HDU/ICU

Managing Spinal Injury: Critical Care

The initial management of people with actual or suspected spinal cord injury in high dependency and intensive care units

by Paul Harrison, RGN, ONC, ENB 371, MAEd

SPINAL INJURIES ASSOCIATION

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Information for acute care sector staff

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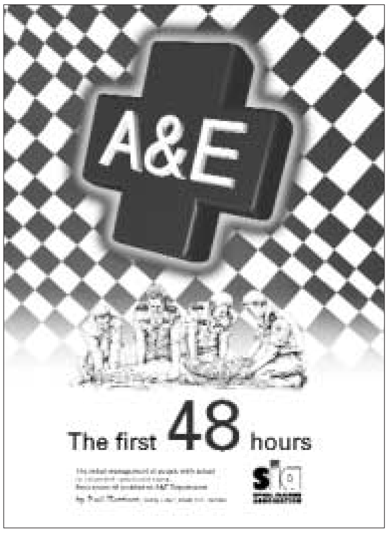
Dedication

This book is dedicated to all those healthcare professionals currently working in Intensive or High Dependency Care Units and Spinal Injuries Units who, along with the Spinal Injuries Association, have committed themselves towards improving the collaborative management of people with actual or suspected spinal cord lesions. Without their expressed interest and support this book would not have been possible.

The first book in this series is also available from the Spinal Injuries Association.



Spinal Injury:
The First 48 Hours

The initial management of people with actual or suspected spinal cord injury from scene of accident to A&E Department

by Paul Harrison, RGN, ONC, ENB 371, MAEd

Information for acute care sector staff

Published by
the Spinal Injuries Association

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Foreword - by Paul Harrison

In comparison to spinal column trauma, the actual incidence of spinal cord injury (SCI) is relatively low. In most instances, transfer of a patient to a specialist Spinal Injuries Unit (SIU) can be achieved direct from the Accident & Emergency (A&E) department or within a few days of the injury. However, a significant proportion of patients will also present with accompanying head injury or multi-system trauma occasioning actual or potential respiratory compromise, single or multi-organ failure. For these reasons, most SIUs now possess dedicated Intensive or High Dependency Care facilities within their infrastructure. This enables them to receive these patients as soon as possible after referral.

Despite this, and recent improvements in the transportation of critically ill patients, transfer distances or the uncertain nature of the patient's condition at the time may force a delay in transfer. In these cases, transfer to a local Spinal Injuries Unit can be delayed by several weeks until the patient's condition improves sufficiently for the transfer journey to be undertaken. During this time the patient will need to be cared for appropriately within the acute and critical care areas of the admitting District General Hospital (DGH). The admission of a person with an actual or suspected traumatic spinal cord injury to the High Dependency Unit (HDU) or Intensive Care Unit (ICU) of a DGH is therefore a potentially real event.[1]

Key point **There is no better way to prepare for this eventuality than by liaising with your local SIU to establish a good rapport and effective channels of communication with your local specialist team.**

Spinal Cord Injury poses significant challenges and concerns for any healthcare professional currently working in critical care areas today. As well as saving lives, these particular healthcare professionals can also make an important contribution towards preventing further disability, thereby facilitating the process of rehabilitation that follows SCI. Complications that occur during the initial hospitalisation can have a detrimental effect on an individual's anticipated outcomes for rehabilitation.[2]

This book is written to make critical care professionals aware of their role and contribution within the rehabilitation process:

'Rehabilitation is a continuous process, beginning at the moment of injury, and is an integral part of critical care. If critical care and rehabilitative care are not combined, people with spinal cord injuries are subject to serious clinical and economic consequences that could otherwise have been prevented.'[3]

The intention of this book is to facilitate, even provoke, both the discussion and the actions associated with the planning and delivery of appropriate care for the next person with actual or suspected SCI to be admitted to your care.

A comprehensive evidence base, derived from the current literature, underpins most good practice recommendations. Where appropriate to the recommendation being promoted, the author's actual words have been used. Where documented evidence has been considered insufficient, consensus opinions, the accumulated clinical experiences and observations of a wide range of healthcare professionals currently employed within ICUs, HDUs and SIUs have been incorporated.

My personal motivation for producing this book has been sustained through close collaboration, over many years, with these healthcare practitioners. The keypoints for developing or improving practice, which are endorsed most frequently by this group, are presented within individual text boxes or emboldened within the text itself.

1 Introduction

Incidence and Prevalence of Spinal Cord Injury

It is estimated that between 500 and 700 people sustain a traumatic spinal cord injury (SCI) each year in the UK.[4] The effects of a traumatic spinal cord lesion are usually permanent and currently there is no cure for this condition. SCI can occur at any age.

'The potential for spinal cord injury is always present in a patient who has sustained trauma to the vertebral column… any patient with injury above the clavicle or any patient unconscious after trauma.' [5]

In the UK and Eire, 12 spinal injuries units (SIUs) provide comprehensive acute, rehabilitation and continuing care facilities for all individuals with SCI. These 12 units provide a network of regional and supraregional specialist care facilities and services.

As recently as 50 years ago, a diagnosis of spinal cord paralysis was akin to a death sentence. Today, as a direct consequence of the knowledge and experience that have accumulated in these specialist centres, the life expectancy of these individuals is at least equal to that of their fellow citizens. The acute and continuing care of people with SCI within dedicated specialist centres of excellence has reduced the incidence of both acute and chronic complications among the population.[4,6]

Management of Spinal Cord Injury in District General Hospitals

There is a long standing expectation upon UK acute healthcare providers to transfer any patient with an actual or potential SCI to a specialist SIU.[6-15] The Spinal Injuries Association (SIA - the national association for and representative of people with spinal cord injuries) and the British Association of Spinal Cord Injury Specialists (BASCIS - the representative body of Spinal Cord Injury Consultants) recommend that this transfer should be made as soon as possible after diagnosis of the SCI.[6,12-15] This provision is normally pre-arranged within local contracting arrangements for accessing specialist services.[6,9,13,15]

In the majority of cases, referral and transfer of SCI patients to a local SIU is usually accomplished within a few days of injury.[6,12-14] The accepted delays in transfer are those where distance, mode of transport or physiological status intrudes.[6,8,10-12,15] However, some patients who present with significant accompanying multi-trauma or actual respiratory compromise can create a situation in which this transfer to a specialist centre may have to be delayed for longer.[6,8,9,12,15]

Under no circumstances should patients with SCI not be referred to an SIU, because this results in detrimental implications for their long-term morbidity and quality of life.[2-4,6,12,14-22] Ultra-high lesions of the spinal cord (above C4) can present with diaphragmatic paralysis at onset, although the need for mechanical ventilation in most cases is for significant chest or abdominal trauma. Head injury or multi-trauma can be present in up to 30% of new admissions to an SIU.[6,23] Any of these patients could be initially admitted to a local HDU/ICU.[1]

Further neurological deterioration, resulting from lesion extension after the initial SCI, can occur naturally in about 5% of cases,[24] and a number of complications associated with the systemic effects of SCI can lead to respiratory compromise. Unfortunately, a significant number of delays and complications can also arise as a result of inappropriate or poorly informed initial management.[10,11,14] Several of these can also cause respiratory failure along with single or multiple organ effects, sufficient for immediate admission to HDU/ICU.[1]

▶Key point **The management of a patient with SCI is a potential scenario for every critical care professional today.**

2 Initial Management of Spinal Cord Injury

The First 48 Hours

The first few days following their accident are the most important for the person who has sustained the SCI. It is during this time that the vast majority of immediate and secondary complications can occur.[2,3,6,12,14,16-19,21,24,25]

It is also the time when the injured person and their family will be seeking an accurate and informed opinion of their full potential for recovery, rehabilitation and future quality of life. Unfortunately, it is also during this time that specialist colleagues in SIUs are currently limited in their ability to have a direct influence on the care that is delivered.[8,10,11] Failure to address properly the full needs of this individual and their family at this time will affect their immediate physiological and psychological status. It also increases the incidence of post-injury complications. This can delay their transfer to a specialist care facility, extend their length of stay and increase care costs.[2,3,6,12,14,18,20,21]

In addition, our increasingly litigious society means that an increasing number of professionals are facing accusations of actual or potential mismanagement, or even negligence, in their delivery of care. The evidence, which underpinned both medical and nursing care practices at the time of an alleged incident, is often called into question in these cases.[10,11] Close and regular liaison with colleagues in specialist units during pre-transfer care is recommended to ensure an informed evidence basis for care is established and maintained in such instances.[10,11,26,27]

Talbot[8] recommends that SIUs influence the pre-transfer care of people with SCI by liaising closely with their colleagues in general hospital units. Advice and information can be obtained over the telephone at the same time as the patient is referred. Alternatively, or in addition, an experienced member of the SIU staff may arrange a liaison visit to support the staff working in the HDU/ICU, discussing appropriate care and demonstrating practical procedures such as turning and bowel management. Your local SIU can also assist you in developing and delivering appropriate collaborative protocols and education sessions. This can be undertaken in advance of your next admission of a patient with a SCI. Clarke *et al* [28] suggest that, an increase in the current levels of knowledge and awareness about SCI among acute care sector professionals:

'…could reduce the incidence of preventable complications resulting from critical events by at least 8%… and… increase the implementation of appropriate nursing interventions by at least 30%… when compared to existing care provision.' [28]

Collaborative multi-professional working and learning which enables the development of integrated care practices is now believed to be one of the most important indicators of quality patient-focused care in critical care environments.[29]

Most of the information within this book is time-limited to the initial needs of the person with an actual or suspected SCI during their first 48 hours after injury. It presupposes that collaborative communication with a nominated SIU will be established as soon as possible after the moment of diagnosis, and that this will continue until transfer of the patient to a specialist centre can be effected.

2 Spinal Injuries Units in the UK and Eire

SIUs and their telephone numbers

1 Queen Elizabeth Spinal Injuries Unit (Glasgow): 0141 201 1100

2 { Northern Regional Spinal Injuries Centre (Hexham): 01434 655655

3 { Northern Regional Spinal Injuries Centre (Middlesbrough): 01642 850850

4 Yorkshire Regional Spinal Injuries Unit (Wakefield): 01924 201688

5 Princess Royal Spinal Injuries Unit (Sheffield): 0114 271 5609

6 Regional Spinal Injuries Centre (Southport): 01704 547471

7 Midlands Centre for Spinal Injuries (Oswestry): 01691 404645

8 Rookwood Spinal Injuries Unit (Cardiff): 02920 415415

9 National Spinal Injuries Centre (Stoke Mandeville): 01296 315000

10 London Spinal Injuries Unit (Stanmore): 020 8 954 2300

11 Duke of Cornwall Spinal Treatment Centre (Salisbury): 01722 336262

12 Spinal Cord Injuries Unit (Belfast): 028 906 69501

13 National Rehabilitation Hospital (Dunlaoghaire): 003 531 2854777

Full addresses are in Appendix, Chapter 21

3 Aetiology of Spinal Cord Injury

Causation

The most common mechanism of injury within the UK population is a sudden, unexpected, impact or deceleration. Velocity is not related to the injury but may influence the extent of cord trauma within each individual case. The potential for SCI is therefore the same after a fall at home as after a motorway collision.[30] The potential for spinal injury is greatest in the scenarios in the box.[31]

Road traffic accidents		**Domestic and industrial accidents**	
Car, Van or Lorry	19%	Domestic accidents (eg fall down stairs or from trees, ladders)	23%
Motorcycle	10%	Accidents at work (eg falls from ladders, scaffolding, falling objects or crush injuries)	14%
Cycle	4%		
Pedestrian	3%		
	Total 36%		Total 37%
Sporting and recreational accidents		**Self-harm and criminal assault**	
Diving into shallow water	6.0%	Self-harm	4.5%
Horse riding	6.0%	Criminal assault	2.0%
Rugby	0.5%		
Miscellaneous (gymnastics, climbing, motorcross, skiing, parachuting)	8.0%		
	Total 20.5%		Total 6.5%

Unusual presentations high-velocity penetration, stabbing, explosion, lightning strike

Please note that this table omits those cases of non-traumatic (medical) spinal cord lesions which make up around 17% of the grand total of people with spinal cord lesions.

Spinal Cord Injury Resulting from Low Falls[32]

Up to 28% of low falls (defined as falls from less than 6 metres or 20 feet) result in spinal injury, irrespective of age at the time of injury. Of these cases, 50% will also sustain a spinal cord injury. Significantly, most of these individuals will have experienced a fall of less than 3 metres or 10 feet. The potential for this mechanism of injury to cause spinal cord injury is poorly appreciated within most trauma centres. Although the incidence is small, the potential for death or severe disability after injury is significant.

3

Illustration by Claire Macdonald / SIA

Cross section:
Demonstrating rupture of anterior spinal ligaments due to forced hyperextension

Example of forced hyperextension injury:
The impact of the chin upon the stair forces the head and cervical spine backwards with sufficient force to rupture the anterior spinal ligaments without accompanying bony injury. With the patient lying in supine alignment on a spine board, there may be no obvious radiographic evidence of injury.

Illustration by Louise E Hunt / SIA

3

Below: cross section –

Forced flexion injury.

Illustration by Claire Macdonald / SIA

Left:

A head-on vehicular impact or collision can result in an unsecured driver or passenger being thrown forward against the windscreen, steering wheel or dashboard causing a forced flexion injury.

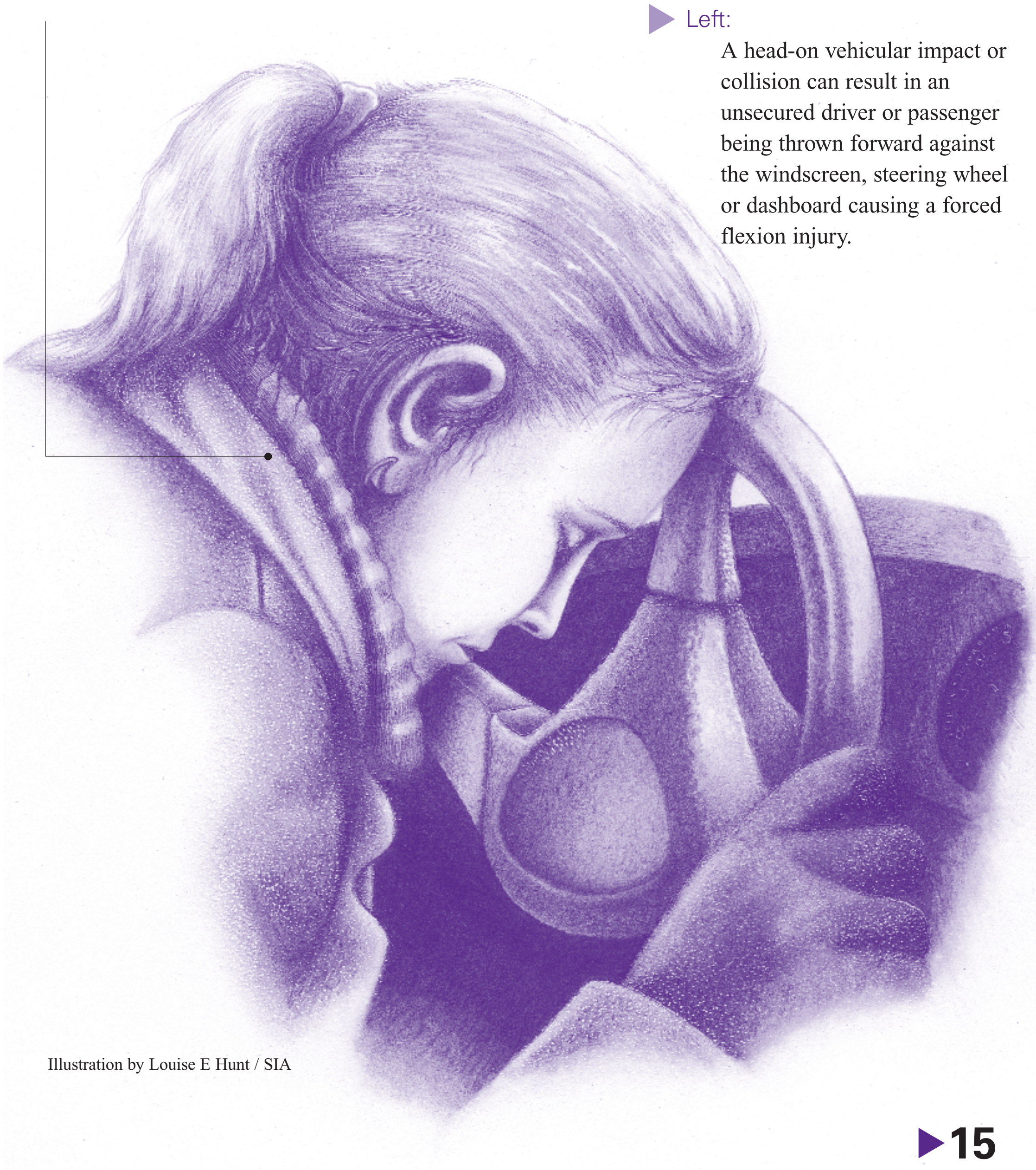
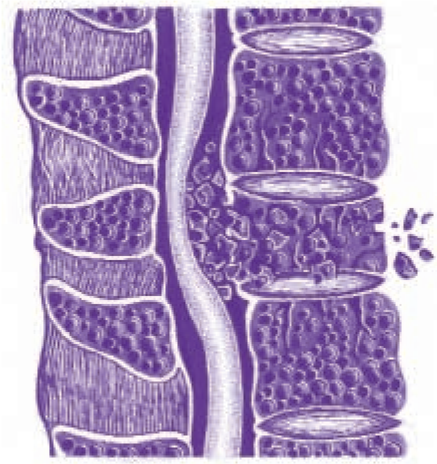


Illustration by Louise E Hunt / SIA

▶ Below: cross section

Compression/ burst fracture, with invasion of bony fragments into the vertebral canal

Illustration by Claire Macdonald / SIA



▶ Below: Diving Injury

Compression fractures are usually the result of in-line traumatic compression forces - as illustrated in this diving injury. However, it is worth considering that the "follow through" force of the diver's body may compound this injury through additional flexion-rotation movements during deceleration and settling of the body. It is not uncommon for these injuries to be further complicated by near drowning or inhalation of vomit after injury.

Louise E Hunt / SIA

3

Main picture:

People who jump from a height and land on their feet will often present in the A&E department with classic bilateral calcaneal fractures. However, the accompanying shock-trauma effects of this condition may mask an injury to the spinal column or spinal cord. Compression forces can have a particularly disruptive effect at those points where the naturally opposing spinal curves meet. Therefore, it is a wise precaution in these cases to obtain good radiological views around the T12/L1 and C7/T1 junctions of the spine.

Inset illustrations by Claire Macdonald / SIA

Illustration by Louise E Hunt / SIA

4 Pathophysiology of Spinal Cord Injury

Process of Lesion Formation

There is a common misconception about the nature and presentation of spinal cord lesions. The use of the words 'transection', 'cutting' and 'severing' in much of the literature suggests that the spinal cord is physically divided at the moment of injury. Although possible in the event of penetrative trauma or gross traction forces, physical disruption of the spinal cord after blunt trauma is a rare occurrence. In truth, the process of formation of a spinal cord lesion is that of ischaemic necrosis.

Displacement of one or more vertebral bodies results in compression of the underlying spinal cord. Alternatively, the cord may be stretched or 'concussed' without any visible disruption of the spinal column.[33] The resulting oedema and vascular damage start a complex series of physiological and biochemical reactions within the spinal cord.[30]

Spinal Shock

There is little room for swelling within the structural confines of the vertebral canal and the oedematous spinal cord is quickly compressed against the surrounding bone. Circulation of blood and oxygen within the spinal cord is disrupted and ischaemic tissue necrosis quickly follows. There is an almost immediate cessation of conductivity within the spinal cord neurons. This is termed 'spinal shock'.

Neurologically, at this time, the patient presents with the loss of all voluntary movement and sensation below the level of the injury. There is also a progressive loss of sympathetic and parasympathetic activity throughout the same area.[30,34-36] At this stage, it is difficult to be certain of the extent or permanence of functional loss within the spinal cord neurons.

The presence of paralysis or paraesthesia does not imply any finality to the process. In some instances, spinal cord oedema and **spinal shock can resolve over time with a subsequent improvement in neurological function**.[30]

Spinal shock usually persists for between two and six weeks dependent on the age of the casualty and the extent of accompanying trauma.[35,36] **During this time, it is impossible for the clinician to provide an accurate diagnosis of the extent of permanent loss of function**.[30] Experience suggests that the effects of spinal shock will persist longest in children and young adults with multi-system trauma who require mechanical ventilation initially.

After SCI the loss of all voluntary movement and sensation below the level of the lesion is probably familiar to most professionals in non-specialist areas. **Less common, however, is an awareness and appreciation of the effects of spinal shock on the internal systems of the body, especially its effects on autonomic and reflex functions. These effects are most pronounced in the tetraplegic patient**.[37,38] The management of the effects of spinal shock within each individual body system are described later.

4

▶**Key point** **The presence of spinal cord paralysis on admission does not imply any finality to the process of lesion formation or give any indication of the potential for permanent loss of function.**

Presentation of Spinal Cord Injury

The main presentations of neurological deficiency after SCI are:

Tetraplegia/Tetraparesis (also called quadriplegia/quadriparesis):
This term is used to describe the complete or partial loss of all movements and/or sensation from the neck downwards, affecting all four extremities and the trunk. Lesions above C4 also incorporate paralysis of the diaphragm.

Paraplegia/Paraparesis:
This term is used to describe the complete or partial loss of all movements and/or sensation from the chest downwards, affecting only the lower limbs.

The term 'complete spinal cord lesion' is used to define the diagnosis of transverse (complete) ischaemic necrosis, which results in the permanent loss of all voluntary movements and sensation below the level of the lesion. However, the process by which spinal cord oedema occurs and progresses towards ischaemia is unique in each case.

There is always the potential at this stage that the oedema will resolve with the subsequent return of some neurological function, as a result of the ability of some nerve fibres to survive. Where this occurs, a diagnosis of 'incomplete spinal cord lesion' is given.[31]

Management of Spinal Shock

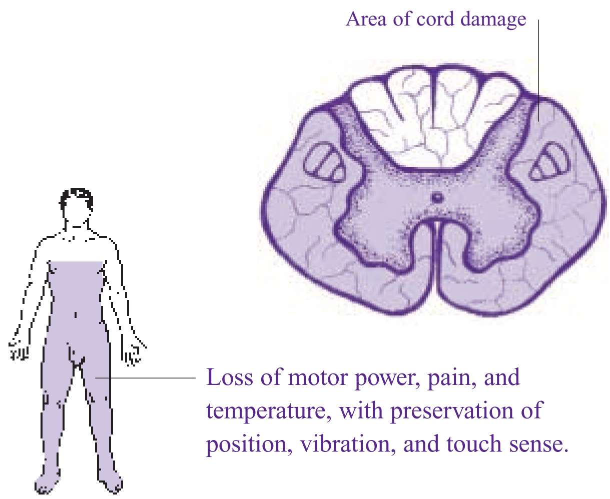
The loss of all voluntary movement and sensation below the level of lesion following SCI is probably familiar to most professionals in non-specialist areas. Less common however, is an appropriate awareness and appreciation of the effects of spinal shock upon the internal systems of the body, especially its effects upon autonomic and reflex functions. Chapters 10-15 will illustrate and explain the manifestation and impact of spinal shock upon the various systems of the body. This approach has been chosen to facilitate the reader's ease of reference and understanding of this relatively rare condition and its management.

'The management of a spinal cord injury with tetraplegia or paraplegia is difficult because within every one patient there are various, equally important, conditions to be treated. None of these must be neglected and in no field does the concept apply more forcibly of treating the patient as a whole. It is for the purposes of description only that it is necessary to consider separately the various features of the clinical picture. The practical management encompasses all details, and naturally, it is only in spinal injury centres where experience in looking after so many aspects of the case at once is likely to be found.'[39]

Incomplete Spinal Cord Lesions

Anterior Cord Syndrome

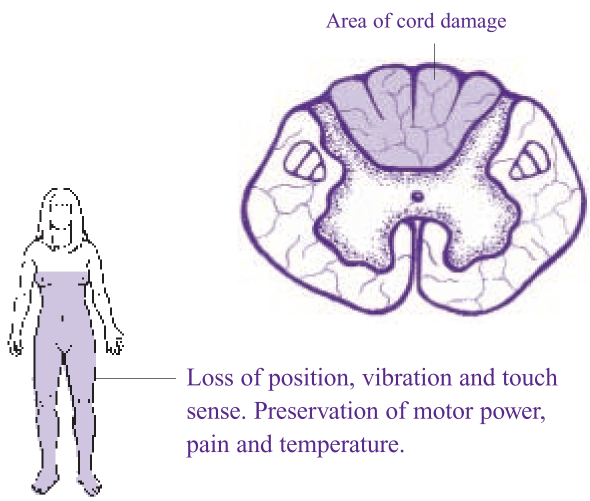
This is the most common form of incomplete lesion after a high-velocity impact trauma. Flexion – rotation results in pressure against the anterior (motor) cortex of the spinal cord, the anterior spinal artery, and the spinothalamic and corticospinal tracts. The spinal cord lesion develops through a combination of physical trauma, bony compression and ischaemia. Anterior cord lesions result in loss of power along with reduced pain and temperature below the level of the lesion. The senses of crude touch, position (proprioception) and vibration are usually well preserved below the level of the lesion.



