West Yorkshire Major Trauma Network

West Yorkshire Major Trauma Operational Delivery Network (WYMTN)

Management of Spinal Injuries

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NHS

Introduction

This document provides clinical guidance on the management of adult and paediatric patients with spinal cord injury within the West Yorkshire Major Trauma Operational Delivery Network. It draws **heavily** on the 2012 document 'The initial management of Adults with Spinal Cord Injuries' (National Spinal Cord Injury Strategy Board) and the 2014 document 'The management of children with spinal cord injuries' approved by the Clinical Reference Group (CRG) in Spinal Cord Injury in June 2014.

Both documents are underpinned by the 2011 publication 'Management of people with spinal cord injury - NHS Clinical Advisory Groups Report'. All 3 documents are available on the WYMTN website.

The Spinal Cord Injury Strategy Board was replaced by the CRG in Spinal Cord Injury in 2013.

All material in this font is taken directly from the documents listed above. All modifications are in *italics*. Figures are locally developed unless indicated otherwise.

Text in this colour is from the paediatric document.

Background

Few disabilities produce the devastation of a spinal cord injury. The effects extend beyond the individual patient and include the impact on the immediate family and society in general. The financial cost is considerable. It is estimated that the annual incidence of traumatic spinal cord injury is 15 per million in the UK. Approximately half of these are cervical injuries, and the majority now have incomplete injuries, with significant potential for neurological improvement.

People who sustain a spinal cord injury require specialised care and rehabilitation. The initial management of a patient with a suspected spinal cord injury can have major implications for the patient's long-term management. Patients with spinal cord injuries (SCI) are extremely vulnerable to avoidable complications, particularly pressure ulcers, urinary tract complications, autonomic problems and joint stiffness / contractures. The avoidance of these complications requires a high level of input from a dedicated multidisciplinary team. The average delay from injury to admission to a Spinal Cord Injuries Centre (SCI Centre) was 46 days in 2008. 41 % of all SCI patients were not admitted within one month, and 21 % were not even referred to the specialised SCI Centre within one month. 24 % of acute injuries had complications on admission to the SCI Centre, 40 % of which were pressure ulcers. Pressure ulcers led to delays in rehabilitation of up to 12 weeks on admission to the SCI Centre, negating any benefit of spinal stabilisation.

This is particularly important for children with SCI who have a specific and unique set of problems that are directly related to the immaturity of body systems and the nature of ongoing and ever-changing physical growth and development. They are extremely vulnerable to avoidable complications, particularly musculoskeletal deformity, pressure

ulcers, urinary tract complications and autonomic problems. The avoidance of these complications requires a high level of input from a dedicated multi-disciplinary team.

A review of published articles about SCI in children reveals that an injury to the child less than 5 years of age is rare. Although the exact frequency is unknown, it represents <4% of the overall incidence of SCI annually (National Spinal Cord Injury Statistical Centre, 2004)

