most commonly affects young and fit people and will continue to affect them to a varying degree for the rest of their lives.

In the extreme, SCI may prove immediately fatal where the upper cervical cord is damaged, paralysing the diaphragm and respiratory muscles.

Partial cord damage, however, may solely affect individual sensory or motor nerve tracts producing varying long-term disability. It is important to note that there are an increasing percentage of cases where the cord damage is only partial and some considerable recovery is possible, providing the condition is recognised and managed appropriately.

The spinal cord runs in the spinal canal down to the level of the second lumbar vertebra in adults.

The amount of space in the spinal canal in the upper neck is relatively large, and injury in this area can be ameliorated if adequate immobilisation is applied. In the thoracic area, the cord is wide, and the spinal canal relatively narrow and injury in this area is likely to completely disrupt and damage the spinal cord.

Spinal shock is a state of complete loss of motor function and often sensory function found sometimes after SCI. This immediate reaction may go on for some considerable time, and some recovery may well be possible.

Neurogenic shock is the state of poor tissue perfusion caused by sympathetic tone loss after spinal cord injury.

Immobilisation – evidence for how to immobilise

A recent Cochrane review found no randomised controlled trials comparing out of hospital spinal immobilisation techniques[1]:

- soft collars do not limit movement[2,3]
- there is variable difference between the various types of semi-rigid collars[2-4]
- addition of side supports and tapes increases immobilisation[2,3]
- combining collar with extrication board improves immobilisation[5]
- the application of devices is more important than the variation of devices[6]
- neutral position needs slight flexion of the neck and the occiput should be raised by two centimetres.[6] Extrication devices are better than extrication boards at reducing rotational movement [7,8]
- patients should spend no longer than 45 minutes on a rigid extrication board[9,10] but padding can extend this[11,12]
- vacuum mattress is more comfortable, and gives better immobilisation[13]
- vacuum mattresses cannot be used for extrication and are vulnerable to damage
- log rolling is not without risk[14] and use of the scoop stretcher may be safer for lifting patients.

Immobilisation – evidence for not immobilising

Penetrating injury to the head has not been shown to be an indication for spinal immobilisation[15,16] and even penetrating injuries of the neck only rarely need selective immobilisation.[17]

A small prospective pre-hospital study[18] indicated that the presence of **ALL** the following criteria can exclude significant spinal injury:

- normal mental status
- no neurological deficit
- no spinal pain or tenderness
- no evidence of intoxication
- no evidence of extremity fracture.

The few missed are often at the extremes of age.[19] Such criteria can be reproducibly undertaken in the out of hospital environment.[20] Mechanism of injury was not shown to be an independent predictor of injury.[21] Criteria were similar for thoraco-lumbar injuries but less specific.[22] Larger trials based in emergency departments (ED's) designed to determine the need for x-rays have drawn similar conclusions.[23,24]

Use of such guidelines can significantly reduce the use of unnecessary immobilisation.[25]

Immobilisation – hazards

The value of routine out of hospital spinal immobilisation remains uncertain and any benefits may be outweighed by the risks of rigid collar immobilisation, including:

1. airway difficulties
2. increased intra-cranial pressure[26-31]
3. increased risk of aspiration[32]
4. restricted respiration[33,34]
5. dysphagia[35]
6. skin ulceration[36-38]
7. can induce pain, even in those with no injury[10,39]

PRIMARY SURVEY

Assess ABCD whilst controlling the spine.

Evaluate whether the patient is **TIME CRITICAL, POTENTIALLY TIME CRITICAL**, or **NON-TIME CRITICAL** following criteria as per **trauma emergencies guideline**.

If patient is TIME **CRITICAL/POTENTIALLY TIME CRITICAL:**

- control the airway
- immobilise the spine
- go to the nearest suitable receiving hospital
- provide a hospital alert message.

En-route continue patient MANAGEMENT (***see below***).

ASSESSMENT

All patients with the possibility of spinal injury should have manual immobilisation commenced at the earliest time, whilst initial assessment is undertaken.

HISTORY

It is vital to determine the mechanism of injury in order to understand the forces involved in causing the injury including: hyperflexion, hyperextension, rotation and compression and combinations of all the above.

Injury most frequently occurs at junctions of mobile and fixed sections of the spine. Hence fractures are more commonly seen in the lower cervical vertebrae where the cervical and thoracic spine meets (C5, 6,7/T1 area) and the thoraco-lumbar junction (T12/L1). 10-15% of patients with one identified spinal fracture will be found to have another.

Road traffic collisions, falls and sporting injuries are the most common causes of SCI. As a group, motorcyclists occupy more spinal injury unit beds than any other group involved in road traffic collisions. Roll over road traffic collisions and the non-wearing of seat belts, causing head to vehicle body contact, and pedestrians struck by vehicles are likely to suffer SCI. Ejection from a vehicle increases the risk of injury significantly.