Anterior cord syndrome:
Cord damage and associated motor and sensory loss.

Posterior Cord Syndrome

Posterior impact injuries or hyperextension forces compress or traumatise the posterior (sensory) cortex of the spinal cord along with the posterior columns. Posterior lesions present with the loss of deep touch, position and vibration below the level of the lesion, with preservation of power, pain and temperature sensation. Unfortunately, the sense of proprioception (the unconscious awareness of a limb's position in space) is lost, which can limit the patient's potential for developing a functional gait.

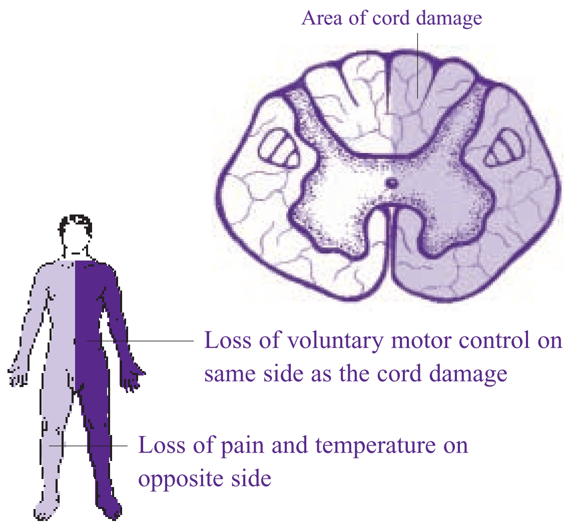


Posterior cord syndrome:
Cord damage and associated motor and sensory loss.

4

Brown-Séquard Syndrome

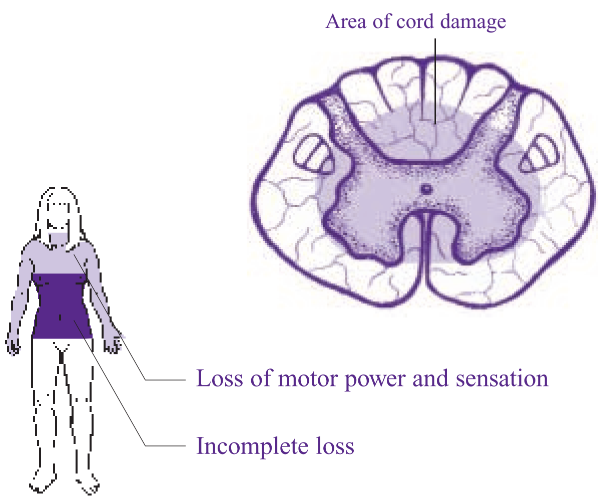
This is a classic neurological lesion, named after the Anglo-French surgeon who first researched it. The lesion presents as a hemisection of the spinal cord. It is most commonly associated with stabbing/penetration injuries, but it may also occur from gross lateral flexion injuries. Motor power is absent or reduced on the same side as the lesion, but pain and temperature sensation are preserved. This presentation is reversed on the uninjured side which has good power but absent or reduced pain and temperature sensation. The peculiarity of its presentation often causes confusion over diagnosis and is the result of the fact that the spinothalamic tracts cross over within the spinal cord, enabling signals to travel up the side opposite to that where the origin of the sensation is perceived to be.



Brown-Séquard syndrome:
Cord damage and associated motor and sensory loss.

Central Cord Syndrome

This peculiar presentation of incomplete spinal cord lesion usually occurs in elderly or spondylotic patients after minor hyperextension trauma to the neck. Vertebrae, discs and ligaments, which have become stiffened or thickened with age, focus compression forces and ischaemia towards the central portion of the cord, where the cervical nerve tracts originate. Patients present with significant loss of function in their upper limbs and hands, and partial preservation of function in their lower limbs, usually with retained sacral sensation and partially preserved bladder and bowel function. The ability to move the lower limbs, while being unable to move the upper limbs, may result in an inappropriate diagnosis of hysterical paralysis or malingering in these patients.

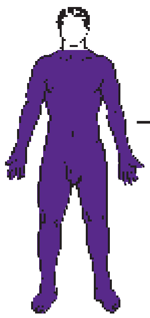


Central cord syndrome:
A cross section of the spinal cord showing area damaged and associated motor and sensory loss.

Level of injury and extent of paralysis

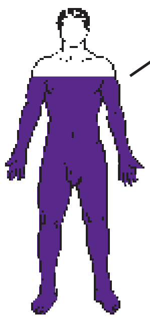
C4

Injury
TETRAPLEGIA
Results in complete paralysis below the neck



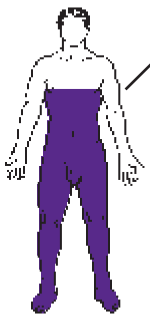
C6

Injury
TETRAPLEGIA
Results in partial paralysis of hands and arms as well as lower body



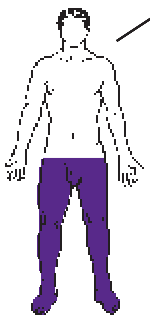
T4

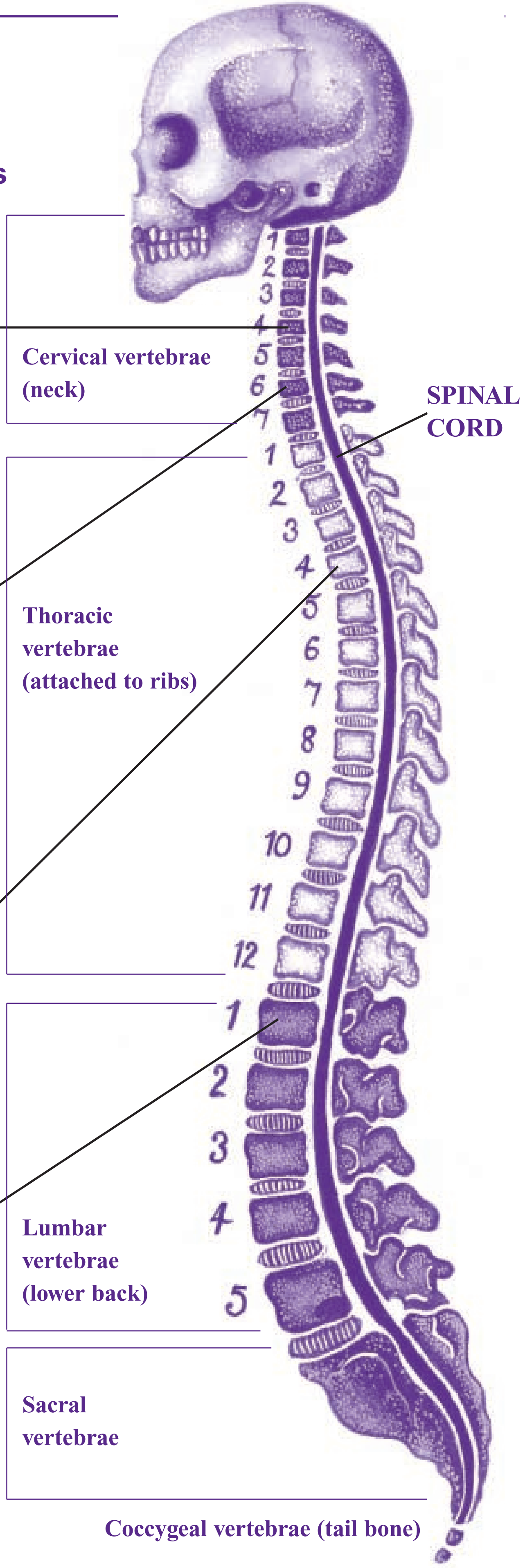
Injury
PARAPLEGIA
Results in paralysis below the chest



L1

Injury
PARAPLEGIA
Results in paralysis below the waist





Illustrations by Claire Macdonald / SIA

5 Guidelines for the Initial Management of Spinal Cord Injury During Admission

Basic Principles

Failure to recognise or suspect actual or potential SCI in a new admission and failure to implement or deliver appropriate care in accordance with evidence-based recommendations can compound what is already '*one of the worst disasters that can ever befall an individual*'.[40]

'Not every patient with injury to the spinal column (the vertebrae) has injury to the spinal cord. However, the potential for spinal cord injury is always present in a patient who has sustained trauma to the vertebral column.' [5]

Initial Airway Management

During the initial post-trauma assessment of a patient, the presence of diaphragmatic (paradoxical) breathing may be noted. This is a classic indicator of cervical SCI. Most patients with tetraplegia at C4 or below are able to make sufficient respiratory effort to avoid the need for mechanical ventilation. However, they will usually require oxygen above 50% initially.[38] Good oxygenation of the patient will also improve tissue oxygenation within the spinal cord which may help to limit the extent of tissue ischaemia.

Initial respiratory problems in these patients are usually due to accompanying chest trauma or pre-existing respiratory disease. The stress associated with SCI and its effects can have a particularly exacerbating effect upon patients with asthma or other pre-existing respiratory disease. Patients with cervical lesions above the level of C4 may have been intubated at the scene of the accident or in the A&E department if the effects of the lesion were slow to develop. In addition, some patients may experience an early extension of their original lesion sufficient to suppress diaphragmatic respiration.

There is the potential for cervical spinal injury in any patient unconscious as a result of trauma or with injuries above the clavicle.[5, 23,41] A patent airway can be maintained without moving the head and neck of the casualty by use of the jaw-thrust/chin-lift technique.[31,41] If this is insufficient, slight extension of the head will most probably not cause further damage to the underlying cord in most patients, but **flexion or rotation of the head should be avoided wherever possible** as appropriate to the circumstances.[5]

If bag-valve resuscitation is being attempted, the patient's head should be stabilised manually by a second person if no cervical collar is in situ. If the decision is made to intubate the patient, the best attempt should be made to maintain the spine in alignment throughout the procedure, preferably by using an assistant to stabilise the head during intubation.[5]

Tracheopharyngeal suctioning should be undertaken with caution because the potential for vagal overstimulation – leading to cardiac syncope – is high in all suspected cases of cervical SCI. During cardiopulmonary resuscitation, the person responsible for airway management must make his or her best attempt to dampen cervical spine movements referred from chest compressions.

If it is necessary to turn a casualty on to their side in order to protect the airway or to relieve the effects of a haemothorax, a modified log-roll should be done, using as many people as possible to maintain alignment. **The traditional 'recovery position' involves rotating the spinal column and should not be used where spinal injury is suspected**.[31]

Cardiovascular Effects of Spinal Shock

Spinal shock has a dramatic effect on the vasomotor system, causing vasodilation and flaccidity of the muscles below the level of the lesion. The effects of spinal shock increase in line with the level of the lesion and are most pronounced after cervical SCI. Initially blood pressure may fall to 60/40mm/Hg, rising to a maximum of 100/60mm/Hg in cases of high paraplegia. Parasympathetic nervous activity is unaffected by an SCI, so cardiac output is dominated by vagal activity. This presents in the casualty as a bradycardia approximating between 50 and 60 beats per minute.

It is imperative that the hypotension associated with spinal shock is not misinterpreted as symptomatic of hypovolaemia. Overinfusion with fluid at this time can result in pulmonary oedema with subsequent respiratory distress.[42,43] This usually necessitates an elective intubation or tracheostomy for mechanical ventilation and pulmonary suctioning. Attempts to reverse the effects of overinfusion with diuretics can result in renal shutdown.

▶Key point **Hypotension and bradycardia in the unconcious casualty are symptomatic of SCI and should not be confused with hypovolaemia or closed head injury. Unless significant blood loss can be clearly established, large volume fluid replacement should not be attempted at this time. However, close monitoring for signs of cardiac failure and the maintenance of good intravenous access is essential.**

Temperature-regulating mechanisms, such as vasodilation and vasoconstriction, will also be affected. There will be a passive dilation of the peripheral vascular system. As a result of this, the casualty will initially feel warm to the touch, but the body soon adopts the local environmental temperature and can quickly become hypothermic or hyperthermic, depending on the locality or time of year. This condition is known as 'poikilothermia'.[44]

Initial Orthopaedic Management

In patients with cervical spinal injury, reduction of any prevalent spinal cord compression is a priority. Early reduction of an existing vertebral displacement and external stabilisation of the fracture site is usually undertaken in the A&E department. Initial orthopaedic management of cervical injuries is usually conservative in nature, utilising in-line traction and closed manipulation under continuous radiological monitoring.

There are strict criteria governing surgical intervention at this early stage. Surgical reduction and stabilisation of the spine at this time can cause further (surgical) oedema at the lesion site with a resulting extension of its ischaemic effects. Transient or permanent neurological deterioration has followed early surgical intervention to the upper/mid cervical spine in patients with tetraplegia. This can result in the need for mechanical ventilation even though the patient was self-ventilating before the surgical intervention.

Moving and Handling

Wherever there is a reasonable suspicion of SCI, the aim is to immobilise the full spine during any moving and handling activity. Up to six members of staff may be required to work together in order to undertake routine turning and transfer procedures. It is important that all moving and handling is co-ordinated by a nominated team leader and is undertaken with a quiet confidence in the team's ability. Gaining the attention, confidence and co-operation of the conscious patient before attempting any turning or transfer technique will enhance the team's efforts to maintain spinal stability throughout the procedure.

'The future of someone with a spinal cord injury may depend upon the extent to which those handling him understand and apply the basic rule that, until proven otherwise by expert medical opinion supported by X-ray and other examination, a spinal injury shall be regarded as potentially highly dangerous and likely to result in injury to the spinal cord and paralysis, if inexpertly handled.'[45]

▶Key point **Wherever the injury suggests the possibility of spinal injury, immobilise the whole of the spine during any transfers between surfaces.**

6 Guidelines for the Initial Management of Spinal Cord Injury in the High Dependency or Intensive Care Unit

The Three Main Scenarios

There are three main scenarios within which a patient with actual or potential spinal cord trauma may be admitted to the HDU or ICU of a local DGH. These scenarios exist irrespective of the patient's level of consciousness or whether or not they are currently receiving appropriate respiratory support or mechanical ventilation.

Scenario 1:

Multi-trauma patient with actual or potential spinal column trauma but without obvious evidence of spinal cord trauma

Where doubt exists over the presence of spinal column or spinal cord trauma, experience has proved time and again that it is better to err on the side of caution. In the presence of a traumatic head injury, SCI should continue to be suspected until consciousness returns.

Scenario 2:

Multi-trauma patient with or without spinal column trauma but with evidence of spinal cord paralysis

The presence of spinal cord paralysis in the absence of bony trauma is not uncommon, especially where the cervical spine is involved. It is also the most common presentation among children and elderly people. Where spinal cord trauma is present, it must be considered in the context of all the care and therapeutic interventions, to prevent any deterioration in the patient's neurological or physiological status.

There is a high potential for respiratory deterioration in patients with combined trauma, which may or may not be apparent on admission.

Scenario 3:

Patient with evident spinal column and spinal cord trauma without accompanying multi-trauma

The patient presents with only a discrete spinal column trauma and accompanying spinal cord paralysis. The reduction of traumatic forces through the presence of safety equipment, or modifications to personal risk-taking behaviour, means that soft tissue trauma, which results in the disruption of spinal ligaments and musculature, makes these types of injuries more common. Critical care staff need to appreciate that there is still also the potential for these patients to deteriorate neurologically after admission, with subsequent respiratory or cardiovascular complications.

▶Key point **Wherever the injury mechanism suggests the potential for SCI, treat all casualties as such, regardless of neurological findings.**

Clinical Examination

Accurate diagnosis combines clinical history, neurological examination, radiography and experienced evaluation of the full range of clinical signs. Transfer of a patient with an actual or suspected SCI to a HDU or ICU is essential to allow a more detailed examination and evaluation of their condition. **In the unconscious patient, SCI should be suspected until consciousness returns or a thorough and informed survey has been carried out with the assistance of those experienced in this condition.**

▶Key point **No bony injury (NBI) and 'normal' neurological result are insufficient to rule out the possibility of spinal injury.**

Conducting the Clinical Survey

The initial primary and secondary survey of the patient's neurological condition will have been undertaken in the A&E department amidst all the distractions and shared priorities which exist within that environment. With the transfer of the patient to HDU/ICU, a more careful and prolonged evaluation of the patient's neurological status may now be possible. As a minimum, it is essential to determine whether the patient's neurological status has deteriorated during transfer from the A&E department, especially if multiple transfers for further radiological examination or specialist scanning were incorporated within the transfer journey. It is imperative that HDU/ICU staff establish their own neurological baseline for the patient on admission, rather than blindly transcribing the pre-transfer values as recorded in the A&E department:

'The main purposes of the neurological assessment are to detect neurological injury, establish the level of cord compromise, and follow the progression or resolution of the neurological findings.'[46]

The level of spinal cord injury is the level at which sensation is altered or absent; or at which weakness or absence of movement is noted. This level may be different to that of the column injury. Examine both sensory and motor functions because the patient may have sensory damage without motor damage and vice versa. Examine and compare both sides of the midline individually because variations can occur. Sensation should always be assessed against that present in a non-paralysed part of the body – such as the face of a tetraplegic patient. Examination of the T4 dermatome should be along the midaxillary line and not the midclavicular line, because C2, C3 and C4 all supply sensation to the nipple line.

Proprioception is the term used to describe the brain's unconscious sense of awareness of the position of each limb in space. This awareness is maintained through sensory stretch receptors positioned around each joint of the body. The sudden loss of this sensory feedback mechanism can cause the brain to create a proprioception phantom – appropriate to the position of the casualty's limbs at the time of, or immediately after, injury – which may indicate the presence of a spinal cord lesion.

Motor function should always be assessed against the full range and strength expectations for an individual of a certain age and capability. For example:

Motor Action Requested	Level of Spinal Cord Providing Function
'Shrug your shoulders'	C4
'Bend your elbow'	C5
'Pull your wrist back'	C6
'Straighten your arm'	C7
'Open and close your fingers'	C8
'Spread your fingers'	T1
'Flex your leg at the hip'	L1, L2
'Straighten your knee'	L3
'Pull your foot up'	L4
'Push your foot down'	L5, S1

It is not unknown for ICU staff to rely on neurological assessments carried out in the A&E department. A&E physicians not uncommonly record 'periphery normal', 'moving upper and lower limbs' or 'motor power +', even in unconcious patients. In acutely injured patients with spinal cord injury, attempts to elicit Babinski's sign (by stroking the sole of the foot) can lead to a 'flexion – withdrawl response' of the lower limb. This may be misinterpreted by medical officers as evidence of 'preservation of sensory-motor function in the lower limbs' – even though, in reality, the patient may be completely paralysed. Such erroneous assessment and documentation has resulted in significant concern to ICU staff when the patient is reassessed after a period of ventilation. Genuine concern over the loss of neurological function due to interventions by ICU staff, and litigation against the health authority by the patient, can be reduced if ICU staff could confer with specific A&E medical officers to ascertain the true extent of those neurological examinations carried out on the patient in A&E,

It is imperative that all possible presentations of spinal cord injury, however minor or incomplete, are accommodated within the assessment:

'An important part of the neurological examination is testing of the sacral segments. Certain incomplete cord lesions may not be appreciated as such if this is omitted.' [47]

Check for perineal sensation to a pinprick and by asking the patient if he or she can feel the urinary catheter *in situ*. Check anal tone by digital examination. Check 'anal wink' and bulbocavernosus reflex. Testing of the anal and bulbocavernosus reflexes provides an indication of the status of the sacral reflex arcs. The anal reflex presents as a visible contraction ('wink') of the anal sphincter in response to a perianal pinprick. The bulbocavernosus reflex provides a similar effect in response to squeezing of the glans penis in the male or the clitoris in the female. Priapism can be used as an indicator of SCI in the unconscious male.

'Even if the patient appears neurologically intact and has no neck or back pain, it should not be assumed that there is no spinal injury.' [5]

▶Key point **Think spinal cord injury – or you will miss it!**

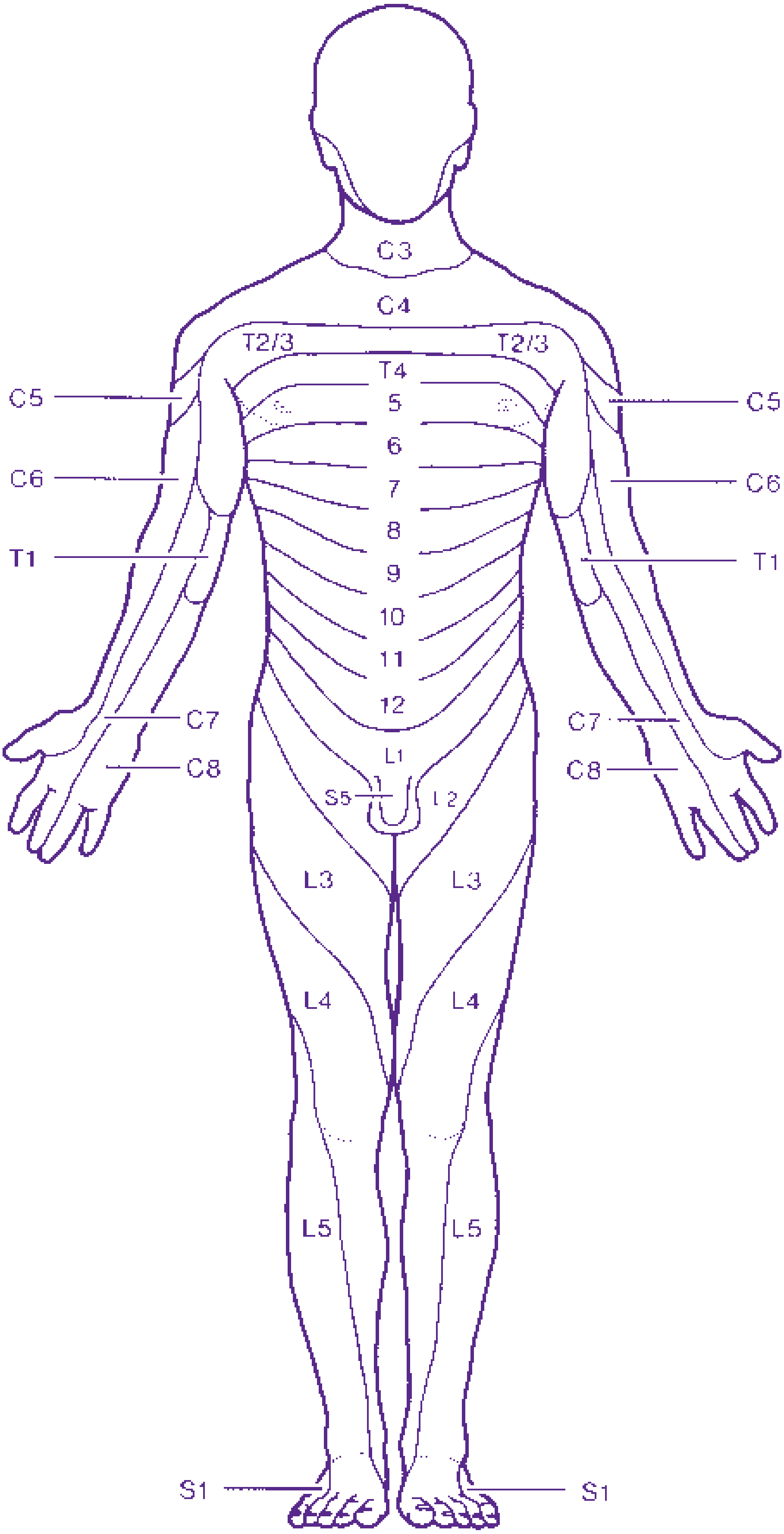
Difficulties in Diagnosis:

Neurological indicators may be particularly lacking in patients with associated head injury or multiple trauma. It is essential that all critical care professionals are appropriately informed, have the appropriate skills and are prepared for the event.