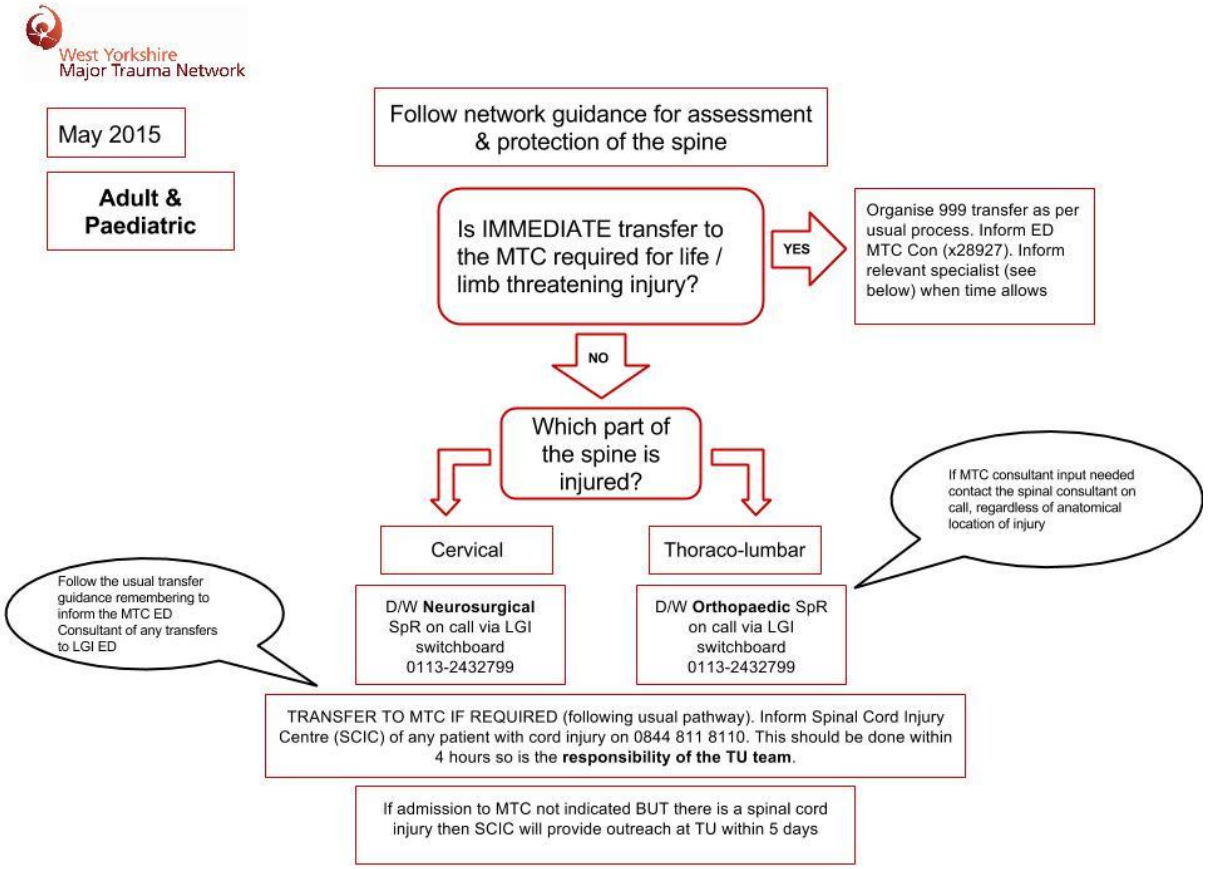
For the young child, the large size of a young child's head and the immaturity of the spinal structures more often result in cervical injuries in those under 9 years of age who are more likely to show neurological recovery.

Children with traumatic SCI have different mechanisms of injury and have a better neurological recovery potential when compared to adults. Traumatic SCI should be highly suspected in the presence of abnormal neck or neurological examination, a high-risk mechanism of injury or a distracting injury even in the absence of radiological anomaly (SCIWORA).