Certain sporting accidents, especially diving into shallow water, horse riding, rugby, gymnastics and trampolining have a higher than average risk of SCI. Rapid deceleration injury such as gliding and light aircraft accidents also increases the risk of SCI.

Examination

Specific signs of SCI

The patient may complain of:

- neck or back pain
- loss of sensation in the limbs
- loss of movement in the limbs
- sensation of burning in the trunk or limbs
- sensation of electric shock in the trunk or limbs.

If patient is a non-time critical patient, perform a more thorough assessment with a brief secondary survey.

Specifically assess:

- administer high concentration oxygen (O_2) (***refer to oxygen protocol for administration and information***) via a non-rebreathing mask, using the stoma in laryngectomee and other neck breathing patients. High concentration O_2 should be administered routinely, whatever the oxygen saturation, in patients sustaining major trauma and long bone fracture, except for patients with chronic obstructive pulmonary disease (COPD) (***refer to COPD guideline***)
- consider assisted ventilation at a rate of 12–20 respirations per minute if any of the following are present:
  - oxygen saturation (SpO_2) is <90% on high concentration O_2
  - respiratory rate is <10 or >30bpm
  - inadequate chest expansion.
- rapidly assess in the conscious patient sensory and motor function to estimate the level of the cord injury (***see Figure 1***).

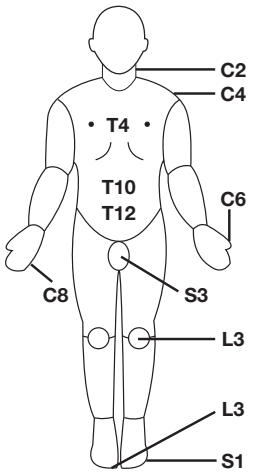

Figure 1 – Spinal Nerves

SENSORY EXAMINATIONS

Examine by	a. light touch b. response to pain
Use	the forehead as the guide to what is normal sensation
Examine	a. upper limbs and hands b. lower limbs and feet
Examine	both sides
T4 Examination	must be carried out in the **MID-AXILLARY** line, **NOT** the **MID-CLAVICULAR** line, as C2, C3 and C4 all supply sensation to the nipple line

Abdominal and chest signs

During the secondary survey, remember that abdominal and chest signs may be unreliable in the presence of SCI.

Assessment in the unconscious patient

It is not possible to fully assess the integrity of the spinal cord in the unconscious patient. The following signs may help:

- diaphragmatic or abdominal breathing
- hypotension (BP often <80-90 mmHg) with bradycardia
- warm peripheries or vasodilatation in presence of low blood pressure
- flaccid (floppy) muscles with absent reflexes
- priapism – partial or full erection of the penis.

NOTE: Spinal injury must always be presumed in the unconscious trauma victim

MANAGEMENT

All patients with a mechanism of injury that suggest the possibility of spinal injury should have manual immobilisation commenced at the earliest time, whilst initial assessment is undertaken.

Management of established spinal cord injury

Evidence is conflicting on the use of early high dose steroids in acute spinal cord injury.[40-42] If benefit exists then steroids need to be given within 8 hours of injury and therefore can be delayed until arrival at hospital.

Neurogenic shock

This is a difficult diagnosis in the out of hospital environment. The aim of shock treatment should be to maintain a blood pressure of approximately 90mmHg systolic.

Fluid Therapy

Obtain IV access.

Current research shows little evidence to support the routine use of IV fluids in adult trauma patients. In circumstances such as penetrating chest and abdominal trauma, survival worsens with the routine use of IV fluids.[43]

Fluids may raise the blood pressure, cool the blood and dilute clotting factors, worsening haemorrhage. Therefore, current thinking is that fluids should only be given when major organ perfusion is impaired.

If there is visible external blood loss greater than 500mls, fluid replacement should be commenced with a 250ml bolus of crystalloid.

Central pulse ABSENT, radial pulse ABSENT **is an absolute indication for urgent fluid. If the patient has a carotid pulse but no radial pulse then other clinical factors should also be considered before decision on fluid administration.**

Central pulse PRESENT, radial pulse ABSENT is a relative indication for urgent fluid depending on other indications including tissue perfusion and blood loss.

Central pulse PRESENT, radial pulse PRESENT **DO NOT** commence fluid replacement,[44] **unless there are other signs of poor central tissue perfusion** (e.g. altered mental state, cardiac rhythm disturbance).

Reassess vital signs prior to further fluid administration.

DO NOT delay at scene for fluid replacement; wherever possible cannulate and give fluid **EN-ROUTE TO HOSPITAL.**

In neurogenic shock, a few degrees of head down tilt may improve the circulation, but remember that in cases of abdominal breathing, this manoeuvre may further worsen respiration and ventilation. This position is also unsuitable for a patient who has, or may have, a head injury.

Atropine may be required if bradycardia is also present but it is important to rule out other causes, e.g. hypoxia, severe hypovolaemia.