The accurate diagnosis of an actual spinal cord lesion is extremely difficult, if not impossible, where the patient is unconscious or has been sedated and chemically paralysed in preparation for intubation and mechanical ventilation. Management can usually only be undertaken within a high index of suspicion that an injury to the spinal cord is present. However, even in the conscious patient, diagnosis of an actual spinal cord injury could be affected initially by one or more of the following:[40,48]

- Failure to appreciate the mechanism of injury.
- Inadequate or improper examination or radiographs.
- Initially minimal or no apparent neurological deficit on examination or incomplete presentation interpreted as 'weird neurology'.
- Multiple trauma, stupor or head injury.
- Associated alcohol or drug abuse.
- Where the casualty is a young child.
- Confusion, dementia or learning disabilities.
- Pre-existing disability, neurological deficit or disease.

▶Key point **If there is any suspicion of drug or alcohol use before the accident, ensure that this does not prejudice your assessment of the patient.**



Affects of Lesion at Level

SENSORY

C2-C3	Neck
C4	Upper shoulder Upper anterior chest
C5	Lateral shoulder
C6	Radial forearm Thumb Index finger
C7	Middle finger Median strip of palm Back of hand
C8	Ring and little finger Ulnar forearm
T1-T2	Proximal medial arm Axilla
T2-T12	–
T4	Nipple line
T7	Lower costal margin
T10	Umbilicus
T12	Groin
L1-L2	Proximal anterior thigh
L3	Anterior knee
L4	Anterior lower leg
L5	Great toe Medial dorsum of foot
S1	Lateral border of foot Sole Along Achilles tendon
S2	Proximal posterior thigh
S3,S4,S5	Genitals and saddle area

MOTOR

Neck muscles

Diaphragm (Phrenic Nerve)
Trapezius

Deltoid, Biceps

Extensor carpi radialis

Triceps
Extensor digitorum

Flexor digitorum

Hand Intrinsics (T2)

Intercostals

–

Abdominals (T7-L2)

–

–

Ileo-psoas
Adductors (L2)

Quadriceps

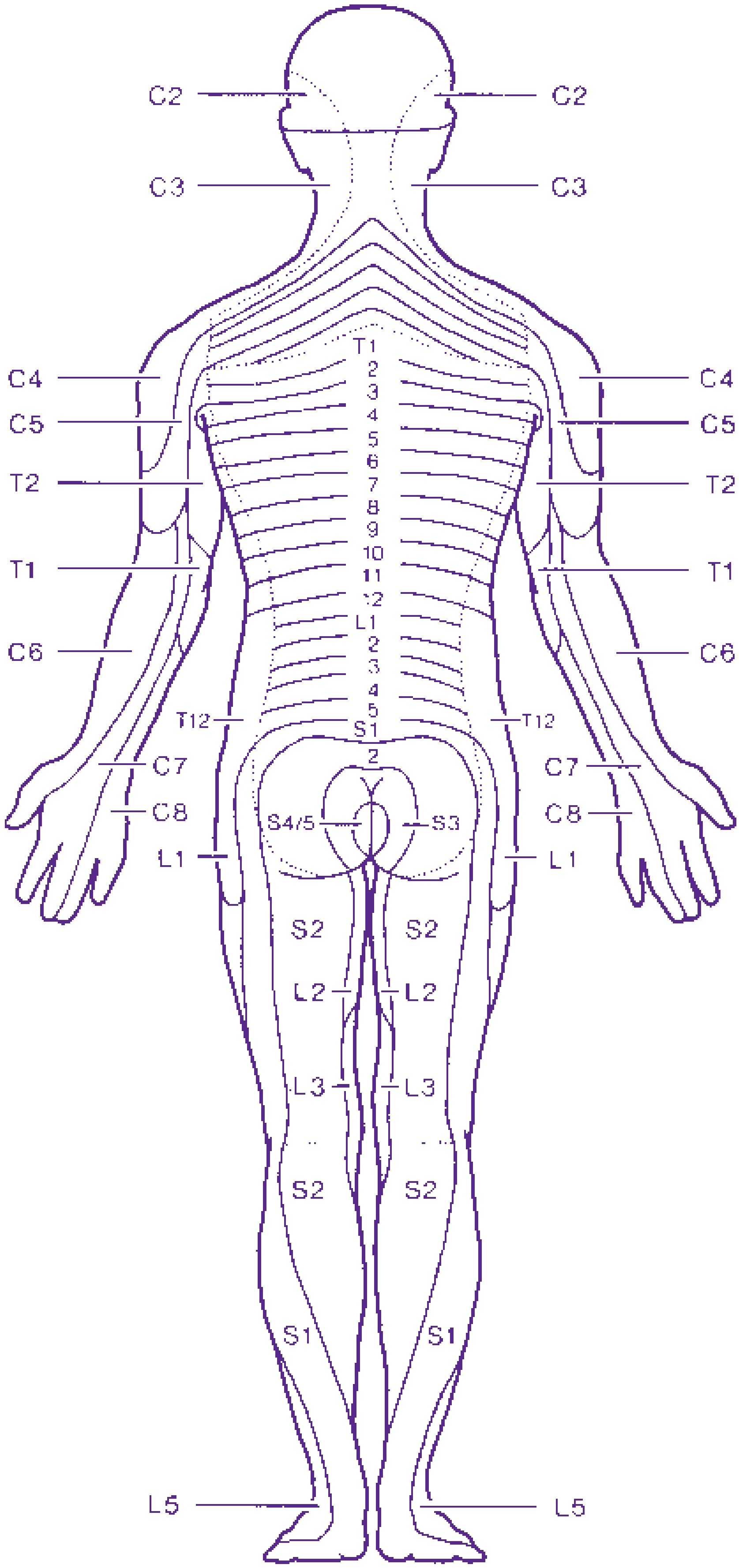
Medial hamstrings
Anterior tibialis

Lateral hamstrings
Posterior tibialis
Peroneals

Extensor digitorum
Extensor halluxis
Gastrocnemius
Soleus

Anal/Bulbocavernosus reflexes
(S2,S3,S4)

Bladder, Lower Bowel



Please feel free to photocopy these dermatome / myotome maps.

7 Radiological Examination

Plain Radiography

Good-quality static plain lateral, anteroposterior and oblique imaging of the full spine is recommended in all cases of suspected spinal injury.[49-51] **Multiple-level vertebral fractures are more common than you may think**.[6,46] The most common sites of injury are C5, C6, C7, T1 and T12, L1.[52]

The standard initial views of the cervical spine – anteroposterior and lateral – should be undertaken in the A&E department with appropriate shoulder distraction to facilitate viewing of the cervicothoracic junction. These are usually supported further by lateral 'swimmer's' views and supine oblique views. Supine oblique views are perceived as safer for initial screening because they require less movement of the patient and often demonstrate the posterior elements more clearly. **Avoiding unnecessary movement at this time is an additional safeguard against secondary injury to the spinal cord**.[51]

Gentle downward traction of the shoulders, where possible, should always be applied when attempting to visualise the C7–T1 level.[49,51,52] However, good visualisation of the cervicothoracic junction may be frustrated because:

'Pain and spasm usually precludes good visualisation of C7–T1 and posterior ligaments until 48 hours after injury.'[53]

Views of the thoracic, lumbar and sacral spine should follow. In multi-trauma patients these demands can usually be included within requests for standard views of the chest and abdomen.

When spinal radiographs are being reviewed, it is recommended that you pay particular attention to:[51]

- Visualisation of the odontoid peg.
- Visualisation of seven cervical vertebrae and C7–T1 junction.
- Visualisation of twelve thoracic vertebrae and T12–L1 junction
- Visualisation of five lumbar and four sacral vertebrae.
- Checking alignment of C1 with occiput and odontoid peg.
- Checking alignment of vertebral bodies, facet joints and spinous processes.
- Checking for rotational deviation.
- Checking for widening of disc spaces.
- Checking for variations in soft tissue mass.

'Radiological evaluation of the cervical spine in the setting of acute trauma can be a great challenge for the radiologist. Without the high-quality plain radiographs and experience in reading trauma cervical spine films, radiographic clearance can be exceedingly difficult.'[49]

Although high-quality films are essential for enabling accurate diagnosis, it is appreciated that there may be many difficulties within the A&E department to frustrate this. Pain, lack of cooperation, concomitant critical trauma, substance abuse and changing levels of consciousness all serve to make the radiographer's task more difficult.[49]

It is anticipated that, wherever a system of SCI management incorporates the routine review of the standard radiological views, outlined above, by an experienced interpreter, then the current false-negative rate will fall below 5%.[49]

For this reason, **it is essential that all radiographic films are reviewed by a person experienced in the detection and diagnosis of spinal trauma as soon as possible after admission to the HDU/ICU, if not before**. Films that are insufficient or inadequately exposed for diagnostic purposes should, ideally, be repeated whilst the patient is still on the A&E trolley, reducing the number of transfers between departments and surfaces needed.

Alternatively, it may be possible to obtain sufficient views using portable machines. However, the limitations of portable radiographic equipment may make it necessary to return the patient to the Diagnostic Imaging department for further screening. **Every transfer between surfaces increases the risk of secondary damage to the spine**. An organised, thoughtful and coordinated approach towards radiological screening can reduce this risk substantially by reducing the number of transfers to the necessary minimum.

Experience has demonstrated that knowledge and awareness of the implications of suspected spinal injury, and the skills, experience in transferring these patients, familiarity with safe transfer techniques and the equipment necessary to maintain spinal alignment varies considerably between Diagnostic Imaging departments. Patients with suspected spinal injury should always be accompanied by at least a suitably experienced member of nursing staff who is able to provide appropriate supervision at all times during transfers and positioning for imaging procedures.

SCIWORA[54] and SCIWORET[55]

Spinal cord injury without radiographic abnormality (SCIWORA) is a common presentation within all paediatric trauma cases. Spinal cord injury without radiographic evidence of trauma (SCIWORET) is a common presentation among elderly people who have experienced minor trauma, usually in the presence of pre-existing cervical spondylosis, spinal stenosis, ankylosing spondylitis and other similar conditions. The most common cause of injury in this age group is a fall at ground level. In such cases further radiographic examination of soft tissue trauma, with specialist scanning equipment, is necessary for diagnostic purposes.[56]

Computed Tomography (CT) and Magnetic Resonance Imaging (MRI)

Specialised imaging of the spinal cord may be available in-house or may necessitate the transfer of a patient to another hospital. Such transfers in the immediate post-injury period should only be undertaken where there is a proven clinical need. In the case of spinal column or spinal cord injury, these procedures should be perceived as second-line imaging examinations after plain radiography, and should be considered only where plain radiography has proved inconclusive. **Where the plain films demonstrate an abnormality, further investigation should be ordered only where it is expected to provide further, clinically vital, information for the evaluation of spinal column or spinal cord trauma.**

The only immediate benefit to be gained from CT is good visualisation of the size, shape and integrity of the vertebral canal. This is useful for locating bony fragments, which may have an influence on the extent and progress of spinal cord oedema. However, subtle, undisplaced fractures may still be missed. CT is also useful for evaluating soft tissue damage and C1–C2 fractures, especially if the patient is intubated. Three-dimensional imaging may permit a better appreciation of the spatial relationship between anatomy and pathology.[49]

MRI is appropriate where it is necessary to evaluate ligament and soft tissue damage, disc herniation or the integrity of the spinal cord itself. Delayed MRI is also useful for evaluating the extent of spinal cord oedema, haemorrhage or haematoma formation. In addition, it is a useful aid for evaluating multi-level injury.[49]

The Risks Associated with CT and MRI Scanning in the Presence of SCI

Not every DGH has access to on-site CT and MRI. In addition, there may also be the need to provide MRI-compatible ventilation equipment. The distance that has to be travelled by the patient in order to access this technology may therefore contraindicate second-line investigations at this time. However, where the patient needs further investigation of accompanying multi-system trauma, the opportunity to add to the clinical evaluation of acute spinal cord trauma should not be ignored.

During scanning, the patient is usually left unattended. It is difficult to monitor a patient's condition during scanning, especially for signs of neurological deterioration. Diagnostic Imaging departments are usually poorly equipped to deal with a patient who deteriorates suddenly. Clinical justification for undertaking these procedures must also include an accurate appreciation of the potential risk for occurrence of secondary spinal cord injury during the transfer and positioning of the patient.

Scanner suites are noisy, cold, draughty places as a result of essential ventilation systems. Patients with spinal cord injuries are at increased risk of hypothermia during scanning because of their inability to control their own body temperature. They are also at risk of developing pressure sores as a result of spending time lying on a spinal board or scoop stretcher.

Moving and Positioning Patients with SCI for Diagnostic Imaging

A number of recurring issues and incidents relating to these procedures have been reported. Such is the consistency of these reports and requests for advice that they have been included in this chapter.

Spinal boards and most plastic/metal scoop stretchers cause minimal artefact problems for radiological screening by experienced radiographers and are usually compatible with both CT and MRI scanners. Modern scoop stretchers are non-magnetic, can be left under the patient during CT scanning and can be used to transfer patients on to MRI tables.

Moving and Positioning Patients with SCI for CT Scanning

As stated above, most spinal boards and scoop stretchers can be left in place during CT scanning without causing gross artefacts. However, some requests to remove a patient from the spinal board or scoop stretcher relate to this point. If a problem is perceived around this issue then the CT staff should test an unoccupied spine board or scoop stretcher against a 'phantom' patient. Only where there is a definite problem with artefacts should the patient be removed from the spinal board or scoop stretcher.

▶Key point

Transfers of patients with suspected spinal injury for CT and MRI scanning should always be supervised by an appropriately trained and experienced member of the medical or nursing team. This person should take charge and ensure that spinal alignment is maintained throughout any manoeuvring. Adequate equipment should also accompany the patient in case his or her condition deteriorates.

The decision to remove the patient from the spinal board or scoop stretcher should be made in consultation with the radiologist and the consultant member of medical staff who requested the scan. It should not be a decision that is left to the discretion of the radiographer and/or escorting member of nursing/medical staff.

Where it is found necessary to transfer a patient from a bed/trolley to the CT scanner table without a spinal board or scoop stretcher in place, a minimum of seven staff are required to maintain lateral alignment of the spine during a sliding board transfer. The trolley or bed height should be the same as that of the scanner table. The patient must be moved across slowly, in complete alignment, using a coordinated team approach. Alternatively, it is usually easier to remove and replace a scoop stretcher beneath a patient on a CT scanner table than a spinal board.

Another problem encountered may be that the spinal board or scoop stretcher does not conform to the mattress of the scanner table enough for the patient's body to pass into the scanner tunnel. This may be a particular problem for obese patients or those with external fixators in place. Ideally, experience of escorting patients for CT should have enabled critical care staff to identify the potential for such a problem in advance.

However, the most commonly encountered problem, and a great cause for concern, is the refusal of some radiographers to remove the plastic face shield from its position at the head of the scanner table. In order to accommodate this, the patient must be removed from the spinal board or scoop stretcher before being manually handled, usually with some difficulty, up the scanner table. The face shield is provided for two reasons. Firstly to mark the appropriately aligned position of the patient's head on the scanner table. Secondly, to provide patients with some perceptible facial protection as they enter the tunnel of the scanner. It is easily removed, is not essential for routine scans and, most importantly, its presence should not be used as a reason for removing a patient from a spinal board or scoop stretcher. It is important that the patient's head is positioned correctly on the scanner table; removing the face shield makes this manoeuvre easier.

Moving and Positioning Patients with SCI for MRI Scanning

Spinal boards and scoop stretchers vary in their metallic and magnetic content. Non-magnetic scoop stretchers and spine boards can at least be brought into the scanner room to transfer the patient onto the scanner table. All-plastic spine boards with Velcro fastenings have a proven potential to be left under a patient throughout the scan, although the position and distance of the body from the magnetic coil is more crucial than for CT. In addition, MRI tunnels, usually, appear to have a narrower diameter than CT scanners.

The following guidelines are provided for moving and positioning patients with actual, suspected or potential spinal cord injury for MRI scanning:

- For cervical injury patients, a properly sized and fitted hard cervical collar should be left in place throughout the procedure. Skull calipers, unless they are MRI-compatible, will have to be removed, and a hard cervical collar should be *in situ* before the traction weight is released. If the calipers are MRI-compatible, the traction cord can be shortened or fastened to the head of the spinal board or scoop stretcher as appropriate during the transfer journey.

- Unless the MRI scanner suite possesses its own transfer equipment, the patient is usually transferred lying on an appropriate spinal board or non-magnetic scoop stretcher with their head positioned as near to the top end as possible. Scanner rooms are purposely kept cool, so monitor the patient's temperature carefully. **Cellular blankets are a fire hazard so take extra bed sheets or cotton counterpanes if required**.
- On arrival, the patient may need to be transferred onto a non-magnetic trolley in the MRI preparation room. Before transferring the patient, check that this trolley has a sheet placed on top of its mattress cover top to facilitate the transfer onto the scanner table. **The escorting nurse/doctor will take responsibility for the patient's head and neck during this transfer and provide appropriate guidance and supervision throughout**.
- Position the top end of the spinal board/scoop stretcher as near as possible to the top edge of the trolley mattress before taking the trolley into the scanner room.
- With the escort nurse/doctor taking the patient's head and neck, slide-transfer both trolley sheet, spinal board/scoop stretcher and patient onto the scanner table using a Pat-Slide or similar sliding board.
- **Positioning the patient from a scoop stretcher:** The scanner table has part of the scanner coil protruding through the top end of the scanner table mattress. These protrusions will be referred to as 'towers'. Ensure that the top of the scoop stretcher is as near to the base of the 'towers' as possible before splitting and removing the scoop stretcher from beneath the patient. This can usually be achieved without log rolling the patient again. The patient's head does not have to lie between the 'towers'. However, if a bed sheet or sliding sheet is placed directly beneath the patient when first placed on the scoop stretcher, it can be used to slide a patient, who does not have skull calipers in place, further up the table, so that their head lies between the 'towers'. This position is sufficient for a normal **Volume Neck Coil** to be fitted.
- The head of patient who is on a spinal board or who has a halo ring or skull calipers fitted will not fit between the 'towers'. In these cases the radiographer should fit the larger **Phased Array C/T/L Coil**.
- For thoracolumbar spine/abdomen/chest scan fit, as appropriate, either the **Phased Array C/T/L Coil** or **Body Phased Array Coil**.
- For some lumbar/abdominal scans it may be more appropriate to place the patient into the scanner feet first.
- Most MRI Scanners have a very sensitive panic alarm fitted. The escorting nurse can help the radiographer to position this appropriate to the patient's ability.
- An MRI scan is very noisy. The nurse/doctor can also help the radiographer to fit earplugs for the patient.
- The escorting nurse/doctor can enter the scanner room at any time to check on their patient – see scanner staff for exceptions, e.g. pregnancy or other contraindications. In some instances it may be necessary for the escorting nurse/doctor to remain in the scanner room with their patient.
- After the scan has been completed, a patient transferred on a scoop stretcher can be log rolled on the scanner table to replace the scoop stretcher for transfer back onto the trolley. The escort nurse/doctor will again take responsibility for the patient's head and neck as well as coordinating the actions of the team throughout the transfer procedure.

8 Moving and Handling Patients with Actual or Suspected Spinal Cord Injuries

Basic Principles

Careful handling, positioning and turning, on every occasion, can prevent secondary cord trauma during patient transfers and movements. Manual transfer techniques need at least five members of staff to maintain spinal alignment throughout the procedure. In addition, the staff must have supreme confidence in their ability to work as a team.

'Many potential or partial injuries have become permanent disabilities because incorrect handling caused secondary spinal cord trauma.' [57]

A wide range of equipment is available to facilitate the movement and transfer of a patient with an acute SCI, increasing both staff and patient safety in these situations. Before investing in any equipment of this nature, staff in general areas should consult with their specialist peers for advice. Of particular interest to staff working in critical care areas is the availability of scoop stretcher hoists such as the Molift Partner or Arjo Multi-Mover.

A properly sized and fitted hard cervical collar, where appropriate, should be used, along with a spinal board or scoop stretcher, whenever the patient is transferred between surfaces or transported from one area to another. Manual support of the head and neck should also be applied during any flat surface transfers as an additional safeguard. If cervical traction is in place, the traction cord should be shortened to maintain the pull of the traction weights during transportation. Alternatively, the traction cord may be tied off to the end of the scoop stretcher or spinal board.

During spinal shock, paralysed limbs are completely flaccid and care should be taken to prevent patients' limbs falling from the surfaces of beds and trolleys or becoming trapped in side rails. **A patient whose flaccid arm falls from a bed, trolley or table may suffer disruption of the rotator cuff and shoulder joint, resulting in a second disabling condition. A leg allowed to fall under the same circumstances could pull a paralysed patient onto the floor**.

Guidelines for Using Spinal Boards

Spinal boards were designed for extrication, transport and transfer of patients with suspected spinal injury from the scene of the incident to hospital. However, their continued use as a transfer aid within the DGH is often inconsistent with their potential for reducing secondary trauma and for giving confidence to those involved in transporting and transferring patients between departments.

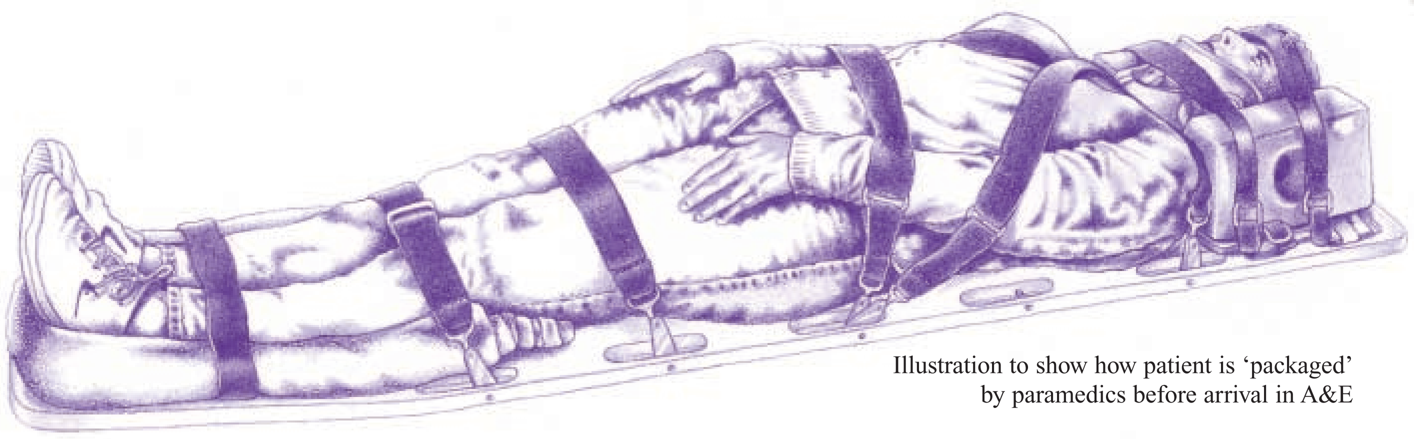


Illustration to show how patient is 'packaged' by paramedics before arrival in A&E

Using Spinal Boards in Flat Surface Transfers

The screening processes and investigations associated with the clinical diagnosis and initial management of a patient with actual or potential spinal injuries can involve numerous transfers between surfaces, e.g. between bed and trolley, trolley and radiography/CT/MRI scanner table/operating room table/bed, etc. In addition, it may be necessary to transfer a patient between wards and departments or even between different hospitals in search of an ICU bed before eventual transfer to an SIU.

'Every transfer is a high risk procedure for the spinally injured' [58]… and remember that… ***'Many potential or partial injuries have become permanent disabilities because incorrect handling caused secondary spinal cord trauma.'*** [57]

Procedure for Removing a Patient from a Spinal Board

Remember to explain to the patient everything that you are about to do and what you expect of him or her. Ensure that the patient understands that a spinal injury is present or has not yet been excluded and that he or she must remain in a supine position on a bed until further notice. For this reason, patients who are still under the influence of drugs or alcohol, who demonstrate confusion, dementia or erratic movements, or who have an existing learning or communication disability, present a significant challenge at this time. In such circumstances, the patient may have to remain on the spinal board initially after admission until a more detailed examination and radiographic survey has been completed, until their condition improves or until a decision to sedate them has been made.

Children, even in the presence of parents, who are in pain or distressed may also need to remain on spinal boards after admission until further screening is completed or a decision to sedate them has been taken. Children and elderly people are at increased risk of pressure sores and should be fast-tracked as a priority for removal from the spinal board. Patients with existing respiratory or cardiac disorders, obese patients and women in the late stages of pregnancy should also be prioritised because of an increased potential for respiratory distress.

The removal of a patient from a spinal board is a team effort. Five people are required to remove a patient from a spine board. There must be an identified team leader to coordinate the transfer procedure. The team leader may be a member of the medical staff or a nurse with appropriate experience who has the confidence of the medical team. The team leader will take the position at the patient's head from where the patient's alignment throughout the manoeuvre can be monitored. The procedure for removing a patient from a spinal board is as follows:

1. **The team leader should check and record the patient's sensory and motor function in all four limbs before the procedure commences**.
2. **The leader takes the head and ensures firm stabilisation of the neck throughout the procedure, even if a hard collar is *in situ***.
3. With the other four team members helping, the spinal board should be slid or lifted to one side of the bed, far enough for the patient to be rolled on to the mattress.
4. Remove all the straps and head blocks from the spinal board.
5. **Do not remove any hard cervical collar *in situ***. If no hard cervical collar is *in situ*, assess the patient for the fitting of a properly sized hard cervical collar if appropriate.
6. With one person supporting the side of the spine board that the patient will roll away from, the other three team members will position themselves to log-roll the patient.
7. The leader will ensure that all the team are ready and give the command to roll (e.g. '*Ready, steady, roll*' or '*1, 2, 3, roll*'), monitoring the patient's alignment continuously.
8. At this point, the spinal board and any remaining clothing can be removed and the patient's back and skin examined. Document any red marks or skin lesions present on admission in the patient's Nursing Notes.
9. When the examination is completed, the leader can give the command to roll the patient back on to the bed.
10. The patient's head should be supported between two sandbags. **No attempt should be made to tape the patient's head down or to establish neck-only fixation to the bed, without the potential consequences of such an action being considered**:

'The use of a head immobiliser attached only to a trolley* (or bed) *is dangerous practice. If the patient suffers a seizure, vomits, coughs or is restless, the unrestrained body will provide movement at the neck. The results are predictable and potentially disastrous for the patient.' [59]

11. The leader then rechecks and records the patient's sensory and motor function in all four limbs. **It is imperative that the same person undertakes both pre- and post-transfer examinations**.

12. **Any changes in function and sensation – however minor – should be reported to a senior member of the medical staff and documented clearly. If not already in progress, a decision to start methylprednisolone as per SCI protocol (see page 63) may be taken**.
13. **If the patient has vomited after injury or is feeling nauseous**, the decision to remove him or her from the spinal board may be deferred until a nasogastric tube has been inserted. **They should not be left unattended**.
14. **The patient must have some way of attracting attention if he or she is to be left unattended**. However, many patient call handsets cannot be operated by people with tetraplegia. It may be necessary to position the patient's bed within easy call of the nurses' station. Alternatively, do not leave the patient unattended at all.

Procedure for Placing a Patient Upon a Spinal Board

At some point after admission it may be necessary to place a patient upon a spinal board again in order to facilitate transfer elsewhere. The procedure for placing a patient on a spinal board is as follows:

1. **Explain to the patient everything that you are about to do and what you expect of him or her**. Ensure that the patient understands that a spinal injury is present or has not yet been excluded, and that he or she must remain passive throughout the procedure and not attempt any active assistance at any time during the procedure.
2. Remove all the straps and head blocks from the spinal board and loosen the bed sheet on which the patient is lying so that it is free from the mattress. Spinal injury patients are nursed naked in bed and the sheet will facilitate the team's efforts when it comes to sliding the patient onto the spinal board. If the patient is not lying on a sheet, it will be necessary to place one *in situ* before beginning this procedure or immediately after log-rolling the patient.
3. **The team leader should check and record the patient's sensory and motor function in all four limbs before the procedure commences**.
4. The leader takes the head and ensures firm stabilisation of the neck throughout the procedure, even if a hard collar is *in situ*. If cervical traction is in use at this time, the traction tongs or cord may also be used to maintain traction during the procedure. Once the patient is secured on the spinal board, the traction cord can be shortened or tied to the head of the spinal board.
5. With the other four team members helping, the spinal board should be positioned on the bed in preparation for the patient to be rolled on to it.
6. With one person supporting the side of the spinal board that the patient will roll away from, the other three team members will position themselves to log-roll the patient.

7. The leader will ensure that all the team are ready and give the command to roll (e.g. '*Ready, steady, roll*' or '*1, 2, 3, roll*'), monitoring the patient's alignment continuously.
8. At this point, the fifth nurse will position the spinal board flat on the bed but under the bed sheet.
9. When the spinal board is in position the leader can give the command to roll the patient back onto the spinal board.
10. With three nurses re-positioned on the opposite side of the spinal board, the team leader can now give the command to slide the patient into the middle of the spinal board, using the sheet. The edges of the sheet should be rolled inwards and gripped as near to the patient's body as possible to prevent lateral movement of the spine.
11. The body straps of the spinal board (or 'spider' securing device) should be secured around the patient before any attempt is made to position the head blocks, head and chin straps:

'If the head immobiliser is applied before the torso is properly splinted to a full spine/body immobiliser* (spinal board)*, the neck will act as the pivoting point for the rest of the body, with gross movement to the cervical spine occurring.' [60]

12. **If a patient is at risk of nausea or vomiting he or she should be 'packaged' securely** (see illustration on page 39) just in case the spinal board has to be turned onto its side to maintain a clear airway. Additional padding, such as rolled blankets, should be used to relieve pressure between the patient's knees, and to fill any space that exists between the patient's body and the securing straps.
13. **Staff should ensure that the body straps do not impair diaphragmatic breathing**.
14. The patient's arms should be secured appropriately for his or her comfort and safety. Patients with upper limb paralysis, or patients who are distressed, confused or restless, are safer with their arms secured against their body, above the covering sheet, but beneath the straps of the spinal board. Large or obese patients are safer and more comfortable with their arms outside the body straps of the spine board but with their hands fastened together with a loop of crêpe bandage.
15. **The leader then rechecks and records the patient's sensory and motor function in all four limbs. It is imperative that the same person undertakes both pre-and post-transfer examinations**.
16. **Any changes in function and sensation – however minor – should be reported to a senior member of the medical staff and documented clearly. If not already in progress, a decision to start methylprednisolone as per SCI protocol (see page 63) may be taken**.
17. **Once the patient is secured on the spinal board, they must not be left unattended**.

Scoop Stretchers

Scoop stretchers are an alternative aid to transfers between surfaces and the following pointers to management are provided:

Spinal injury patients are nursed naked in bed and it is advisable to insert the scoop stretcher beneath the bottom bed sheet.

- Patients should be log-rolled to enable the two halves of the stretcher to be placed beneath them. **Attempting to bring the two halves of a scoop stretcher together (like a pair of scissors) beneath a supine patient who has no skin sensation can result in significant tissue trauma.**

- Some scoop stretchers can be attached to special hoist arms to avoid the need for manual lifting. Alternatively, a patient on a scoop stretcher can be moved between flat surfaces on a sliding board.

- It is usually possible to remove a spinal board without log-rolling the patient for a second time.

- One key disadvantage of many spine boards is the lack of appropriate head immobilising blocks and body straps.

It is essential that critical care staff are aware of the availability, both generally and within their own hospital, of an appropriate range of patient transfer equipment for people with actual or suspected spinal cord injuries. It is equally important that they are confident and competent in their use of the same.

9 Use of Cervical Collars

Guidelines for Using Cervical Collars

A properly sized and fitted cervical hard collar should always be used whenever there is any suspicion of cervical spine or spinal cord damage.[5,58,60-62] Indications of possible cervical injury are:

- Mechanism of injury suggesting sudden impact, collision or deceleration (see page 13)
- Patient unconscious or evidence of traumatic head injury
- **Patient complaining of severe neck pain (at any stage from initial injury)**
- Significant head, neck or facial injury
- Other injuries related to high-speed impact (e.g. long-bone fractures, thoracic and/or abdominal injury)
- Bony tenderness over cervical vertebrae
- **Patient complaining of motor and/or sensory deficit in limbs or from neck down (however bizarre the presentation)**

However, a hard collar alone does not protect the cervical spine.

'A hard collar is just a flag which says, "Protect this neck, it may be injured"… A hard collar must be paired with manual in-line stabilisation or rigid head immobilisation.' [41]

▶ Manual Support for the Cervical Spine:

Louise E Hunt / SIA

Manual support for the cervical spine is essential during any patient movement or transfer – even if a hard cervical collar is *in situ*. The nurse supporting the patient's cervical spine will be nominated as team-leader during any patient movement and the best position for them to occupy is to stand at the head of the bed, so that they can monitor spinal alignment throughout. Ideally, hands should offer support for the entire cervical curve from the base of the skull to C7. The patient's head is immobilised between the nurse's forearms. Alignment of the body from head to toe is visible from this position. The nurse should make every effort to avoid twisting his/her own spine inadvertently when log-rolling a patient with cervical spinal injury.

▶Key point **If the patient presents with any of the above indicators, take cervical spine precautions.**

The use of hard collars for protecting the cervical spine is now well established in most HDU/ICU environments.[63] Two kinds of collars are in routine use. One-piece collars such as Laerdal's Stifneck range are used initially and are usually supplied and fitted by paramedics at the scene of the accident or by staff in the A&E department. Two-piece collars such as the Philadelphia or Aspen models are commonly provided for long-term use during the acute bed-rest stage, as they are usually more comfortable to wear in bed and cause less skin problems.[63] They are usually supplied in-house from the orthopaedic unit or physiotherapy department. Soft collars do not provide any protection for the damaged cervical spine and usually have no role during the acute stage management of spinal injury unless approved by a more experienced consultant.

Applying a Cervical Hard Collar

It is important to know how to measure and size a hard collar and to be aware of the different types available. All hard collars have pre-cut access panels for observation of the position of the trachea, monitoring and accessing the blood vessels of the neck and positioning tracheostomy tubes.

1. **All collars should be applied with the patient lying supine**.
2. **Explain to the patient what you are going to do and why. Remove any earrings or jewellery**.
3. **Check the patient's sensory and motor function in all four limbs before applying the collar.**
4. With a suitably experienced nurse to assist, measure and apply the hard collar in accordance with the instructions provided by the manufacturer. One-piece collars can be easily applied by sliding the collar behind the patient's head in the supine position. The posterior shell of a two-piece collar is usually applied after log-rolling the patient onto his or her side.
5. Place sandbags on either side of the patient's head. **Do not tape the patient's head to the mattress** (see page 40).
6. **Recheck the patient's motor and sensory functions in all four limbs**.
7. **A hard cervical collar that has been applied too tightly can over-stimulate baroreceptors in the carotid arch and the vagus nerve, causing a sudden hypotension or cardiac syncope**.[5] Therefore, carefully monitor the patient's blood pressure and pulse initially after applying or re-applying a hard collar.
8. **If the patient complains of nausea, he or she must not be left unattended**.

Ensure that suction is available at the bedside and, if the patient vomits, log-roll him or her onto their side. If the patient is to be left in a lateral position, support the patient's head in alignment with a thin pillow. Ensure that the patient has some way of attracting attention if left unattended.

Extra caution is required when considering the best method of cervical support for the patient with pre-existing spinal deformity such as ankylosing spondylitis. In some instances, the application of a hard cervical collar can be dangerous, forcing the cervical spine into an inappropriate position of extension.

▶Key point **Do not apply or remove the cervical collar without manual immobilisation of the head and neck being in place.**

Justification for the Removal of a Cervical Hard Collar

On occasions, a cervical collar is put on a patient as a precaution. Consensus opinion regarding the removal of cervical collars suggests that the following criteria are usually sufficient:

- The patient is conscious, alert and orientated and able to answer questions reliably (i.e. not deaf, confused or demented, does not have learning difficulties, and is not receiving opiates, sedatives, muscle relaxants, anti-spasmodics or anti-convulsants).
- **There are no neurological signs or symptoms (e.g. pins and needles in limbs, reduced or changed sensation or reduced limb movement/muscle power).**
- The patient has no painful distracting injury elsewhere (e.g. rib fractures, severe lacerations or long-bone fractures).
- **The patient has no neck tenderness, pain, restricted range of movement or muscle spasm.**

However, even if the collar was fitted as a precautionary measure, it should be remembered that:

'Even if the patient appears neurologically intact and has no neck or back pain, it should not be assumed that there is no spinal injury.' [5]

Therefore, **the decision to remove a cervical collar is a medical decision and should not be made, even in the conscious alert patient:**

'…until at least after completion of the primary survey, initial resuscitation, and first-line X-rays.' [59,64]

This may seem extreme but there is a significant incidence of failure adequately to exclude cervical spinal injury (whether bony or soft tissue).[40,48] In addition, the increasingly high incidence and nature of soft tissue trauma accompanying minor cervical spine trauma may further frustrate screening attempts. Remember:

'Pain and spasm usually precludes good visualisation of C7–T1 and posterior ligaments until 48 hours after injury.' [34]

However, the sedatives and muscle relaxants, which are used to enable intubation prior to mechanical ventilation, can negate this protective mechanism. This means that unconscious, sedated or ventilated patients are at increased risk of secondary spinal injury if appropriate spinal protection is not maintained until consciousness returns or sedation and ventilation is discontinued. The patient is then usually able to respond appropriately to a detailed examination and assessment of his or her neurological status.

However, in the event of a protracted period of unconsciousness or sedation, staff in HDU/ICU identify with the need to maintain a prolonged programme of spinal protection. The need to justify maintaining spinal precautions over several weeks or months is often a cause for concern amongst medical and nursing staff in critical care units. In such an instance, close and regular liaison with your local SIU will enable your staff to adapt their care provision over time, to provide appropriate levels of spinal protection throughout the patient's admission:

'Once the cervical spine has been immobilised, the protection must not be removed until the spine has been cleared by an appropriate clinician, who will use the results of any investigations in conjunction with the clinical state of the patient to decide when and if it is safe to proceed'.[62]

There is a need for critical care areas to establish clear guidelines concerning the removal of cervical collars in the unconscious patient. Gupta *et al*.[64] surveyed 25 ICUs and found that 76% of the units surveyed removed collars whilst the patient was still unconscious. The remaining 24% waited for the patient to regain consciousness before removing the collar.

Managing Cervical Collars for the Unconscious or Ventilated Patient

The ongoing management of hard cervical collars in the unconscious or dependent patient on supine bedrest presents many challenges for HDU/ICU staff. The two most commonly reported concerns are the development of pressure sores beneath the collar and the potential for a tight-fitting collar to increase intracranial pressure (ICP) in patients with accompanying or suspected head injury:

'...a collar can cause significant elevation of intracranial pressure by relative obstruction of venous drainage in the internal jugular veins.' [65,66]

In cases where actual spinal column trauma has been identified, cervical skull traction may be preferred, thereby eliminating the risks outlined above. However, the need to accommodate the precautionary and prophylactic use of hard cervical collars, in cases where a clear diagnosis is still forthcoming, will still exist. Cervical traction may also be excluded in some cases where complex or extensive skull fractures preclude the positioning of most skull calipers. Crutchfield calipers are positioned high in the skull, usually avoiding the most common sites of skull fracture. Halter traction is another option still in use today. Thus, there is a real need for us all to consider the possibility that a patient with actual or suspected spinal cord injury may have to be nursed without a cervical collar at some time during their admission to HDU/ICU. With the help of HDU/ICU practitioners it has been possible to develop some initial, but appropriate, practice recommendations to forestall some of these problems:

- Unconscious or sedated patients, who are being nursed in hard cervical collars **as a precaution against undetermined spinal injury**, should be carefully assessed to determine their potential for inappropriate, unexpected movement or convulsions.
- Where the perceived risk is negligible or low, the patient's collar may be loosened during rest, being tightened fully only during actual turning. Sandbags or 1 litre bags of intravenous fluid, suitably covered, should be placed either side of a patient's head.
- If a two-piece collar is being used, the front shell may be removed or loosened completely for the period of time that the patient is in a supine position. If removed, the front shell should be placed in clear view beside the patient's head for use in the event of an emergency. The rear shell along with a suitably sized neck roll should be left *in situ* in order to maintain the appropriate neutral to slight extension position of the cervical spine. The patient should also be nursed with sandbags *in situ* as above.
- A one-piece collar may also be similarly removed for the period of time that the patient is in a supine position. However, a suitably sized neck roll should always be placed *in situ* in order to maintain the appropriate neutral to slight extension position of the cervical spine. The patient should also be nursed with sand bags *in situ* as above. The manoeuvring required to remove and replace a one-piece collar repeatedly in such circumstances makes obtaining and using two-piece collars in such circumstances the preferred and popular option.
- A range of padded two-piece collars is also available and should be explored as an additional aid to comfort and tolerance by patients as well as a means for reducing the incidence of pressure sores.

- Removal or loosening of collars in order to reduce or prevent the incidence of raised intracranial pressure (ICP) must be qualified within the team's documentation. **There must be a proven and significant risk, or actual incidence of, raised ICP recorded before the decision to discontinue cervical spinal precautions is made**. In such an event, the patient should be nursed with a neck roll and sandbags *in situ* as above.
- Where a hard cervical collar has been removed before spinal injury has been excluded, it is recommended that, wherever possible, a soft cervical collar is fitted. Whilst offering no protection against inappropriate movements of the cervical spine, a soft collar will at least remind both staff and patient that the possibility of a spinal injury has not yet been excluded.
- Patients who are unconscious because of traumatic brain injury or who have been sedated and mechanically ventilated will usually rouse suddenly and violently. They are usually frightened, confused, disorientated and in some degree of pain. Patients showing signs of rousing, or who have had their sedation discontinued, should have full spinal precautions in place and should not be left unobserved during this time.
- Contrary to usual practices, it is usually necessary to physically restrain or re-sedate patients with actual or suspected spinal injury during fits or other periods of violent, uncoordinated activity. Even in the event of high tetraplegia, the patient is still liable to make violent head movements when rousing, in pain, disorientated or frustrated.
- **It is imperative that the advice of an appropriately experienced and informed member of the trauma/spinal injuries medical team is involved in making any of these decisions in order to confirm or inform the HDU/ICU team's assessment of the risks involved.**

Removing the Collar Safely

The procedure explained below assumes that the patient is conscious and orientated sufficiently to be able to verbalise, or otherwise indicate clearly an appropriate response to the questions that will be put to them. It is recommended that the removal of a cervical collar in the unconscious, confused or disorientated patient is delayed until the risk of ligamentous injury has been eliminated, and the opinion of a specialist consultant has been obtained.

The decision to remove a cervical collar is a medical decision. The investigation and tests necessary before such a decision is made may take some time to complete, and the decision to discontinue spinal precautions should not be overly influenced by the pressures and constraints that such a device places upon the delivery of nursing care procedures. The actual removal of a cervical collar is best undertaken by a suitably experienced member of the medical team or an experienced nurse under the supervision of, or with the confidence of, a member of medical staff. **The unsupervised removal of a cervical collar by nurses or therapists is only appropriate if the practice is approved by senior medical, nursing or therapy staff:**

1. **Explain to the patient what you are doing and why**. Ensure that the patient understands that he or she must not move their head or neck unless instructed to do so and to inform the nurse immediately of **any** pain, muscle spasm or change in neurology experienced during the procedure.
2. **Have the patient lying supine** (unless this compromises breathing – which should constitute an exception report in the patient's Medical and Nursing Notes).
3. An assistant should support the patient's head while a suitably experienced doctor or nurse loosens the collar.
4. Wait a few minutes while the patient's neck adjusts to the change in weight-bearing pressure and support.
5. If there is **no pain, spasm or change in neurology,** remove the collar completely.
6. Again, wait for a few minutes while the patient's neck adjusts to the change in weight-bearing pressure and support.
7. If there is **no pain, spasm or change in neurology,** gently palpate the cervical vertebrae, to assess for pain or deformity.
8. If there is **no pain, spasm or change in neurology**, allow the patient to move their head **slowly** in all directions, **one movement at a time**.
9. If there is **any** complaint of pain, restricted movement, muscular spasm or motor or sensory changes during this manoeuvre, **STOP!** Ask the patient to keep perfectly still and **replace** the collar and sandbags, and ask for a doctor to see the patient immediately. Commence **methylprednisolone** as per SCI protocol if indicated (see page 63).
10. If the patient has no problems and is pain free on movement, the collar and sandbags may be left off. If appropriate, the patient should then be raised **gradually** to a sitting position, if tolerated, to check spinal column stability during weight-bearing.

If a cervical collar has been *in situ* for some time, the patient may experience difficulty in maintaining a good head posture against gravity when sitting without support. A soft collar along with a physiotherapist-led programme of neck-strengthening exercises will usually resolve this problem. Difficulty in moving or holding up the head against gravity may indicate a missed injury of the cervical ligaments.

▶Key point **Remember, if there is any doubt about a patient possibly having a cervical spine injury, full spinal precautions must be taken until proved otherwise.**

10 Systemic Effects of Spinal Cord Injury: Musculoskeletal System

Reduction and Stabilisation

Reduction of spinal cord compression is a priority in these cases. Early reduction of an existing vertebral displacement and stabilisation of the fracture site are usually undertaken in the A&E department before transfer to the HDU/ICU. Conservative fracture management is the preferred primary method of initial management,[14,67,68] and 90% of all spinal fractures heal spontaneously after conservative reduction and the maintenance of adequate alignment throughout a period of bedrest.[11,30,69]

'As we discuss the use of management methods we must be guided principally by the academic principles as well as by the patho-physiological condition of each patient encountered, for each is an individual and each is different. It is also important to be certain where the patient will be treated and by whom the patient is to be treated. All of these factors affect the surgical decision. Surgical judgement or surgical balance is of much greater importance than surgical technique. The advantages or disadvantages of any particular method of acute management of spinal injuries must be considered before a particular programme of management is laid down to suit the individual, as well as the individual's fractures.' [11]

Initial orthopaedic management uses in-line traction and closed manipulation under continuous radiological monitoring. There are strict criteria governing surgical intervention at this early stage. Post-operative morbidity in tetraplegic patients is well-known to adversely influence rehabilitation outcomes.[14,21,70] Inappropriate surgical procedures can cause further (surgical) oedema at the lesion site, with a resultant extension of ischaemic effects.[24,70] **Lesion extension in cervical injuries may lead to total paralysis of the diaphragm and subsequent mechanical ventilation. Some procedures for the surgical fixation of the thoracic spine may involve a thoracotomy – necessitating a period of mechanical ventilation post-operatively**.

Where early surgery is being considered, a thorough and detailed explanation of the intended procedure along with alternative management scenarios, and the inherent risks involved in each, must be given to the patient and their relatives. Such an explanation should be appropriate to their ability to understand. Where possible, before the operation, they should be provided with the opportunity to verbalise their fears and anxieties. This is informed consent. Litigation in the event of a claim of mismanagement, occasioned through inappropriate or unnecessary surgery, could incur damages in the order of several million pounds sterling, given the early age at which most SCI events occur.[10]

'In my experience, several patients deteriorated after surgery performed in the first few days after injury. Except where there is overt evidence of neurological deterioration, between admission and diagnosis, I now avoid surgery within the first 14 days after injury.' [70]

If cervical skull traction has been applied, a careful check must be made of the security of pins, cord, knots and weights before any further movement is attempted. If traction is not going to be used for an individual, then a properly sized and fitted hard cervical collar must remain *in situ* until all investigations to determine appropriate spinal column stability have been completed. In the unconscious patient, protection of the cervical spine must be maintained until the patient has regained consciousness sufficient for a full neurological examination and evaluation to be completed.[64] **After the initial reduction and stabilisation of the injury site, spinal alignment must be maintained at all times to prevent secondary trauma to the spinal cord**. Cervical traction or a cervical collar are also commonly used post-operatively for several weeks after a cervical fixation.

In addition to the cervical traction in place, a neck roll made from gamgee roll, towels or pillowcases can, where appropriate, be used to support the cervical curve. A thin gel or foam pad can be used to relieve pressure on the occiput. For thoracolumbar injuries, a lumbar pillow of appropriate thickness can, where appropriate, be used to support the lumbar curve.

The period of cervical traction and bed rest is usually six to eight weeks until radiographic examination demonstrates that sufficient new bone growth (*callus*) is present. Examination and testing of soft-tissue strength and stability will then follow. The bed-rest period following thoracolumbar injury is usually between six and ten weeks and is dependent upon the expected load bearing and postural strain that will be exerted upon the damaged area during and after mobilisation.

Prevention of Pressure Sores

People with SCI are at the greatest risk of developing pressure sores when hospitalised outside SIUs.[25] Part of the explanation for this is the low priority given to skin care in the pre-admission area as a result of the critical status of the patient on arrival. This situation should not be allowed to continue beyond the A&E department.[71] The patient should be assigned an appropriate level of pressure support for their condition which combines pressure relief along with sufficient support for the spine. For example, the standard Vaperm mattress combines optimal support for the fracture site along with appropriate pressure relief over the main weight-bearing areas and bony prominences of the body.