When not to immobilise

Blunt trauma

All patients should be initially immobilised if the mechanism of injury suggests the possibility of SCI.

Following assessment it is possible to remove the immobilisation if **ALL** the following criteria are present (***Appendix 1***):

- no alteration in consciousness or mental state and patient is able to fully co-operate with examination
- no evidence of intoxication
- no complaint of spinal pain
- no vertebral tenderness
- no neurological deficit or complaint
- no significant distracting injury.

Spinal pain does not include tenderness isolated to the muscles of the side of the neck.

Children

None of the studies have been validated in children. It is recommended that these guidelines are interpreted with caution in children although there is some evidence to support similar principles.[45,46]

Penetrating trauma

Those with isolated penetrating injuries to limbs or the head do not require immobilisation.

Those with truncal or neck trauma should be immobilised if the trajectory of the penetrating wound could pass near or through the spinal column.

IMMOBILISATION

Cautions

Vomiting and consequent aspiration are serious consequences of immobilisation. Ambulance clinicians must always have a plan of action in case vomiting should occur. The collar will usually need to be removed and manual immobilisation instituted. This may include:

- suction
- head down tilt of the board
- rolling on to side on the board.

Methods

If immobilisation is indicated then the whole spine must be immobilised.

Only two methods are acceptable:

1. manual immobilisation whilst the back is supported
2. collar, head blocks and back support.

There are several acceptable means of back support and the optimal method will vary according to circumstances. The following techniques may be used:

1. **Patient lying supine**
   - log roll patient with manual immobilisation of the neck to enable long extrication board to be used
   - directly lift patient or use a scoop stretcher then insert a vacuum mattress underneath patient.
2. **Patient lying prone**
   - log roll patient with manual immobilisation of the neck to enable long extrication board to be used
   - 2-stage log roll on to a vacuum mattress.
3. **Patient requiring extrication**
   - extrication devices should be used if there is any risk of rotational movement[8,47]
   - rearward extrication on an extrication board
   - slide extrication invariably involves some rotational component and therefore has higher risks in many circumstances.

The techniques for use of devices are described in Pre-Hospital Trauma Life Support (PHTLS) and other manuals.

Precautions

The restless patient

There are many reasons for the patient to be restless and it is important to rule out reversible causes e.g. hypoxia, pain, fear. If, despite appropriate measures the patient remains restless, then immobilisation techniques may need to be modified. The use of restraint can increase forces on the injured spine and therefore a “best possible” approach should be adopted.

Emergency Extrication

If there is an immediate threat to life, for example, fire or airway obstruction that cannot be resolved in-situ, then the Ambulance Clinicians must decide on the relative risks of spinal immobilisation and the other factors.

Rapid extrication techniques with manual immobilisation of the cervical spine are appropriate in these circumstances; this includes side extrication.

Children

In children it is difficult to assess the neutral position but a padded board, straps and collar appear to be the optimal method. [3,48]

Transportation of spinal cases

Driving should balance the advantages of smooth driving and time to arrival at hospital. No immobilisation techniques eliminate movement from vehicle swaying and jarring.[49] The technique of loosening the collar is not supported by evidence.

There is no evidence to show advantage of direct transport to a spinal injury centre.[50]

Patients can tolerate a 30 minute journey on a long extrication board.[10] The receiving ED staff should be told how long the patient has already been on the board so they can make an appropriate judgment on the timing of its removal. The duration of time on the extrication board should be recorded on the clinical record. The extrication board should be removed as soon as possible on arrival in hospital.[51]

If a journey time of greater than 30 minutes is anticipated, the patient should be transferred from the extrication board using an orthopaedic ("scoop") stretcher to a vacuum mattress.[11] It may be appropriate to use a mattress on a board in non-extrication situations.

If a journey time greater than 30 minutes occurs unexpectedly it is not appropriate to add further delay by transferring the patient to a vacuum mattress. The journey should proceed but the ED should be advised of the length of time the patient has spent on the board.

If there is a clear paralysing injury to the spinal cord then the benefits of the back board may be limited, while the risk of pressure sores may be very high. In these circumstances, the use of a vacuum mattress is often preferred. However, as half of cases of spinal injuries have other serious injuries, an unnecessary delay at scene or in transit should be avoided.

AT HOSPITAL

As well as the usual information at the time of handover it is important to give the duration of immobilisation.

Assist in early removal from the extrication board.

Key Points – Spinal Trauma

- Immobilise the spine until it is positively cleared.
- Immobilise the spine of all unconscious trauma victims.
- If the neck is immobilised the thoracic and lumbar spine also need immobilisation.
- Standard immobilisation is by means of collar, headblocks, tapes and spinal board.
- Aspiration of vomit, pressure sores and raised intracranial pressure are major complications of immobilisation.

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METHODOLOGY

Refer to methodology section.

APPENDIX 1 – Immobilisation Algorithm