▶Key point **Dynamic alternating pressure matresses should not be used for nursing patients with actual or suspected acute spinal injuries without reference to your local spinal injuries unit.**

The patient's skin condition should be checked for the effects of pressure on arrival in the HDU/ICU and this should be documented in their Nursing Notes. A note should be made of the estimated time that a patient has spent in a particular position and on what kind of surface. Particular attention should be paid to weight-bearing surfaces and bony prominences. **The initial turning programme should avoid the patient being turned onto any discoloured areas of skin present on admission**.

Pressure Sore Prevention:

- Turn the patient two-hourly, avoiding friction and shearing.
- Avoid turning the patient onto a discoloured area of skin wherever possible.
- Minimise the incidence of the other contributory factors of pressure sore formation (e.g. maintain adequate nutrition and hydration, check for anaemia, avoid soiling/creating moist environments etc.).

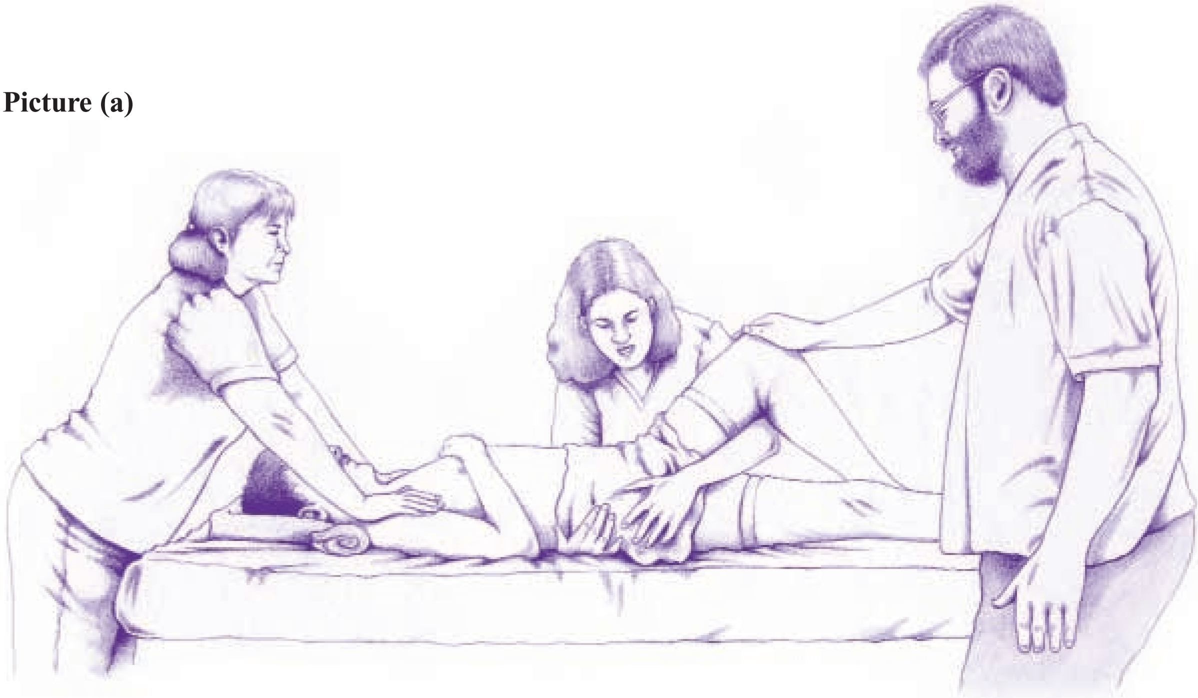
The incidence of pressure sores increases significantly where there is a delay in transferring a patient with SCI to an SIU.[3,4,6,12,14,16-18,20-22,25,72]

There is still considerable anxiety and uncertainty within general care areas in respect of the manual turning of people with acute SCI. Clinical experience gained over many years has demonstrated that routine two-hourly turning for pressure relief is the optimal practice for this period. Two turning techniques are recommended – log-rolling for patients with thoracolumbar injuries and pelvic-twisting for patients with cervical injuries.[73-75] These techniques are illustrated on pages 54-57.

As the pelvic twist does not allow for the full visualisation of the upper back and occipital area, it is essential to log-roll tetraplegic patients once a day for a complete skin check. This manoeuvre will require at least five members of staff and should be planned accordingly to incorporate a daily back wash and sheet change.

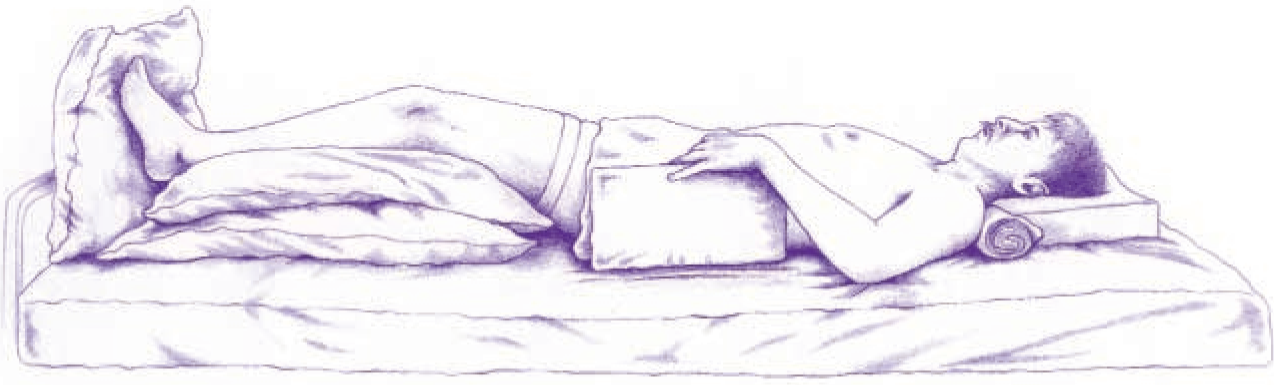
▶Key point **It would be both inappropriate and unprofessional to implement a new manual handling practice based solely on the information provided in this book. A request to your local SIU may enable you to organise a practical moving and handling workshop with an experienced facilitator. Most units are also able to provide opportunities for clinical placements as developmental opportunities.**

Picture (a)



Picture (b)

Picture (c)



Illustrations by Louise E Hunt / SIA

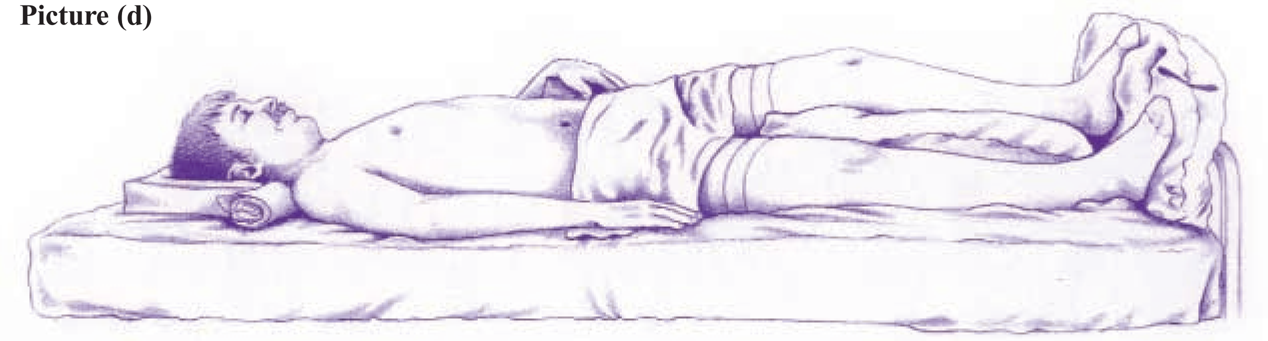
▶ Opposite: Pelvic Twist

Picture (a) This technique is utilised for cervical injuries only. It is contra-indicated in the presence of thoraco-lumbar or pelvic trauma. It may also be contra indicted in some cases of spinal deformity or rigidity e.g. ankylosing spondylitis etc. The patient's shoulders are 'pinned down' by the nurse standing at the head of the bed. With the assistance of the third nurse, a second nurse passes her left hand beneath the patient's left leg and her right hand beneath the patient's lumbar curve. Both of the second nurse's hands meet over the patient's right hip.

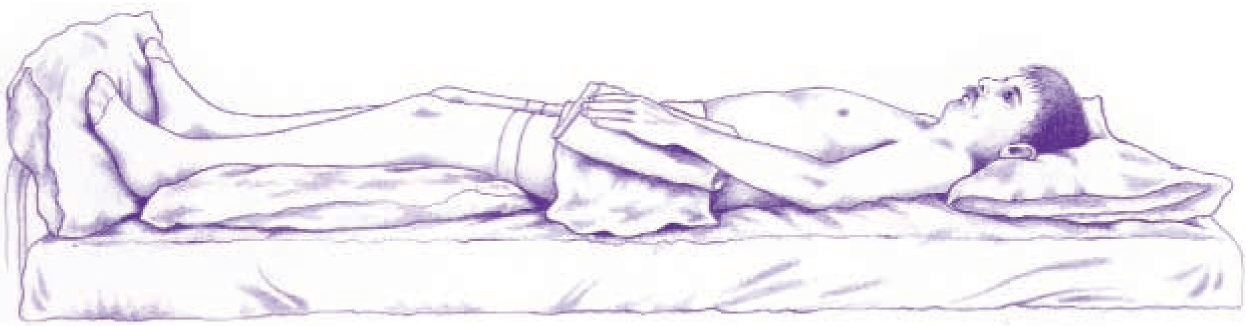
Picture (b) The twist is acomplished by a sliding upward rotation of the patient's left hip. The second nurse's hands provide a barrier against friction and the angle of twist should not exceed 30º.

Picture (c) The first two nurses hold their position whilst the third nurse places a foam wedge or folded pillow *in situ* beneath the patient's left buttock – above the sacrum. To prevent compressing of the buttocks, the nurse will manually raise the upper (left) buttock, releasing it only after the wedge/pillow is *in situ*. The patient's sacrum is maintained free from pressure and buttocks are kept apart. Two pillows are placed to support the upper (left) leg.

Picture (d)



Picture (d) The pelvic twist should not be so far as to place weight onto the lower (right) trochanteric pressure area. The patient's feet are 'blocked out' with pillows at the end of the manouvre to prevent foot drop. The patient's top (left) leg rests behind his lower (right) leg for stability and comfort. The patient's arms are positioned in an appropriate position of rest, on pillows if necessary. This procedure can also be utilised for non spinal-injured patients with arthritic or painful shoulders, hemiplegia, fractured or fixated limbs, chest drains or with head/brain injuries..

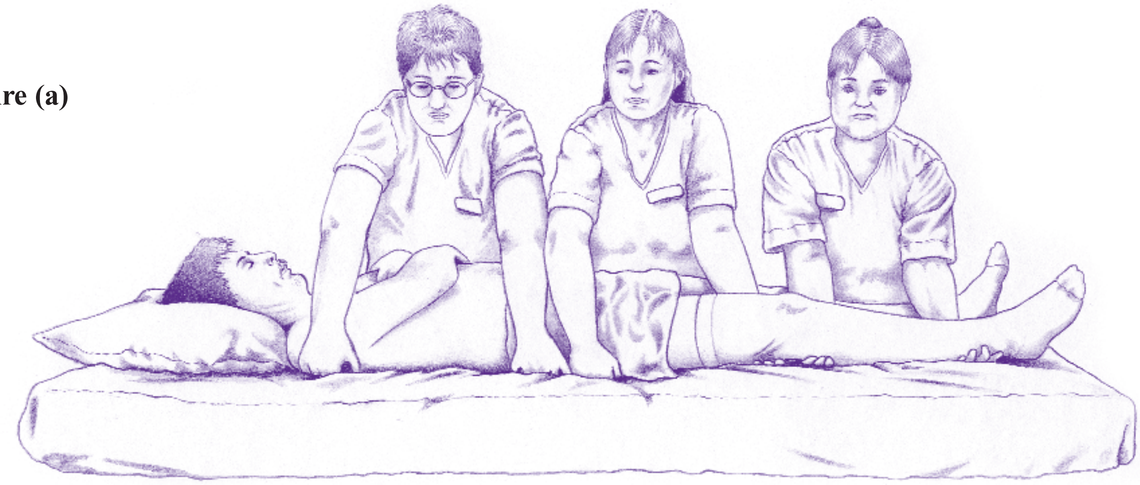


▶ Above: Supine position

This picture illustrates an acute paraplegic patient at rest in a supine psition with all pillows *in situ*.
Note how the patient's heels are maintained free from any pressure through the strategic positioning of pillows.

10

Picture (a)



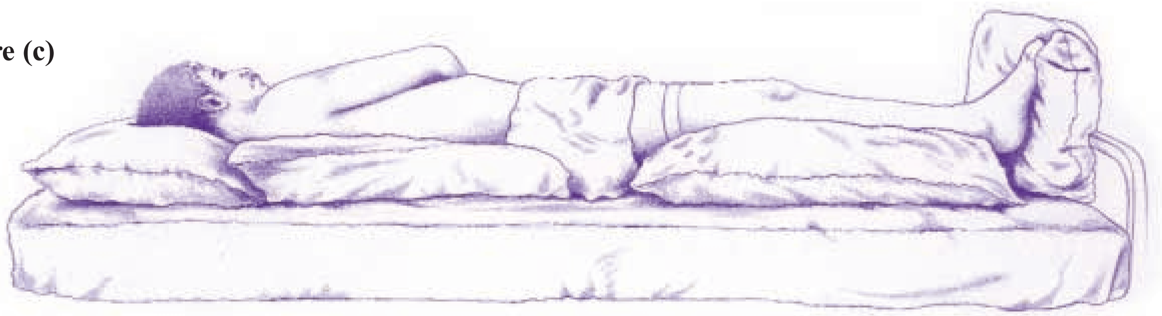
Above and Below: Log-Rolling

Picture (a) Three nurses prepare to log-roll an acute paraplegic patient. If present, a lumbar pillow can be utilised during the turn. All commands will come from the nurse nearest the patient's head.

Picture (b)

Picture (b) The patient's upper (right) leg must be kept in alignment throughout the turn to prevent movement at a thoraco-lumbar fracture site. An additional nurse is required to support the cervical spine when log-rolling a patient with a cervical spine injury (tetraplegic).

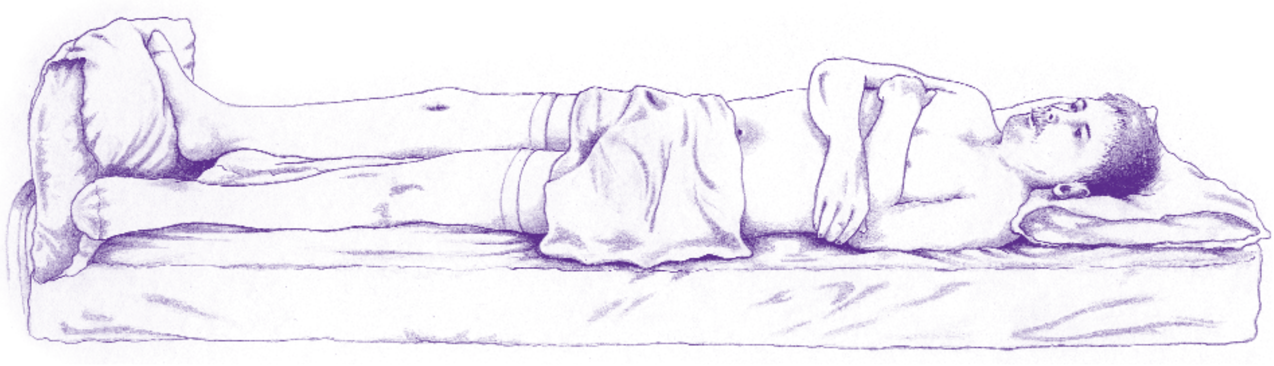
Picture (c)



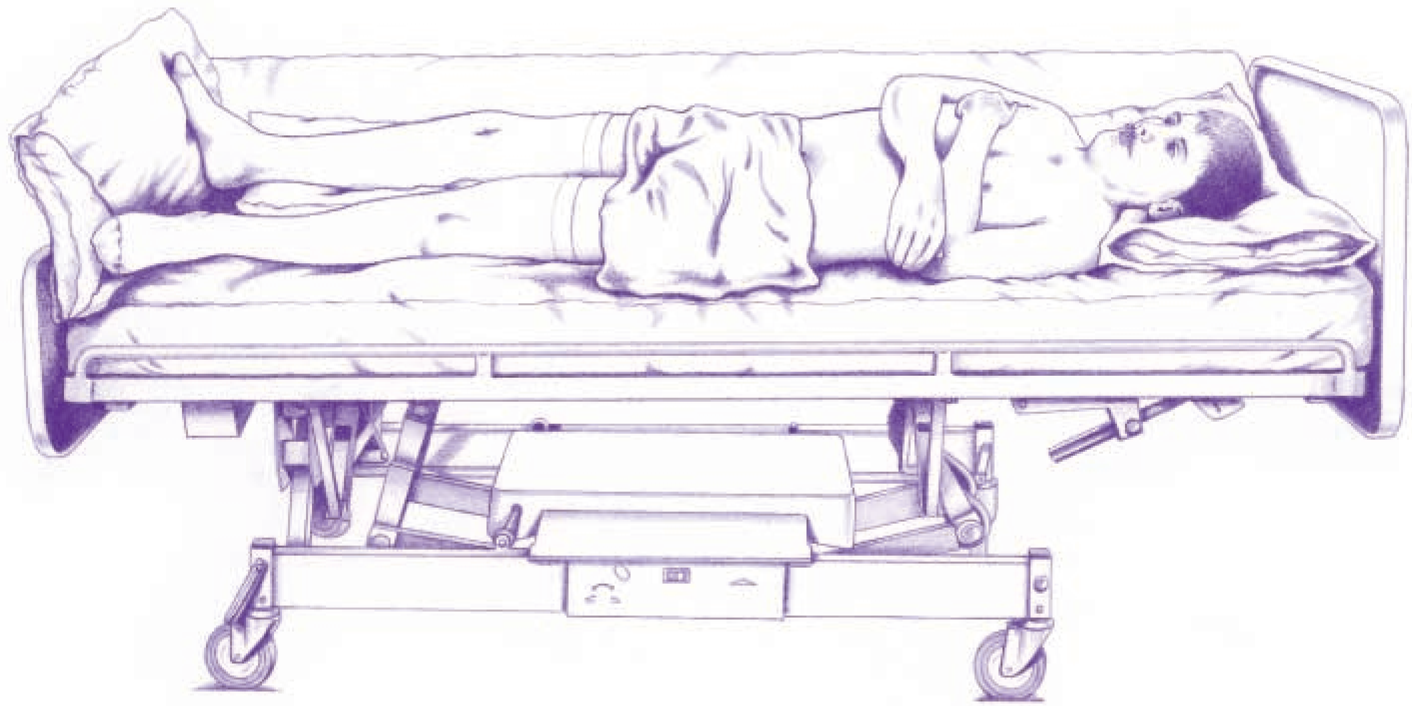
Illustrations by Louise E Hunt / SIA

Picture (c) A completed log-roll. Pillows have been placed appropriately *in situ*, sufficient to maintain the patient in a 30º lateral position. Lateral positioning can vary between 30º and 90º dependent upon skin condition, comfort and clinical need, although a position between 30º and 50º is preferred to prevent excessive pressure being exerted upon the lower (left) trochanter.

Picture (d)



Picture (d) The patient's upper (right) leg is positioned behind the lower one for both pressure relief and better spinal alignment. Once again, please note how pillows have been used to prevent foot drop and to eliminate adverse heel pressure.



Above: Electric Turning Bed

Electric turning beds (such as this Paragon 9000) are extremely useful for nursing those SCI patients who present with respiratory problems, multiple injuries, multiple levels of vertebral trauma or who are obese. Cervical traction can be supported on this model of bed. The bed should always be operated under manual, rather than computer, control and the patient maintained in a lateral turn/supine for no more than 2 hours intially. The usual preferred angle for routine turning is between 20º and 40º. Manual re-positioning of the patient between turns is essential to relieve adverse skin loading and the patient should be log-rolled at least daily.

Where staffing numbers make manual turning difficult, or where a patient presents with injuries to both the cervical and thoracolumbar spine, or with multiple injuries, which make lateral positioning difficult or painful, an electric turning bed (such as Egerton's Paragon 9000) can be used.[73-75] Wherever such beds or turning tables are used, the automatic or computer-controlled turning facility should be deactivated in preference to manual control.

The patient should be turned every two hours between 20° and 30° only. This is because it is impossible to guarantee that a paralysed patient will maintain their lateral spinal alignment against gravity if the bed is turned beyond this angle, increasing the risk of secondary cord trauma due to lateral movements of the spine. A patient with SCI complicated with chest problems may, with care, be supported in a lateral turn of 40° to 50° for short periods during the day, for the purposes of postural drainage and active chest physiotherapy. Head-up and head-down positioning for postural drainage should not be attempted without a careful assessment of the risk that increasing the axial loading of the spine may cause further damage to the cord.

People with spinal cord injuries are nursed naked in bed. This allows staff to avoid numerous dressing and undressing manoeuvres, as well as eliminating the potential contribution of creased clothing towards the development of pressure sores. It also enables staff to monitor spinal alignment during turns and transfers by observing the alignment of bony landmarks and to monitor all pressure-bearing areas for the effects of pressure. A theatre gown or modesty sheet can be used to maintain patient dignity during turns and transfers, adjusted so that bony landmarks are visible throughout.

Before and after any roll, turn or transfer, the patient's position and alignment should be checked, and the skin loading adjusted as required. Particular care must be taken to ensure that the patient's buttocks are not allowed to compress against each other when supine, because this can contribute to the formation of natal cleft sores. Manual separation of each buttock from its neighbour at the end of each turn usually suffices.

The Multiple System Benefits of Regular Turning

Current literature regarding the implementation of a programme of routine manual turning primarily focuses upon the time and manpower requirements necessary to sustain such a programme. Authors emphasise our ability to replace manual turning as a means of preventing pressure sores through the technology of pressure relieving mattresses and dynamic beds.[76] However, as Hawkins *et al.*[76] discovered:

'Little evidence or information could be found in the literature specifically discussing the other advantages of turning patients…We possess the ability to prevent some of the respiratory, neurological and musculo-skeletal consequences of enforced immobility.'[76]

A sustained programme of two-hourly turning can deliver multiple benefits to patients with spinal cord lesions during the acute bedrest stage. These benefits go far beyond the simple prevention of pressure sores and will be represented within the following chapters.

Cast Management with SCI

Lack of sensation in paralysed limbs means that, where limb fractures are being managed in cylinder or backslab casts, the patient is at an increased risk of developing plaster sores. All casts should be well padded to reduce the effects of pressure. Great care should be taken when a lower limb is being raised during the plastering process. The patient's hip should not be flexed beyond 40°. The same care should be exercised for requests to elevate a patient's limb during bedrest. Backslab splints should be removed at least twice each day and the underlying skin inspected for the effects of pressure. Cylinder casts should be bi-valved at the earliest opportunity for the same purpose.

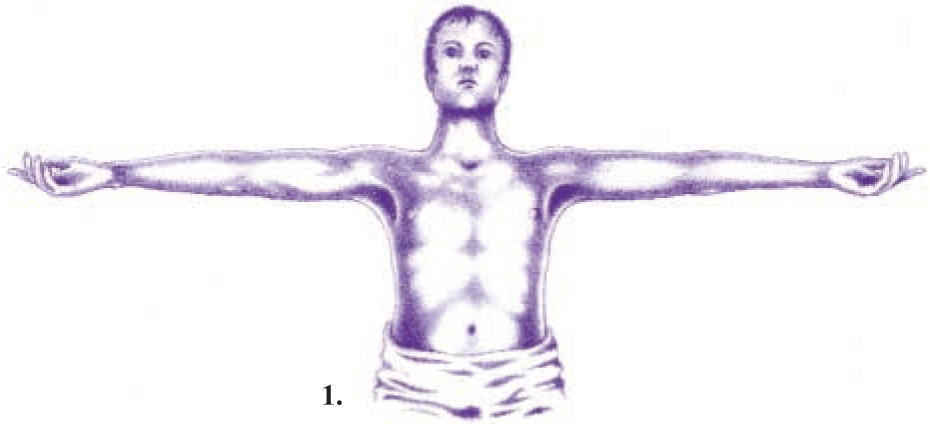
Prevention of Contractures

Joint contractures can occur rapidly following the onset of spinal cord paralysis but are easily prevented.[17,72,77] Physiotherapists should ensure that each acute patient receives a full range of daily passive movements for paralysed limbs within the limitations of any accompanying injuries.[17,72,77] **Passive movements should not be undertaken until the injury site has been appropriately stabilised**. A consultant opinion regarding the proposed range of passive limb movements should be sought before commencement. Limits may be set upon the range of shoulder elevation for patients with cervical injuries and hip flexion for patients with lumbar injuries. Additional limits may be set for patients with ankylosing spondylitis and similar conditions. A medical assessment is also essential if anticoagulation therapy has been delayed. Wherever possible, passive movements should be performed with the patient in supine.

Following consultation with local physiotherapy staff, additional passive movements can also be undertaken by nursing staff before and after turning the patient. Conscious, cooperative patients should be encouraged to exercise non-paralysed limbs through active exercises and involvement in care processes as appropriate to their level of injury.

Tetraplegic patients with spinal cord lesions above C7 are at high risk of developing biceps muscle contractions owing to their lack of an opposing triceps muscle.[17,72,77] Arm or wrist splints are not recommended at this stage because of their great potential for skin damage. Both staff and relatives of the patient should passively extend the patient's forearms whenever it is noticed that flexion has occurred. Although time consuming, perseverance in this endeavour is rewarded during rehabilitation (see page 60).

'From an holistic perspective the patient will benefit from regular turning and careful positioning. This will not only prevent secondary complications developing but will also promote recovery.'[76]



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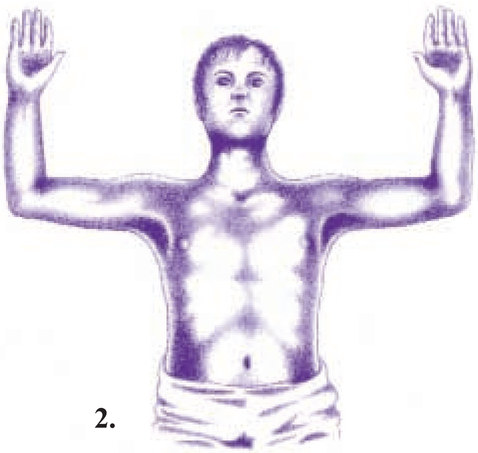

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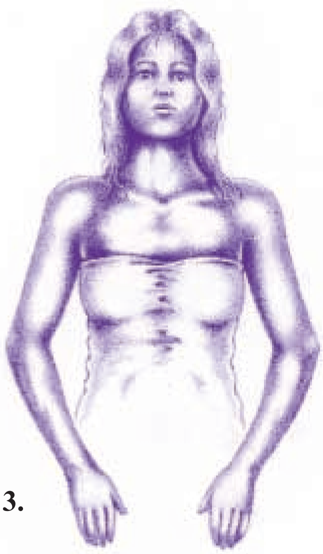

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Illustrations by Louise E Hunt / SIA

Tetraplegic arm positioning:

Pictures 1-3 illustrate appropriate arm positioning for the prevention of upper limb contractions in tetraplegic patients. **Picture 4** illustrates the potential onset of biceps muscle contracture (known as ‘coathanger syndrome’). The developing contraction is also drawing the resting weight of the patient’s hands, wrists and forearms across the diaphragm. This could further impair her respiratory effort.

The potential for an individual with tetraplegia to undertake a range of personal and meaningful tasks such as feeding, brushing teeth, etc, could be denied by an upper limb contracture that developed during the initial period of bedrest.[17,72,77] A rolled crêpe bandage placed to support the tetraplegic patient's hand in a tenodesis position is sufficient to prevent finger contractures.

The incidence of joint contractures increases where transfer of the patient to an SIU is delayed.[17,72] The risk of contracture is further increased in the presence of head injury or multi-trauma.[72]

Management of Pain with SCI

Despite their paralysis, patients with SCI can still experience pain, especially from around and above the site of their spinal injury. As with any other orthopaedic trauma, immobilisation of the site of a spinal injury, as described earlier, contributes significantly to the reduction of post-trauma pain. Where severe pain is experienced, from the presence of complex or multiple injuries, an electric turning bed is beneficial for relieving the discomfort experienced during manual turning. Some complaints of pain in SCI patients may be referred from the abdominal viscera (see 'Acute Abdominal Complications' in Chapter 14).

Opiates, even fragmented doses, should be avoided in cases of non-ventilated tetraplegia or high paraplegia in case they cause respiratory suppression. Diclofenac is the drug of choice for these patients, although most other general analgesics, such as dihydrocodeine, codeine phosphate or buprenorphine, can be used for more severe pain. Oversedation of a patient with tetraplegia will affect their respiratory effort, which may be confused with fatigue.

Where opiates have been administered during the early post-injury period, with resulting respiratory suppression, the possibility of the same respiratory difficulty being caused by an ascending extension of the initial spinal cord lesion should be considered and excluded through the immediate administration of naloxone. There will be no temporary recovery of respiratory function in the event of lesion extension. In such an event, vital time will have been lost in determining the true problem. **This is the true rationale for avoiding opiates initially. Either event may result in the patient requiring urgent mechanical ventilation**.

Tetraplegics are also particularly prone to shoulder pain owing to a form of adhesive capsulitis ('frozen shoulder'). This is easily prevented in most cases by regular, passive, repositioning of the arms at rest after every turn (see page 60).[74,78] **Some complaints of shoulder pain in SCI patients may be referred from the abdominal viscera** (see 'Acute Abdominal Complications' in Chapter 14).

11 Systemic Effects of Spinal Cord Injury: Neurological System

Autonomic Effects of SCI

The most significant feature of spinal shock is the way that it affects the activity and functions of the autonomic nervous system.[30,44] Sympathetic activity below the level of a spinal cord lesion is suppressed to such an extent that:

'…a complete cervical injury is equivalent to a total sympathectomy.' [79]

The effects of this are most manifest in injuries above the sixth thoracic nerve (T6) – the base level of the body's main sympathetic outflow. Parasympathetic activity is not greatly affected by an SCI, so it dominates all autonomic activity.

On average, the duration of spinal shock is between 48 hours and 14 days after trauma. In some instances, it can persist for up to six weeks or more. Notably, these instances are usually when the injury involves a child or where there is significant accompanying trauma requiring major surgical intervention in the immediate post-trauma period. Extended periods of chemical paralysis/sedation and mechanical ventilation can also extend the period of spinal shock even further. Careful monitoring for the return of reflex activity, sensation or voluntary movement should begin in earnest 48 hours after injury or cessation of paralysing/sedating agents.

Management of Spinal Cord Oedema

Research studies have suggested that high-dose methylprednisolone therapy may have a role to play in reducing the effects of spinal cord oedema after trauma.[80] They also identified a window of clinical effectiveness that limits the commencement of this therapy to within the first 8 hours after injury. Although far from being a magical 'cure', the potential for this therapy to influence the process of lesion formation could mean a significant improvement in rehabilitation outcomes and quality of life after injury. **However, this therapy is not without risk and the methodology and results that underpin the claims of this therapy are now being questioned**[81,82]. Further research is necessary. Suggested guidelines for the administration of methylprednisolone are outlines on page 63.

Monitor the casualty's neurological level every 15 minutes initially, reducing over time, where there is no evidence of further neurological deterioration.[83]

Sensation should always be assessed against that present in a non-paralysed part of the body – such as the face of a tetraplegic patient. Motor function should always be assessed against the full range and strength expectations for an individual of a certain age and capability.

> ***'The use of methylprednisolone in the acute management of SCI remains controversial and advice should be sought from your local spinal injuries unit'.***
>
> Statement issued on behalf of the British Association of Spinal Cord Injury Specialists (BASCIS). 8 June, 2000.

METHYLPREDNISOLONE: DOSING DETAILS FOR ACUTE SCI

BOLUS DOSE = 30mg/kg i.v. in 100ml 5% dextrose over 30 minutes (3.3ml/min)

- Bolus must be given within 8 hours of the injury
- Bolus dose is rounded to the nearest 250mg before being reconstituted with a suitable volume of 5% dextrose, taken from a 100ml mini-bag, before being replaced in the mini-bag and infused over 30 minutes

INFUSION = 5.4mg/kg per hour in 230ml 5% dextrose over 23 hours (10ml/h)

- 20ml is drawn off from a 250ml bag of 5% dextrose. Infusion dose is reconstituted with a suitable volume, taken from the remaining 230ml and returned to the bag. After reconstitution, 230ml is infused at 10ml/h for 23 hours
- The reconstituted infusion has an expiry of 24 hours

Patient weight (kg)	40	45	50	55	60	65	70	75	80
Bolus dose (g)	1.25	1.50	1.50	1.75	1.75	2.00	2.00	2.25	2.50
Infusion dose (g)	5.00	5.50	6.25	7.00	7.50	8.00	8.75	9.25	10
Patient weight (kg)	85	90	95	100	105	110	115	120	125
Bolus dose (g)	2.50	2.75	2.75	3.00	3.25	3.25	3.50	3.50	3.75
Infusion dose (g)	10.50	11.25	11.75	12.50	13.00	13.75	14.25	15.00	15.50

11

The Initial Management of Spasm

Spasm is the manifestation of the body's innate protective withdrawal mechanism in response to a locally perceived noxious or painful stimulus. Spasm presents as sudden, sometimes violent, contractions of muscles and limbs below the level of lesion. The patient has limited means of control over these movements, and limited ability to voluntarily suppress them. This reflex is suppressed during the spinal shock stage and there is no way to predict when spasm will return or how severe it will be. **Spasm is usually more pronounced in patients with incomplete sensory lesions, patients with multi-trauma and those who have undergone early surgery or a period of mechanical ventilation**. For the tetraplegic patient, abdominal spasm can interfere with respiration. In addition spasm is painful, being perceived as a 'burning', 'stabbing' or 'cramping' pain at or below the original site of injury.

Severe spasm can create problems with maintaining spinal alignment. In the course of their normal patient care delivery, staff must identify which limb positions, movements or points of skin contact trigger spasm. Sudden noises, cold hands, the sudden switching on of bright lights and the removal of bed sheets with painful or discomforting procedures or investigations involving the paralysed areas of the body – such as catheterisation or cannulation – can all trigger spasm.

Most episodes of spasm during the bed-rest period can be prevented, or at least reduced, through regular turning, passive movements and changes in limb positioning. Patients, relatives and staff can often struggle to understand the concept of reflex limb movement, initially believing that it heralds the return of normal function. Realisation of the true nature of spasm can come hard. However, with appropriate education, physical and pharmacological therapy within an informed rehabilitation programme, spasm can become a useful aid to daily living for a person with a spinal cord lesion, facilitating standing and sitting transfers, relieving sitting pressures, exercising paralysed joints and muscles, and aiding bladder and bowel emptying.

Physiotherapy aims are to maintain a functional range of movement, develop or maintain muscle bulk, identify trigger points and to de-sensitise nerve fibres through a planned programme of handling, stretching and guided movements.

The use of anti-spasmodic agents and analgesics is regulated by the need to maintain the functional benefits without over-sedating the patient or suppressing other reflex activity such as peristalsis or diaphragmatic functioning. Spasm can also be influenced by emotional trauma, necessitating appropriate referrals for psychological support and counselling to develop appropriate coping strategies.

The onset of spasm in the acute SCI patient should prompt a request for advice and assistance from the specialist care team at your local SIU.

Patients with complete spinal cord lesions below the level of the first lumbar vertebra (L1) will have a permanently flaccid lesion. In these cases it is important that staff provide appropriate protection for the patient's flaccid limbs and joints throughout the period of bedrest. Particular care must be taken during turning and transferring these patients.

WARNING

- **Report any and all changes in neurology as soon as they are noticed.**
- **Do not confuse reflex spasticity with voluntary movement of limbs.**
- **Do not equate the return of sensation to a part of the body with potential return of voluntary movement to the same.**
- **Abdominal/lower limb spasm may simulate voluntary respiratory effort when the ventilator is in Synchronised Intermittent Mechanical Ventilation (SIMV) mode.**
- **Ensure that the patient's partner/relatives are made aware, in advance, of the potential occurrence of any of the above.**

12

Systemic Effects of Spinal Cord Injury: Respiratory System

Respiratory Muscle Paralysis

All patients with cervical injuries suffer the effects of respiratory nuscle paralysis; primarily affecting their diaphragm, intercostal and abdominal muscles. However, the accessory muscles of respiration (sternocleidomastoid, scaleni, trapezius) and other muscles in the neck can usually still assist in respiration. Tetraplegia at or above the level of the third cervical nerve (C3) results in respiratory insufficiency caused by diaphragmatic paralysis, necessitating immediate mechanical ventilation. From the level of C4 down, however, the patient should be able to breathe unassisted, except where pre-existing disease or accompanying trauma requires assisted breathing.

Where a patient demonstrates symptoms of respiratory fatigue, a prophylactic tracheostomy may be performed to reduce the amount of respiratory dead space that the patient has to contend with.

'In general, vital capacity is reduced by 30-50%, functional residual capacity by approximately 25%, and expiratory reserve volume by as much as 75%. These findings reflect the loss of abdominal and chest wall muscle strengths and control that results from SCI.' [84]

Management of the non-ventilated patient at this stage is designed to develop the patient's respiratory capacity and ability.[37,77] Humidified oxygen via a facemask or nasal cannulae should be given over the first 24 to 48 hours sufficient to maintain the blood saturation levels as far above 90% as possible. This therapy will also maximise blood oxygen levels at the lesion site in the spinal cord. Half-hourly deep breathing exercises should also be encouraged.

The tetraplegic patient also becomes consciously aware of the efforts required to maintain his or her respiration. This can lead to anxiety, a fear of respiratory failure, panic attacks, a denial of fatigue and resistance or refusal to sleep, causing sleep deprivation. Nasal congestion caused by vasodilatation may be relieved by ephedrine nosedrops. Sleep apnoea is a potential problem for some tetraplegic patients, but be aware that Continuous Positive Airway Pressure (CPAP) therapy delivered via a face or nasal mask may cause gastric distension, as the patient may experience difficulties with their swallowing reflex. Most tetraplegic patients will become mouth breathers requiring regular, efficient mouth care.

Measuring and Monitoring Respiratory Function

Roth *et al.*[84] determined that vital capacity (VC) is the simplest and most appropriate measure of pulmonary function after SCI:

'The excellent correlations between vital capacity and nearly all the other pulmonary function tests support the use of VC as a single global measure of ventilatory status in SCI patients.' [84]

The diaphragm is an under-utilised muscle which in most patients responds readily to respiratory training. A programme of deep breathing and assisted coughing should be established on admission. Experience has shown that tetraplegic patients can make significant improvements to their vital capacity in as little as 48 hours after injury. The following table suggests the expected extent of improvement in VC that can be achieved through an appropriate programme of rehabilitation. This table is adapted from Zejdlik[44] and assumes that normal VC for an adult male is 4600 ml ± 20%:

Level of lesion	Vital capacity during acute bed-rest period	Vital capacity after an appropriate programme of rehabilitation
C1-2	5-10% of normal (500-600ml)	Ventilator dependent for life
C3-6	20% of normal (1000ml)	Usually ventilator free (C4-6) or ventilated part-time. 50% of normal
C7-T4	30-50% of normal (1380-2300ml)	60-70% of normal
T5-T10	75-100% of normal 3450-4600ml	Nearly normal
T11-S5	Normal	Normal

Monitoring Blood Gases

Discrepancies in the reported levels of circulating blood oxygen may occur, dependent on the method of monitoring. Arterial sampling will always be accurate; however, reduced peripheral circulation caused by vasomotor changes in the peripheral circulation of tetraplegic patients may, over time, produce lower values when measured via peripherally sited infrared monitors. Most models of pulse oxymeter provide for the use of a sensor that attaches to the patient's earlobe. As this site will always be above the level of spinal cord lesion, readings should be consistent with the patient's actual status.

A regular and sustained programme of respiratory training aimed at developing remaining respiratory muscle strength and endurance should commence as soon as possible after admission. These programmes have a proven ability to prevent or reduce the incidence of pulmonary complications.[35-38,44,57,77,84,85]

The patient is encouraged to develop and maintain a routine that incorporates regular deep breathing, assisted coughing and flow resistive devices throughout the period of acute bedrest. A physiotherapist should be asked to instruct nursing staff in delivering regular assisted coughing where competence is lacking.

The illustrations below show the appropriate positioning of hands to brace and restrict the movements of the ribcage while the diaphragm is forcibly pushed upwards in coordination with the patient's attempt to cough.

Assisted coughing must not be attempted without prior instruction. Inappropriate hand positioning may result in the forced expulsion and inhalation of stomach contents. In the presence of paralytic ileus, undertake assisted coughing by pushing laterally on the ribs, avoiding the need to place hands on the abdomen (see illustrations below). Patients with acute cervical injuries will need an additional person to brace the shoulders against the force of an assisted cough to prevent movement of their neck during the procedure.

Illustration by Louise Hunt

Appropriate hand positions for performing assisted coughing on a supine patient by one or two persons. Force is directed upwards against the diaphragm. The amount of force required to provide an effective 'assisted cough' is often underestimated. Physiotherapists in spinal injuries units are available to advise in this technique.

Another effect of SCI that is often poorly appreciated in critical care areas is the fact that tetraplegic patients find it easier to breathe in a supine position:

'In supine the effect of gravity is eliminated and the abdominal contents are more easily displaced, allowing greater diaphragmatic excursion. Consequently, vital capacity is generally greater in supine than in sitting for persons with high tetraplegic injuries, which may lead to increased difficulty in tolerating the sitting position.' [86]

For this reason, as much as for the need to maintain spinal alignment and to avoid weightbearing through the traumatised spine, patients with acute spinal cord injury should be nursed in a level, supine position throughout the initial period of bedrest.

Actions designed to raise a patient's head above the level of their body should be qualified in the patient's Medical and Nursing Notes against appropriate clinical indicators and, preferably, after discussion with specialist colleagues.

Regular turning in supine or changes in position, where possible, also contributes to the mobilisation of pulmonary secretions and improves the uptake of oxygen.[76,87]

'Regular turning enhances the reduction of the incidence of pulmonary infection and the development of sepsis. The movement from the supine position to side-lying has numerous physiological advantages. Body position changes enhance oxygen transport due to the effect of gravity on the distribution of ventilation and perfusion throughout the lungs… Altering chest position is thought to redistribute and mobilise mucus and interstitial fluid from dependent lung areas, which helps to prevent the development of atelectasis within these areas… A chest infection is a major source of sepsis so turning to prevent a pressure sore could also prevent a chest infection, which could also prevent a pressure sore.[76]

Acute (Adult) Respiratory Distress Syndrome (ARDS)

There is a significant potential for the development of this condition after SCI.[42,43] In some situations, the recommended treatment may be to nurse the patient prone.[88] Where this is the case, particular emphasis must be placed on the need for staff to practice and adopt an appropriate method for the prone turning and positioning of a ventilated patient with SCI, in complete alignment throughout.

Pape *et al*[89] demonstrated that the increase of ARDS in at-risk patients with traumatic injuries can be significantly reduced by implememting a programme of routine and regular turning from an early stage after admission. Turning also improved systemic oxygenation and overall survivability in these patients.

Use of Mini-Tracheostomy

A mini-tracheostomy may be used to reduce the amount of respiratory dead space or to facilitate the clearing of excessive pulmonary secretions.[90] **SCI patients with tracheostomies or mini-tracheostomies *in situ* can suffer overstimulation of the vagus nerve during suctioning, leading to cardiac syncope.**

A similar proviso applies to pharyngeal suctioning. To reduce this risk, hyperoxygenate the patient before suctioning, minimise the time that the catheter is in the patient's trachea, and monitor the heart rate throughout the procedure. Give prophylactic atropine or ephedrine if this is a persistent problem.

Rolling a patient onto their left-hand side for a protracted period of examination or treatment, or an increase in tracheal pressure resulting from the tracheostomy becoming obstructed from accumulated secretions can also induce vagal overstimulation.

Associated Chest Injuries

Rib or sternal fractures, along with a haemo/pneumothorax, may often accompany SCI. Bleeding into the pleural cavity may arise from the site of a thoracic fracture. There is little additional information to add to existing care and management guidelines, except to continue monitoring the patient's respiratory effort for signs of slowly developing respiratory complications. In the event of respiratory distress, avoid sitting the patient upright in bed when the presence of potential spinal column trauma is suspected.

Pulmonary Embolism

Where appropriate prophylactic anti-coagulation is undertaken pulmonary embolism is rare after an SCI. When it does occur, it is usually silent in nature and may present initially as supraventricular tachycardia (SVT)[91] or an acute disturbance in the patient's normal behaviour.[92]

If breathing is compromised sufficiently to require a change in posture against gravity, **do not sit the patient up or raise the bed head** – tilt the entire bed to a reverse Trendelenberg position instead, just enough to ease patient distress. Provide oxygen/nebuliser, etc. as appropriate. Avoid positioning the patient in an upright sitting position, at least until a more informed opinion has been received. Check patient's neurology after every change in position.

▶Key point **Secondary or delayed cord compression can occur as a result of the effects of gravity on the cervical spine, even when a hard collar is *in situ.***

Mechanical Ventilation

Respiratory insufficiency following spinal cord injury is a frequent complication. The need for ventilator support is dependent upon the level of cord lesion and the extent of any accompanying injuries or complications:

'Mechanical ventilation may be required after SCI to maintain adequate ventilation in patients with intercostal or phrenic nerve damage or to allow sufficient oxygenation after aspiration or chest trauma. The main aims of ventilatory support are to maintain adequate gas exchange, to diminish barotrauma and to improve patient synchronisation between patient and machine effort'. [43]

Intubation of an individual with actual or suspected cervical spinal cord/column injury is not without its hazards.[93] Cervical alignment in neutral must be maintained throughout the procedure. A hard or semi-rigid cervical collar can impede mouth opening and usually has to be removed.[79] In such cases manual support of the head and neck must be in place before the collar is removed and must be maintained throughout the intubation procedure. The passing of an endotracheal tube may stimulate vagal overactivity. There is a high risk of aspiration if intubation is undertaken on a full stomach. For these reasons alone it is preferable, wherever circumstances permit, that intubation is undertaken as a controlled, rather than an emergency, procedure as soon as possible after the need for it is identified.

For medico-legal purposes it is imperative that, wherever circumstances allow, a full neurological assessment of the presence and effects of any SCI is undertaken and documented before intubation is attempted.[93]

Anaesthesia in Acute SCI Patients

It is important that all staff exercise additional care when transferring, turning and positioning an SCI patient following the administration of a muscle relaxant, as the protective muscle spasm that persists at the fracture site will disappear, increasing the potential for secondary trauma and lesion extension.

The traumatised and swollen spinal cord can be damaged further through inappropriate movement of the head or neck post-injury, the same applies to lumbar or thoracic movement. The most damaging movement of the spine is rotation. Problems can therefore arise in maintaining spinal alignment during transporting, inducting, intubating and positioning the acute spinal injured patient undergoing anaesthesia. In cervical injuries traction is often used to stabilise the head along the spinal axis and to protect against inadvertent movement. It will be maintained throughout induction, operation and post-operatively.

The commonest mechanism of cervical spinal column injury is a forced flexion rotation. Most of these patients will tolerate a position of slight extension with minimal risk of further cord damage. This should be sufficient to enable an experienced anaesthetist to pass an endotracheal tube without much difficulty. The alternative is to undertake an elective tracheostomy, particularly if a protracted period of mechanical ventilation is anticipated.

▶Key point **The anaesthetist must always be notified whenever the actual or suspected mechanism of injury was hyperextension of the cervical spine.**

A full stomach is an added hazard, although regurgitation is more probable than vomiting due to abdominal muscle paralysis. Predisposing factors can be a head-down tilt, airway obstruction, Continuous Positive Air Pressure (CPAP) therapy or Intermittent Positive Pressure Ventilation (IPPV) before intubation and the use of depolarising muscle relaxants. Emptying the stomach via nasogastric tube is no guarantee of prevention and may actually facilitate regurgitation if left in place during intubation. The passing or presence of a nasogastric tube can also increase vagal stimulation. A head-up tilt may decrease the possibility, but may in itself cause an increase in axial loading in the damaged area of the spinal column, aggravate or initiate hypotension, and may also add to intubation difficulties.

The administration and use of general anaesthesia following acute SCI is hazardous and should be undertaken with great care and consultation with those experienced in this condition where appropriate.[93]

'The use of any anaesthetic agent that causes myocardial depression may be hazardous in a patient who is hypotensive following the sympathectomy of spinal shock'.[93]

Circulatory disturbances can be intensified by anaesthetic and narcotic agents with myocardial depressing and vasodilatory effects. Therefore, the intention should be to ensure that the anaesthetic level will be as light as circumstances allow, and drugs given at minimum possible dose.

A pre-induction electrocardiogram is essential. In addition, most anaesthetic gases induce hypotension and hypothermia. The trends of BP, pulse, urinary output, fluid administration and the use of inotropic agents should be carefully monitored. A warming blanket may be used with care and all parenteral fluids should be warmed to body temperature.[79,93] The patient's ventilatory capability needs careful assessment before induction, and there is always a risk of pulmonary embolism within the first few weeks post-injury.

Halothane is potent in low concentrations and is therefore preferred. It also has the advantage of being non-irritant to the respiratory tract and effecting depression of laryngeal and pharyngeal reflexes, facilitating intubation under anaesthesia. The use of suxamethonium carries a significant risk of fasciculation of the neck muscles, with possible displacement of a cervical fracture, and should be avoided if at all possible.[93] Its use outside of the first 72 hours after injury is also associated with a high incidence of cardiac arrest due to hyperkalaemia, as the denervated cell membrane is altered in an atypical response to depolarisation. This commences on the sixth day after injury and can last for up to twelve weeks.[93] The use of suxamethonium is best restricted to the essential life-saving surgery necessary within the first 48 hours after admission:[79]

'One of the indications for intubation several days post injury is for surgical fixation of an unstable spine. In these situations suxamethonium is no longer suitable'.[79]

Hypovolaemia from blood loss is poorly tolerated by tetraplegics and therefore requires immediate identification and treatment of the cause. Blood should only be replaced where it is seen to be lost.[93] No transfusion is required for a sympathetically induced hypotension. The central venous pressure (CVP) level may be misleading in tetraplegics, as it may reflect the balance between changes in cardiac output and diminished venous return. The tendency of the CVP to rise because of cardiac depression or hypovolaemia might be masked by the venous pooling that results from the reduction of peripheral venous tone.[93] Severe hypotension in the absence of hypovolaemia can be corrected by the temporary use of vasopressive drugs, which have both a cardiac and peripheral action.[93]

Bradycardia can be induced by traction or hypoxia from vasovagal stimulation.[79] Vagal overactivity, leading to syncope can occur because mechanical ventilation does not increase automatically with the level of hypoxia. The best treatment in these cases is atropine and increased oxygenation.[79]

Weaning

'Weaning from respiratory support is an important aspect of ventilatory support and is an important aspect of intensive care. Since mechanical ventilation is likely to entail complications such as infection, tracheal injury, barotrauma, oxygen toxicity and cardiovascular compromise, discontinuation should be achieved as soon as possible'.[43]

The most successful and preferred method of weaning for individuals with SCI is progressive ventilator-free breathing (T-piece weaning).[94] Alternative methods, in order of preference, are Synchronised Intermittent Mechanical Ventilation (SIMV) and CPAP. **Failure to wean is not usually related to the method used but is more likely to occur where the patient is intubated for more than one week**.[43]

For some patients with SCI, modern methods of weaning often appear to be implemented as an endurance challenge with set goals and times outlined within a rigid protocol. However, experience has proven that a more traditional programme which advocates a more flexible, opportunistic, approach to weaning is often better:

'There are no hard-and-fast rules for weaning patients from the ventilator but many short periods off the ventilator are generally preferable to a prolonged interruption of mechanical ventilation.' [95]

The incidence of ventilator associated pneumonia also increases with time.[96] It has a significant mortality amongst patients with high SCI and can extend their period of hospitalisation to the extent that **each week spent on a ventilator can equate to an extra month spent in rehabilitation**.[97] The average period of mechanical ventilation after SCI is 3 weeks.

Ventilator Dependency

Developments in the initial management of patients with ultra-high spinal cord lesions (C3 and above) has enabled many individuals to survive a significant and usually mortal neurological trauma. **During the critical care period, it may be difficult to perceive the rehabilitation and resettlement potential that exists for a person who will be dependent upon a mechanical ventilator for the rest of his or her life**:

'With recent advances in medical technology increasing numbers of people survive high spinal cord injury but are dependent upon technology. These individuals who are ventilator dependent present a considerable challenge to us.' [98]

SIUs have risen to the challenge, developing and establishing the knowledge, skills and attitudes that enable these special individuals to eventually return to their homes, families, communities and lives.[99] Rehabilitation of these individuals is extensive, complex and expensive, but ultimately satisfying for all concerned.[99-101]

'Spinal injury centres clearly demonstrate that people who are ventilator dependent can be re-established in their own homes and that this level of disability need not prevent individuals from returning to their community and starting to develop a lifestyle again.' [98]

13 Systemic Effects of Spinal Cord Injury: Cardiovascular System

Vasomotor Effects

The loss of vasomotor tone throughout the paralysed areas of the body provides the doctor or nurse with the classic diagnostic observations of spinal shock – hypotension, bradycardia and poikilothermia. The impact of this effect varies depending on the level of injury. It is most pronounced in cases of tetraplegia.

The loss of tone throughout most of the body's anti-gravity muscles, combined with the passive dilation of its vascular network, can result in an average (tetraplegic) blood pressure (BP) of 80/50mm/Hg. Unopposed vagal nerve activity results in a (tetraplegic) bradycardia averaging 52 beats per minute.[30] This effect requires a reinterpretation of the anticipated baselines for observations whenever a patient with traumatic SCI is admitted.[52] Sustained hypoxia has a detrimental effect upon the patient's cardiovascular status. Vagal activity increases with a high risk of cardiac syncope. This can be corrected through the administration of high concentrations of oxygen and the use of atropine.[43]

'Rapid infusion is not required if the hypotension is due to SCI alone. Indeed, vigorous fluid therapy may produce pulmonary oedema. A systolic blood pressure of 80-90mm/Hg… is quite satisfactory in these circumstances.' [47]

BP, pulse, central venous pressure (CVP) and mean arterial pressure (MAP) will have to be recalibrated. This can cause particular difficulty in determining the presence of actual hypovolaemia or cardiac failure.[43,102] **In these instances, it is worth remembering that it is the dynamic trend of the observation, rather than the actual numerical value recorded at the time, that is being measured; this indicates deterioration or improvement in a patient's condition**. In addition, the recorded BP of a SCI patient undergoing Positive End Expiratory Pressure (PEEP) or Intermittent Positive Pressure Ventilation (IPPV) may be maintained at an artificially higher level because of changes in intra-thoracic pressure.[43,79] Changing to a different ventilator mode may cause a sudden and noticeable, but artificial, drop in BP.

Monitor and record observations every 15 minutes initially, reducing over time as appropriate to the patient's progress. Wherever possible, avoid turning the patient on to their left side for prolonged periods (such as during a back wash or sheet change), as this can increase vagal stimulation and may induce cardiac syncope. Turning the patient onto their right side does not have the same effect and this problem is not usually an issue during routine turning or twisting to the left side for pressure relief. A cervical collar applied too tightly may also cause syncope.

Circulation

Do not confuse spinal shock with hypovolaemia.[30,32,40,42,43,47,79,93] Massive fluid replacement in the absence of actual blood loss is a common error at this point, resulting in pulmonary overload and subsequent pulmonary oedema.[42,43,93] It may also trigger acute (adult) respiratory distress syndrome (ARDS).[43,79] In the presence of actual multi-trauma, fractures or abdominal injuries, proceed with caution when replacing lost fluid. Where erroneous massive fluid replacement has been attempted, it is worth noting that, in most cases, this does not produce a significant increase in blood pressure. If hypotension persists – in the absence of identified blood loss – and is a cause for concern, vasopressor drugs can be used to replace the lost neurogenic vasoconstriction.[43,79,93,103] Application of thromboembolic deterrent (TED) stockings can replace some of the lost muscle resistance, as well as reducing the risk of deep vein thrombosis (DVT).

BLOOD LOSS ACCOMPANYING SPINAL CORD INJURY

There is a requirement within most trauma management protocols that hypotension caused by actual or suspected neurogenic or spinal shock care will be treated as hypovolaemic shock until proved otherwise.[41] This is sound advice. To presume that hypotension is solely attributable to the effects of spinal shock can have serious repercussions for the casualty.[93] However, where the perceived hypotension is primarily the result of the autonomic effects of SCI, there is a significant risk that the patient can become overinfused and develop pulmonary oedema. This situation is very difficult to reverse and may lead to further pulmonary complications, even mechanical ventilation.

A judicious programme of fluid replacement should, therefore, be prescribed until a careful and rigorous assessment of the patient's potential blood loss has been completed.[52] In the unconcious and mechanically ventilated patient with accompanying SCI, it is worth recalling that, in the event of significant occult bleeding, the observed trend is for a falling blood pressure and rising pulse rate, whatever the numerical value being recorded.

Deep Vein Thrombosis

DVT is a potential complication after an SCI, but the incidence can be minimalised through good prophylactic management.[104-106] Apply appropriately measured and fitted thigh-length TED stockings but ensure that the skin beneath the stockings is checked at least twice a day for the effects of pressure.

Routine anticoagulation with subcutaneous heparin 5000 units three times a day or enoxaparin 40mg daily should commence on admission and its effectiveness monitored. Regular turning and repositioning of the patient during bedrest, supported by a full range of passive movements to the paralysed lower limbs, as described earlier, will also improve venous return.[76,104-107]

Accurate and timely detection of an actual DVT in a patient with SCI is difficult.[108] A swollen lower limb will only be apparent about ten days after the clot has formed. **The only reliable diagnostic indicator of early DVT formation is a sudden, unexpected, pyrexia.**[109] As this may be masked in the presence of an apparent or detectable infection, every pyrexial episode should be considered as a potential DVT episode as a precaution. Doppler ultrasound scanning has proved significant in detecting thromboses in SCI patients.[108] **The risk potential for DVT following SCI increases significantly following spinal surgery.**[107]

Thermoregulation

Sweating, shivering and piloerection (goose-flesh) all depend on spinal nerves for stimulation. In addition, peripheral vasodilation means that the patient's core temperature can soon equal the environmental temperature through circulatory conduction. This is termed 'poikilothermia'. Thermal imaging has demonstrated that a tetraplegic patient's body temperature can be up to 1°C lower below the level of the lesion.[110] Therefore, it is wise to add or subtract 1°C to whatever reading is recorded for a more accurate representation of actual body temperature. This is particularly important when you are considering whether to take blood cultures from a pyrexial patient or to warm a patient with apparent hypothermia actively. Rectal temperature has been shown to be the most accurate measurement for acute SCI patients, aside from invasive blood monitoring.[111]

▶Key point

Many hospitals operate a protocol for the taking of blood cultures in suspected septicaemia. The usual trigger is pyrexia at or above 39°C. In the presence of SCI, this trigger value should be recalibrated to 38°C. A similar recalibration of thinking should be applied to those values that trigger treatment protocols for hypothermia.

It is the responsibility of every healthcare professional to ensure that the patient's body temperature is maintained at an appropriate level during all procedures, treatments, investigations and transfers.[52,63] It should be anticipated that the patient's body temperature will drop significantly both during and after sedation and the administration of an anaesthetic. Active warming should be undertaken cautiously for fear of causing skin damage.

Another reported problem of SCI temperature regulation is that the pressure-relieving effects of thermal contouring mattresses can be significantly reduced for SCI patients. This has proven a particular problem amongst tetraplegic patients where the majority of their body mass fails to achieve the optimum surface temperature necessary for these products to work effectively.

Immune Response

Severe central nervous system (CNS) trauma has an adverse effect on the body's immune response mechanism;[112] therefore, all procedures and invasive investigations should be conducted with scrupulous attention to asepsis. Catheters, drains, CVP lines, intravenous and arterial lines each have their own potential risk of infection.[43] In combination they put the acute SCI patient at high risk of developing septicaemia if infection control procedures are neglected.

The incidence of MRSA amongst patients admitted to HDU/ICU or who undergo surgery pre-transfer is significant,[113] and the presence of MRSA may also delay transfer to the SIU, as well as delaying and complicating rehabilitation activities.[114,115] SIUs have had to invest heavily in barrier nursing facilities over the last 10 years to enable them to care for increasing numbers of patients admitted with MRSA.

MRSA is now perceived within the speciality as a complication associated with a delay in transfer beyond 48 hours. As such, it provides another justification for efforts and investments designed to enable critical care areas to achieve the earliest transfer of patients with SCI to a specialist SIU.

14 Systemic Effects of Spinal Cord Injury: Gastrointestinal System

Paralytic Ileus

Every SCI patient will present with an initial loss of peristalsis as a result of spinal shock.[116] Vomiting after injury is a potential hazard for tetraplegic patients, but the incidence is such that the routine passing of a nasogastric tube is not always essential in the non-ventilated patient. A nasogastric tube should only be passed in the conscious patient if he or she vomited after injury, complained of nausea or had ingested significant amounts of food or fluids before injury. If a nasogastric tube is passed, it should be aspirated hourly and left on continuous drainage between aspirations. There is a potential for vagal overstimulation both during and after the passing of a nasogastric tube and the passing of a nasogastric tube may be contraindicated in SCI patients with accompanying head or facial trauma.

▶Key point **Paralytic ileus is an immediate consequence of SCI. All SCI patients should be kept nil-by-mouth for at least the first 48 hours after injury without exception – even if bowel sounds are present on admission.**

In the absence of actual fluid loss or obvious cardiac insufficiency, intravenous fluids prescribed at this time should be for hydration only and should not exceed two litres over 24 hours. Observe the patient carefully for signs of abdominal distension during this period, because this may impair diaphragmatic breathing.[79] **Gross abdominal distension can cause embarrassment and splinting of the diaphragm sufficient to necessitate mechanical ventilation**.

After 48 hours, where crisp, clear bowel sounds are detectable, a graduated oral or nasogastric fluid regime, similar to that followed by patients who have undergone major abdominal surgery, can commence. The patient starts on fixed fluid volumes (30ml/hour) increasing to free fluids before commencing a soft diet. If tolerated, this can be followed by a gradual return to full diet.[116]

Traumatic SCI requires an individual nutritional assessment that adjusts for age and accompanying injuries, pre-existing metabolic disease, complications and mechanical ventilation. Nutritional management aims to support post-injury energy demands, to protect and facilitate the recovery of the gastrointestinal tract and prevent inappropriate muscle wasting. Appropriate nutritional support can be provided through a combination of oral diet and supplement feeds. The patient will require between two to three litres of fluid daily to maintain a good renal throughput. The multidisciplinary team of each SIU includes a dedicated dietitian who can provide further information on the nutritional support of SCI patients.

If the paralytic ileus persists beyond 72 hours then total parenteral nutrition (TPN) should be considered. Initially, a peripheral route is preferred but the actual method and route of feeding will be determined by patient tolerance and after discussion with the local nutrition support team. The use of metaclopramide or erythromycin may also be proposed at this time as both have some proven ability for influencing the return of delayed peristalsis.[117,118]

The potential contribution of multiple lumen nasojejunal tubes is under review at this time, but no success has yet been reported when used within the first 48 hours and their proposed use in the presence of spinal shock is still controversial. The need for these tubes to be inserted via an endoscope creates an additional hazard in the case of cervical injuries. Percutaneous endoscopic gastrostomy (PEG) or percutaneous endoscopic jejunostomy (PEJ) feeding is preferred as an intermediate to long-term solution where the need for nutritional support is prolonged.

Acute Abdominal Complications

Unopposed vagus nerve activity is thought to be a key factor in high-risk stress ulceration occurring after injury. This risk is particularly high for tetraplegic patients. The administration of a prophylactic antacid (sucralfate) along with an H2-receptor blocker (ranitidine) on admission has proved successful in reducing this risk.

In the event of an actual visceral ulcer or trauma occurring, the tetraplegic patient may complain of referred visceral discomfort,[119] **although this is not always guaranteed. Visceral ulceration or perforation may be perceived by the patient as a 'burning' or 'persistent' pain in or around the anterior or outer shoulder unrelated to movement**.[120,121] If an ulcer is suspected, the administration of a single dose of an antacid preparation may give relief, confirming the presence of the suspected problem. **Traumatic abdominal or visceral injuries sustained at the time of an accident may also be perceived by the patient as non-specific abdominal discomfort. Any such complaints or suspicions should be investigated further by ultrasonography, CT or peritoneal lavage as per departmental policy**.[122-124] Hyperglycaemia caused by accompanying pancreatic trauma may manifest itself as acute lethargy in the SCI patient. **This information may also prove useful in the event that your HDU/ICU admits a person with a long-established SCI with actual or suspected visceral trauma or disease**.

14

Bowel Management

The rectum and anus are also flaccid initially after an SCI. Accumulation of faeces in the rectum can lead to overdistension of the stretch receptors in the bowel wall and frustrate the return of reflex anorectal activity. In addition, obstruction of the bowel can weaken the bowel wall and increase the risk of perforation.

A digital check per rectum (PR) to determine the presence of the anal sphincter reflex should be undertaken as part of the initial neurological examination after admission. A gentle digital manual evacuation (ME) of any faeces present at this time must be undertaken with sufficient lubrication. Glycerin suppositories should be used to soften the stool if required. **Any attempt to stimulate a reflex bowel action using suppositories or enemas at this stage will fail**. Too vigorous an ME may damage sensitive nerve and muscle fibres within the anal sphincter and may also induce vagal overstimulation.[125]

The anal reflex is the first spinal reflex to return, usually about 48 hours after injury. A daily PR check is necessary until a reflex contraction is felt. At this point, reflex bowel emptying can be undertaken in line with the patient's oral intake. Alternate-day micro-enemas are used in combination with digital stimulation (see box overleaf). This is the beginning of a complex programme of rehabilitation with implications for the patient's future quality of life. For this reason, reflex bowel management should always be undertaken in collaboration with specialist SCI practitioners.

Patients with complete spinal cord lesions below the level of T12 will not recover reflex bowel activity as their lesion involves the cauda equina, disrupting the sacral reflex arc. In this instance the bowel will remain flaccid permanently, necessitating a routine daily ME to be performed until transfer.

As digital evacuation of the bowel usually falls outside the usual scope of practice for most general nurses,[126] here is another incentive to liaise with a specialist centre where such procedures are routinely undertaken.

In either event, it is to be expected that there will be a minimal result initially until faecal matter is able to form in bulk within the lower bowel. An extended period of paralytic ileus or the use of tube feeding as an alternative to an oral intake of solid food may prolong this period. **However, constipation and impaction of the bowel is a common complication of SCI management outside of specialist environments.**

BOWEL MANAGEMENT AFTER SCI

PR Examination

Place patient in left lateral position or left-sided pelvic twist as appropriate to their level of injury, with sufficient protection for bedsheets and patient dignity. Check for ano-rectal sensation in the conscious patient. Check for any haemorrhoids or rectal bleeding at the same time. If sensation exists, insert 2% lignocaine gel and wait for 4 minutes before proceeding further. Inserting one gloved and lubricated finger, note any resistance or reflex contraction of anal sphincter. Rotate finger gently within the rectum. Note any faeces present or if rectum is distended with gas. Take the opportunity presented to check the prostate of mature males and the positions of the coccygeal vertebrae if trauma in this area is suspected.

Manual Evacuation (Flaccid bowel only)

Undertake PR examination as above. Ensure that bowel is still in a flaccid state before undertaking this procedure. Remove any faeces present by inserting and gently rotating a single gloved and lubricated finger within the rectum, sufficient to draw the faeces backwards and out through the anal sphincter. The finger should be slightly crooked away from the bowel wall. Repeat until the bowel is empty, monitoring patient's condition throughout for signs of pain, distress or vagal overactivity. Repeat insertion of 2% lignocaine gel as necessary. Do not attempt to 'hook and drag' faeces as this can damage the bowel wall. If faeces are hard and dry, insert two glycerin suppositories 30 minutes before commencing procedure. If faeces are too soft to remove effectively, consider leaving the patient for another 24 hours to enable further reabsorption of water content, review fibre content of diet/feed or prescribe an appropriate bulking agent.

Reflex Bowel Emptying

Undertake PR examination as above. Ensure that anal reflex is present. Insert two micro-enemas or bisacodyl suppositories. It is essential that the enema fluid or suppository comes into direct contact with the bowel wall. If faeces were present in the rectum on examination, it may be necessary to undertake a gentle manual evacuation to provide sufficient space for the enema fluid/suppository to work effectively. After insertion, leave the patient resting in position for 20 to 30 minutes. If the anal reflex has developed sufficient strength and coordination, it may evacuate some faeces automatically onto the protective pad during this time. Whether or not a reflex bowel action has taken place, further digital stimulation is usually necessary to ensure that the bowel is completely empty. Insert one gloved and lubricated finger into the rectum. Turn the finger so that the padded inferior surface is in contact with the bowel wall. Rotate the finger three times in a clockwise direction, maintaining contact with the bowel wall throughout. Withdraw the finger and await a reflex evacuation. Repeat every 10 minutes until reflex activity ceases. In the event of no reflex activity occurring at all, do not repeat digital stimulation more than three times. If a large amount of faeces remains in the rectum, its presence may be delaying the return of an efficient reflex. In such an event a further gentle manual evacuation may be necessary.

Your local SIU should be informed if there has been no solid bowel action within 3 days of the commencement of oral diet or within 5 days of tube feeding commencing. Specialist advice should also be sought before any aperient, bulk-forming medication or bowel stimulant is prescribed.

Bowel Management Problems Outside of Specialist Units

It is neither unusual, nor always inappropriate, for people with established spinal cord lesions to be readmitted to their local DGH for treatment or investigations. However, the ability of DGHs to either deliver or maintain an appropriate level of care for these patients is often questioned. **The issue of people with spinal cord lesions being refused a manual evacuation of their bowel (ME) after readmission to their local DGH is a cause for concern.**[127]

Many people with established, flaccid, spinal cord lesions use ME as their established and routine method of bowel management at home. Therefore, they cannot understand why it is so difficult to continue to receive appropriate bowel management after admission to a DGH. ME is not usually an established or routine procedure in DGHs. It is rarely performed by nurses working within general areas of care. It may be more familiar to nurses working in some critical care areas, the community or in residential homes, but it is only usually well practiced by those who regularly care for people with spinal cord lesions.

The actions and activities of all UK Registered Nurses (RNs) are guided by the *Code of Professional Conduct*[128] published and policed by the United Kingdom Central Council for Nursing, Midwifery and Health Visiting (UKCC). Failure to abide by this code can find the nurse facing disciplinary action. In the most serious instances a nurse's name can be removed from the UKCC Register of Nurses.

The *Code of Professional Conduct* states that the primary requirement of all nurses is to:

'…act always in such a manner as to promote and safeguard the interests and well-being of patients and clients.'[128]

This rule represents the UKCC's expectation that nurses should 'do the patient no harm' and is equivalent to a doctor's Hippocratic Oath. In addition, the *Code of Professional Conduct* also expects nurses to:

'...acknowledge any limitations in your knowledge and competence and decline any duties or responsibilities unless able to perform them in a safe and skilled manner.'[128]

Therefore, a nurse working in a general or critical care area of a DGH who refuses to undertake an ME (an unfamiliar procedure) for a person with flaccid paraplegia unable, owing to injury or illness, to maintain their established method of bowel management is acting in the best interest of her or his patient. However, nurses are not only responsible and liable for their individual actions, but also for the overall standard of the care they provide. The *Code of Professional Conduct* expects nurses to:

'...ensure that no action or omission on your part, or within your sphere of responsibility, is detrimental to the interests, condition or safety of patients and clients.' [128]

Failing to follow or maintain an established programme of care could find a nurse being accused of failing to provide appropriate care for a patient. To continue with the above example, our nurse, having established that she or he cannot undertake ME personally, must now identify an appropriate source of assistance in order to maintain the patient's established programme of care. To do this, the needs of the patient, and the nurse's own inability to meet them, must be represented to the Unit Manager or Senior Nurse. The *Code of Professional Conduct* anticipates this problem and expects nurses to:

'...report to an appropriate person or authority any circumstances in which safe and appropriate care for patients and clients cannot be provided...' [128]

Unfortunately, the recent experiences of some people with spinal cord lesions suggest that some nurse managers are unsure of how to deal with this situation properly. Many are of the mistaken impression that nurses are 'forbidden' from undertaking ME. In one person's experience, his problem occurred after being transferred from the ICU to HDU. The HDU nurse manager refused to allow nurses to undertake ME, even though the patient had been receiving ME as part of his daily care in ICU and despite the fact that the hospital had a policy supporting ME by appropriately trained nurses.

Many DGHs have an established policy for patients requiring ME. These policies usually identify experienced personnel within the hospital able to undertake or teach ME. These are usually nurses employed in wards or departments within the DGH where ME is a more common procedure. Alternatively, a doctor, rather than a nurse, may be required to undertake ME. Such personnel will be grateful for any information or advice that the patient, their partner, family or personal carer can provide to maintain the effectiveness of their established programme of bowel management. Additionally, most DGHs, where appropriate, will support and encourage an established personal carer who wishes to maintain involvement in the care of the patient, especially where the HDU/ICU staff have difficulty in meeting the demands of the patient's established programme of care.

In some instances a nurse manager or doctor might also question the patient's need for an ME. This is because this procedure can and has been abused in the past. In such an event, it is important to emphasise that ME is a necessary and established part of the patient's personal care programme and that attempting to introduce an alternative method of management may actually be harmful.

This year the Royal College of Nursing (RCN) published an updated version of *Digital Rectal Examination and Manual Removal of Faeces*.[125] This publication explains when ME is appropriate and how to undertake ME safely. It also stresses that experience in undertaking ME is essential for patient safety. The needs of people with spinal cord lesions are well represented in this booklet. Your local SIU and the RCN are more than happy to discuss these issues further with any nurse who considers that she or he has a problem in maintaining an established programme of bowel management.

15 Systemic Effects of Spinal Cord Injury: Genitourinary System

Effects on the Urinary Bladder

The urinary bladder is flaccid throughout the period of spinal shock. Insertion of an indwelling urethral or suprapubic catheter enables continuous bladder drainage and monitoring of urinary output. Experience has demonstrated that reduced bladder activity increases the incidence of sedimentation and catheter blockage. This increases the risk of urinary retention and urinary tract infection after an SCI. An adult urinary catheter French gauge (FG) 14 – 16 is therefore recommended. Silicone catheters are also recommended for their durability and reduced risk of blockage. The catheter should be changed routinely **every 4 weeks** to prevent blockage.

At this stage after injury, the vast majority of patients with an SCI have the potential to recover reflex bladder function during their rehabilitation at a specialist centre. Overdistension of the bladder during initial management can result in the overstretching of nerve and muscle fibres within the bladder wall, reducing their potential to recover reflex function. Dilatation of the ureters and reflux of stale urine towards the kidney can also occur, leading to severe renal complications.

Reduced Urinary Output

The sudden hypotension that accompanies spinal shock stimulates the production of large quantities of antidiuretic hormone (ADH) by the pituitary gland. Levels of ADH production increase in relation to the level of the SCI. **In the event of tetraplegia, urinary production may fall to the level of 0.5ml/kg per hour**.[79] **Therefore, an initial urinary output in the region of 30 – 50ml per hour should be expected. An initial period of oliguria is not uncommon**.[129] In view of the effect of spinal shock on diuresis, hourly monitoring of urinary output is essential during the first few days after injury. However:

'Urinary output should not be used as a guide to adequacy of volume replacement in the mechanically ventilated patient with SCI. Rather, measures from a pulmonary artery catheter should be used as a more accurate indicator of volume status.'[43]

Indiscriminate increases in fluid infusions and the use of diuretics – where there is no clear evidence of renal or cardiac problems – is discouraged. ADH secretion increases further if surgery is undertaken during the early post-injury period.

Routine and regular turning of the patient during the period of initial bedrest will agitate the contents of the bladder reducing sedimentation and the risk of infection, bladder calculi and catheter blockage. In the acute patient, bladder distension due to a blocked catheter is usually painless but can delay or prevent the return of the voiding reflex as well as increasing the potential for reflux.[44]

AUTONOMIC DYSREFLEXIA[48,130]

The autonomic response to painful (noxious) stimuli perceived below the level of the lesion is a potential complication for all patients with spinal cord lesions above the level of T6. **The most common stimulus is a blocked catheter. This problem manifests as acute hypertension. Systolic blood pressure can easily exceed 200 mm/Hg. Unresolved, it can cause fatal cerebral haemorrhage**. This reflex response is usually suppressed during the period of spinal shock for an initial, acute admission. However, **it is a potential complication for individuals with established SCI who are readmitted to acute care environments**.[130-131]

The most common presenting symptoms of autonomic dysreflexia are:

- Severe hypertension
- Bradycardia
- 'Pounding' headache
- Flushed or blotchy appearance of skin above the level of lesion
- Profuse sweating above the level of lesion
- Pallor below the level of lesion
- Nasal congestion
- Non-drainage of urine (urinary obstruction being the most common cause).

The most common causes of autonomic dysreflexia among people with established spinal cord lesions who may present in the HDU/ICU are:

- **Distended bladder**
  (usually resulting from catheter blockage or some other form of bladder outlet obstruction)
- Distended bowel (usually caused by constipation or impaction)
- Ingrown toenail/fracture below level of lesion
- Pressure sore/contact burn/scald/sunburn
- Urinary tract infection/bladder spasms
- Renal calculi/bladder calculi
- Visceral pain/visceral trauma
- Pregnancy/delivery
- Deep vein thrombosis/pulmonary embolism
- Severe anxiety/emotional distress.

THIS IS A MEDICAL EMERGENCY!

AUTONOMIC DYSREFLEXIA *(continued)*[48,130]

In the unconscious patient – check for a Dysreflexia Emergency Alert card.

The main presenting features of autonomic dysreflexia are:

- Severe (pounding) headache
- Profound vasodilation (flushing) above the level of the cord lesion and vasoconstriction (pallor) below the 'line of demarcation' – visible even in different skin types
- Profuse sweating above the level of cord lesion.

In the presence of visible primary symptoms, it is recommended that the initial investigation and treatment of cause should not be delayed through a poorly prioritised need to take and document a patient's blood pressure and pulse.[130]

Actions in the event of autonomic dysreflexia should be prioritised as follows:

1. Identify or eliminate the most common (most lethal) cause of autonomic dysreflexia, which is non-drainage of urine. If this is not the cause, then proceed to investigate alternative causes according to the list provided on page 87. Reassure the patient throughout because anxiety increases the problem.
2. Remove the noxious stimulus, e.g. re-catheterise immediately in the event of a blocked catheter. **Do not attempt a bladder washout because there is no guarantee that the fluid will be returned**.
3. If possible, sit the patient up, or tilt the bed head-up, to induce some element of postural hypotension.
4. If symptoms remain unresolved after removal of noxious stimulus, or if the noxious stimulus cannot be identified, administer a proprietary chemical vasodilator, such as sublingual glyceryl trinitrate (GTN) or captopril 25mg, sublingually. **Nifedipine capsules, which were previously recommended for use in treating or preventing autonomic dysreflexia, are being withdrawn as they have been implicated in episodes of severe hypotension.**[131]
5. Record blood pressure and give further reassurance. Monitor patient's condition.
6. Refer to local SIU for a specialist opinion/referral.

THIS IS A MEDICAL EMERGENCY!

16 Psychological and Emotional Support

Dealing with Fear and Anxiety

The initial impact of spinal cord injury (SCI) on an individual is sudden and unexpected. The fear and anxiety that follows the realisation of a serious injury with an apparent and severe loss of movement and sensation throughout a significant proportion of the body cannot be imagined.[98] Fear and frustration are compounded by the seeming inability of doctors and nurses to give a clear diagnosis because of the presence of spinal shock.

Psychological management and support of the SCI patient at this time should aim to inform both the patient and their family sufficiently to gain their cooperation. For most patients in the acute stage, awareness of the extent of their injury is distracted by the combined onslaught of examinations, investigations and treatments, and dulled by analgesics or anaesthesia. Many patients report post-traumatic amnesia and the young age of many of these individuals means a lack of developed coping mechanisms. The following advice is offered for staff supporting the SCI patient in non-specialist critical care environments:

- Be truthful with all information given to the patient within the limitations of your own knowledge and experience of this condition. Use the inherent delay (due to spinal shock) in providing an accurate diagnosis and prognosis to hold out some hope to your patient initially. **Ensure that all care team members 'sing the same song' at this time**.
- Care for your patient with both competence and confidence in your own abilities, so that the patient feels 'safe in your hands'. This is difficult where knowledge and experience are limited, and further supports the need for early contact with specialist colleagues.
- Make every reasonable effort to reduce the effects of sensory deprivation. However, be aware that the greatest form of sensory deprivation experienced by your patient is the loss of touch and positional awareness throughout the paralysed areas of their body.[132] **The physical contact experienced during routine and regular turning, repositioning and passive exercises is an effective method of reducing the effects of sensory deprivation.**

'From a psychological perspective, dependency can lead to behavioural problems such as withdrawal, and there is a need for regular contact and interaction to provide opportunities for orientation, socialisation and communication.' [76]

- Encourage partners and relatives to maintain appropriate physical contact with the patient.
- Involve patients in simple decision-making and encourage their active participation in personal care activities where possible.
- Inform your patient and the family of your intention to transfer him or her to your local SIU as soon as possible. Explain why this is necessary. An early visit from the hospital social worker may be necessary to resolve or advise on financial problems relating to family expenses, travel costs, accommodation, benefits and support for other family members both before and after transfer.
- **Above all, use your local SIU for additional advice as required.**

A number of SCI patients will present with pre-existing psychological or psychiatric conditions, which may have contributed to their accident or injury. They may also complicate both the diagnosis and initial management of SCI. The contribution of the local mental healthcare team should be sought. Enabling patients with SCI to gain early access to specialist staff and environments can reduce the potential for long-term psychological problems after injury.[2-4,16,18,19,22,35,36,44,98,114,132]

17 Spinal Cord Injury in Children and Elderly People

Special Needs of Children and Elderly People

Spinal cord injury (SCI) is not confined to any particular age group. Children and elderly people are, however, more susceptible to the effects of severe multi-trauma. Accurate diagnosis of SCI within these age groups is often difficult and these patients are more vulnerable than others to its systemic effects. They are particularly susceptible to the enhanced effects of spinal shock on their respiratory and cardiovascular systems, with an increased potential for developing early complications. **The complications of SCI occur with greater frequency among these two age groups – more than in any other group – whenever there is a delay in transfer to an SIU.**

Spinal Cord Injury in Children

Incidence and Occurrence

Less than 10% of SCIs involve children under 14 years of age.[132] **Most of these injuries are caused by road traffic accidents (RTAs), but with a higher mortality accompanying pedestrian or cycling accidents as a result of the higher incidence of multiple injuries in child casualties**. Of these cases, 75% involve significant multi-trauma; of cases of SCI, 40% are secondary to severe head injuries. However, falls from heights, accidents at home, diving, gymnastic and other sporting accidents are more likely to be survived at this age.[44,133-134] Where such facilities exist, the child may need to be transferred to the local Paediatric Intensive Care Unit (PICU).

Pathophysiology

The pathophysiology of lesion formation in older children, as with adults, is caused by ischaemic necrosis after blunt trauma. However, infants and children under the age of 14 have a more flexible 'green' spine, which allows a wider range of vertebral movement than possible in adults.[134-135] The injury mechanism for SCI in such cases is that of severe flexion-extension-rotation, which may result in a physical tearing of the spinal cord as a result of the distraction forces experienced along its length.

Such traction injuries usually result in a higher incidence of complete tetraplegia. If the traction forces also disrupt spinal blood vessels, a more extensive and flaccid lesion may result.

Orthopaedic Management

The inherent instability, laxity and range of movement of the paediatric cervical spine, coupled with the disproportionate size of a child's head compared with the body, means that cervical lesions predominate in very young children.[134-135] **It is not unusual for a child to present with the symptoms of a spinal cord lesion with no evidence of a fracture or other bony injury**.[54,136]

Immobilisation of a young child, distressed and in pain, is never easy but is essential in these cases.[44] **Often, sedation and mechanical ventilation are necessary in order to maintain spinal alignment in a distressed child**. Care needs to be taken if skull calipers are used. Penetration of the soft bony skull plates is possible. Dependent on the age of the child, a properly sized and fitted hard collar may suffice instead of cervical traction.

The disproportionate size of a child's head compared with their body can also cause problems with maintaining alignment in supine. Whenever the child is being nursed in a supine position, whether in bed, on a trolley or on a spinal board, an appropriate level of padding should be placed *in situ* below the level of the child's shoulders.[60] An appropriately sized neck roll will support the cervical curve and a thin pad positioned beneath the occiput will relieve pressure under that bony prominence.

Because of the increased risk of pressure sores, the collar may be loosened or removed altogether whilst the child is sedated. Sandbags should be kept in place throughout and the collar should be tightened or replaced before undertaking any turns or transfers. The collar should also be kept in place whenever an attempt is being made to rouse the child, if the child is agitated or has a tendency for unexpected convulsions.

Gaining child/parent cooperation is essential to the maintenance of alignment. Internal fixation of the paediatric spine is not recommended because it can impinge directly on future growth and development.

Children are particularly prone to developing pressure sores in the acute stage. Occipital sores are a particular problem as a result of the size and weight of the child's head.

Respiratory Management

There is a high incidence of vomiting after injury with subsequent inhalation of vomit in the immediate post-trauma period.[44] **In this instance, the routine insertion of a prophylactic nasogastric tube on continuous drainage, combined with regular aspiration, is recommended**. The passing of such a tube increases vagal activity and careful monitoring for increasing bradycardia should be assured. **The higher incidence of accompanying chest injuries increases the possibility of mechanical ventilation amongst all child casualties regardless of age**.

Cardiovascular Management

Children suffer much more from the effects of bradycardia because of their normally much higher heart rate.[44] Subsequently, cardiac syncope is a frequent problem requiring careful monitoring of their condition. **Hypotension is also more pronounced because they have much less anti-gravity muscle bulk. They are also more susceptible to the effects of overinfusion**. Gross hyponatraemia as a result of excessive antidiuretic hormone production demands careful calculation and restriction of fluid intake. **Poikilothermia can also be problematic because a child's normal body temperature is around 37.5°C**.

Gastrointestinal Management

Abdominal distension caused by accompanying abdominal trauma or paralytic ileus can be deadly in children because their diaphragms are easily compromised. In the absence of complaints by the child of referred 'burning' shoulder pain, staff should be aware that **unsubstantiated distress or pain responses in a child may be indicative of an acute abdomen**.[44]

Genitourinary Management

Children also need to be catheterised in order to evaluate the effects of spinal shock on their renal function. Infant feeding tubes are a useful fine-bore substitute. **Urinary output during the acute stage should approximate 0.5 to 2ml/kg per hour**.[44]

Parental Needs

Never assume that parents are unable to cope with a severely traumatised child. Always be prepared to accredit them with prior life experiences. **It is important to pass on to SIU staff any observations regarding family dynamics during the time that the child was in the HDU/ICU**. Many parents feel that they are abdicating responsibility for their child's care to professional staff at a time when they feel a need to express their love for their child the most. Professionals can use this perceived need to involve parents in aspects of care-giving during the initial care stage.

▶Key point **SCI in children requires extra care and vigilance to avoid morbid complications.**

17

Spinal Cord Injury in Elderly People

Incidence and Occurrence

Approximately 20% of all spinal cord injuries occur in individuals over 65 years of age.[137] The frequency of SCI is at least equal to that of any other age group. Elderly people are much more vulnerable to cervical spinal injury and spinal cord compression because of the presence of age-related diseases such as osteoporosis and spondylosis.[5,138] In fact, the narrowing of the vertebral foramen as a result of the natural ageing processes means that it is not unusual for an elderly person to present with all the symptoms of a spinal cord lesion with no evidence of a fracture or soft-tissue trauma after a sudden neck movement.[139] This syndrome is defined as spinal cord injury without radiological evidence of trauma (SCIWORET).[55,56,137] The forces required for this are such that, in a younger person, they would not even produce symptoms of 'whiplash'.

Incomplete lesions, especially those of a central cord nature, predominate among this population. As with the general elderly population, there is a significantly larger proportion of female casualties within this age group.

Presentation and Diagnosis

The accurate taking and interpretation of radiographs in these situations are difficult at the best of times. The late onset of significant neurological deficiency is common amongst this age group. The opinion of an experienced radiologist should be secured as a matter of course in these cases before a decision to discontinue spinal injury precautions is made.[49,50]

Dementia, confusion and other conditions that affect communication, history taking and examination, as well as pre-existing neurological or locomotor deficits or disease may also frustrate an accurate diagnosis of new neurological trauma where the pre-injury status cannot be established. In such circumstances, it should be accepted that, where it is impossible to exclude the presence of an SCI at this time, a high degree of suspicion should be maintained until all observations, tests and examinations have been satisfactorily concluded.

Systems Management

With appropriate management, there is no evidence to suggest that elderly patients will have a significantly greater incidence of complications.[137] Their need for mechanical ventilation is consistent with the requirements and criteria outlined earlier. It should be anticipated that chronic obstructive pulmonary disease (COPD) is more prevalent amongst this population.

The elderly patient who has sustained spinal shock will be sensitive to salt and may easily become overinfused. Therefore, an infusion rate of not more than 100ml/hour should be set initially.[5] In cases of severe hypotension, a central venous pressure (CVP) line may be required as an additional method for monitoring the cardiovascular status.

The most important general consideration for this group of patients is that, on average, their body tissue provides less padding against the effects of pressure. This makes them more prone to pressure sores through immobilisation. Where immobilisation of an elderly casualty is required, the best attempt should be made to provide them with regular pressure relief, in accordance with their status.

▶Key point **Mechanisms and forces normally associated with minor injuries may result in SCI in elderly people.**

18 Transferring the Patient to a Spinal Injuries Unit

Guidelines of the British Association of Spinal Cord Injury Specialists for Transferring Patients to SIUs

Patients with spinal cord injuries (SCIs) are usually transferred from their receiving hospital to a specialised spinal injuries centre.[4,6,12,13] This transfer is usually undertaken within the first hours or first few days after injury. Patients can have some specific problems related to their spinal column or spinal cord injury. In addition, others may have sustained multiple injuries during their accident. Their fitness for transfer and the most suitable method of transfer should be discussed by the medical teams of the transferring hospital and the receiving spinal injuries centre.[140]

Transfer from DGH to SIU is usually undertaken by road at normal speed with an experienced paramedic crew. However, in some circumstances, helicopter transfer may be preferred and the transfer team may need to seek further advice from the SIU regarding any additional safeguards or risks associated with this form of transport.[141] In either case it is important that every effort is made to maintain spinal alignment during the journey. Careful monitoring of the neurological status and cardiorespiratory status should continue until the patient arrives at the receiving SIU.[140-142]A record of any observations made during the journey should be passed over or copied before the transfer team leave the SIU.

▶Key point

Patients with actual or suspected SCI whose ongoing care requires their transfer to an SIU for further management must be assured a safe and effective transfer. To facilitate this, the earliest contact should be established with the receiving unit to discuss, in advance, the patient's condition and support needs during transfer. It is essential that all medical, nursing and therapy notes, radiographs and test results are transferred with the patient. The staff member(s) travelling with the patient should be sufficiently familiar with the patient's condition and care so as to provide an accurate and informed handover on arrival.

- Spinal injury patients may be harmed by travelling over rough surfaces and going around corners fast. However, normal speeds on dual carriageways and motorways should cause no problems.
- SCI patients are prone to develop hypothermia and the ambulance should be kept warm and the patient well covered (but hot water bottles and electric blankets must not be used).
- It is dangerous for patients to vomit while being transferred on their backs, so their stomachs should be emptied either by fasting or by nasogastric tube before transfer.

- The expected total journey time should usually not exceed 2.5 hours. Road travel can be undertaken at normal speeds on good roads. Travel slowly around sharp corners, at roundabouts and over 'bumps', etc. If the journey is likely to exceed 2.5 hours, consider helicopter transfer. If it is anticipated that the transfer cannot be completed within 2.5 hours, consult the receiving SIU.
- Transfer, whether by road or by helicopter, should be undertaken in consultation with the receiving SIU. The receiving SIU should be informed of the time that the patient left the general hospital and the expected time of arrival at the SIU.
- **All relevant notes and radiographs must accompany the patient as either copies or originals.**
- **An experienced and informed member of staff, who is aware of the care the patient has received before transfer to the SIU, is also an essential requirement as an escort.**
- The patient should travel with appropriate support for the area of fracture/neurological damage, i.e. traction should still be *in situ*, a hard collar for cervical injuries and appropriate lumbar support for thoracolumbar injuries. A spinal board transfer is not necessarily required, but may be undertaken on the recommendation of the transferring physician after discussion with the SIU. Medical support in the event of respiratory difficulties should form part of the assessment criteria before transfer.
- Potential complications that may be encountered en route are respiratory difficulties, potential extension of lesion (dependent on time after injury) and autonomic dysreflexia (in which event equipment sufficient for the change of catheter or drainage of a full catheter bag may be included). However, this complication usually occurs only in patients with long-established spinal cord injuries. The patient may feel nauseous, or vomit, during transit, and feel subsequent distress if the level of pain control is inadequate.

▶Key point

The rapid transfer of people with acute SCI from a general hospital to a specialist facility has proven to be the most effective method of reducing the effect and incidence of complications associated with this condition.

19 Conclusion

As has been stated throughout this book, every spinal column injury has the potential to involve the spinal cord. The fact that the actual incidence nationally of SCI is so low may, in part, result from the fact that most A&E departments maintain an appropriate awareness of this condition. Unfortunately, there is currently still a potential for healthcare professionals working in acute care to miss, misdiagnose or mismanage an actual SCI. There is also the potential, as the patient passes through departments, for a secondary spinal cord lesion to occur.

The fact that people with actual, rather than potential, SCI present so rarely within HDU/ICU also supports the need for healthcare professionals working in or associated with critical care departments to maintain an up-to-date awareness of this condition in accordance with current and informed evidence-based recommendations for practice. In addition, appropriate and informed management of people with spinal cord injuries during the initial post-injury period is directly associated with a better rehabilitation potential.

As with any other area of healthcare, knowledge and practice associated with the management of people with actual or suspected SCI are continually developing. Such development demands that all those involved within the lifetime care process are given an opportunity to contribute. Hopefully, this book has aroused your interest; sufficient for you to review and discuss the current knowledge and provision of care for people with SCI within your own area of practice. Your comments in respect of this publication and its contents are welcomed and may be used to inform future editions.

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21 Appendix

Spinal Injuries Units in the UK and Eire

The Queen Elizabeth Spinal Injuries Unit
Southern General Hospital
1345 Govan Road
Glasgow G51 4TF
Tel: 0141 201 1100

The Northern Regional Spinal Injuries Centre (Rehabilitation/Re-admission Services)
Hexham General Hospital
Hexham NE46 1QJ
Tel: 01434 655655

The Northern Regional Spinal Injuries Centre (Acute Care Services)
South Cleveland Hospital
Middlesbrough TS4 3BW
Tel: 01642 850850

The Yorkshire Regional Spinal Injuries Unit
Pinderfields General Hospital
Wakefield WF1 4DG
Tel: 01924 201688

The Princess Royal Spinal Injuries Unit
Northern General Hospital
Herries Road
Sheffield S5 7AU
Tel: 0114 271 5609

The Regional Spinal Injuries Centre
Southport and Formby District Hospital
1 Town Lane
Southport PR8 6PN
Tel: 01704 547471

The Midlands Centre for Spinal Injuries
Robert Jones and Agnes Hunt Orthopaedic Hospital
Oswestry SY10 7AG
Tel: 01691 404645

The Rookwood Spinal Injuries Unit
Rookwood Hospital
Cardiff CF5 2YN
Tel: 02920 415415

The National Spinal Injuries Centre
Stoke Mandeville Hospital
Aylesbury HP21 8AL
Tel: 01296 315000

The London Spinal Injuries Unit
Royal National Orthopaedic Hospital
Stanmore HA7 4LP
Tel: 020 8954 2300

The Duke of Cornwall
Spinal Treatment Centre
Salisbury District General Hospital
Salisbury SP2 8BJ
Tel: 01722 336262

The Spinal Cord Injuries Unit
Musgrave Park Hospital
Stockman's Lane
Belfast BT9 7JB
Tel: 028 906 69501

The National Rehabilitation Hospital
Rocheston Avenue
Dunlaoghaire.
County Dublin. Eire
Tel: 003 531 2854777

For further information on Spinal Cord Injury contact:

Spinal Injuries Association
76 St James's Lane
London N10 3DF
Tel: 020 8444 2121
www.spinal.co.uk

22 Index

Abbreviations; SCI, spinal cord injury; SIU, spinal injuries unit.

The Patient's family

The family of a patient with spinal cord injury will probably want to know more about spinal injuries and more about the quality of life that can be expected following spinal cord injury.

The Spinal Injuries Association has a FREEPHONE Information line that can begin to answer these questions, staffed by people with day-to-day knowledge of the questions most likely to be asked.

Dial Freephone 0800 980 0501

SPINAL INJURIES ASSOCIATION

www.spinal.co.uk