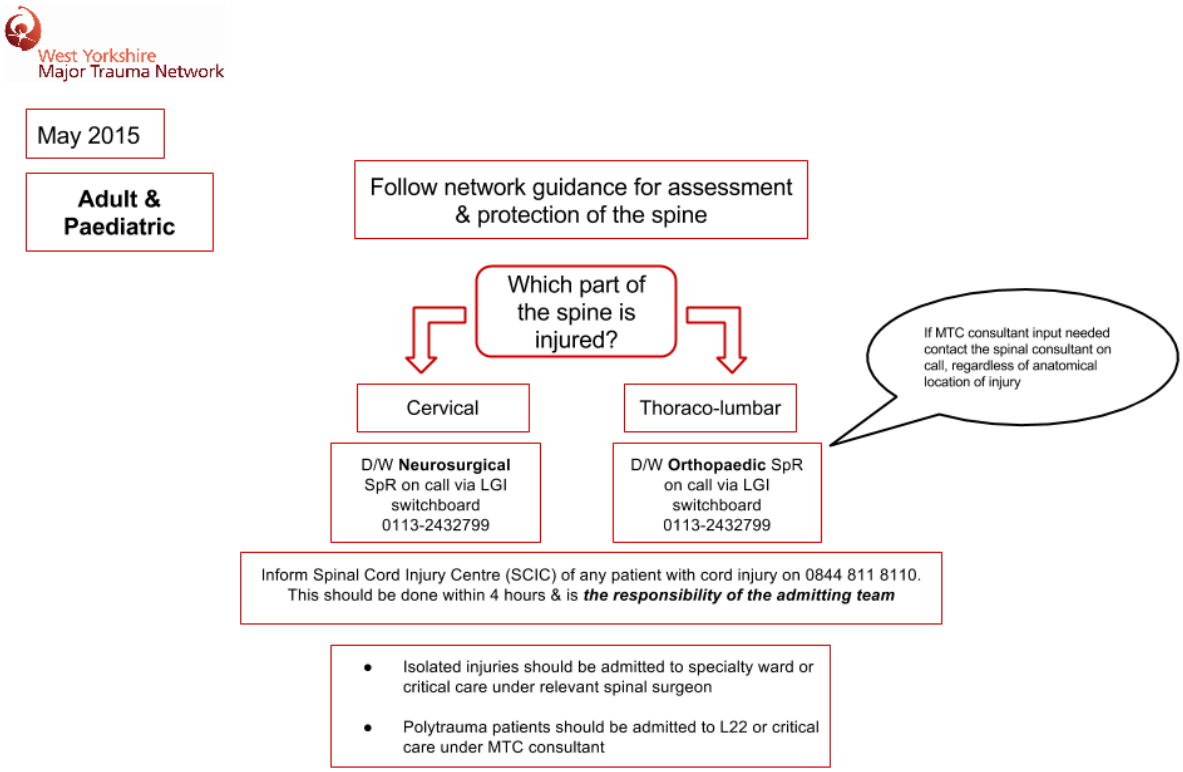
WYMTN Pathways for the initial management of patients with spinal injuries

All pre-hospital triage decisions should follow the agreed triage pathway. All patients with spinal injury suspected by abnormal neurology meet the criteria for bypass to the Major Trauma Centre at the LGI.

If a patient with a spinal injury is at a trauma unit the following pathway should be followed:



For MTC patients the following pathway should be followed:



Informing the Spinal Cord Injury Centre (SCIC)

The SCIC team should be informed within 4 hours of identification of an injury. At the time of initial contact they will require only basic demographics, a brief injury description and where the patient will be being admitted. Ring 0844 811 8110 (Mid Yorks Hospital) and ask for the consultant on call for spinal injuries.

Patient Assessment

Think Spinal Injury

Following an injury the potential for a spinal cord injury to exist must be considered. People may present with full movement and sensation of all four limbs; however, they may have a vertebral fracture and, if handled incorrectly, the spinal cord may be damaged and the results could be devastating.

Of 569 patients admitted to a Spinal Cord Injuries Centre, 52 injuries (9%) were missed at presentation and of these 26 had experienced further avoidable deterioration. Only 5 of these missed injuries were at C1/2 or the cervico-thoracic junction. One-third of patients with missed injuries had a significant head injury, 13 required early ventilation, 9 were intoxicated and 7 were though to be hysterical. X-rays were of poor quality in 18, failed to demonstrate the whole region in 11, 4 were of an uninjured region, there were 10 with

unrecognised soft tissue swelling and 6 had no vertebral injury 4.

In general, spinal injuries should be suspected in all casualties who have been involved in:-
(1) A road traffic accident
(2) A fall or jump from a height
(3) An accident resulting in impact or crush injuries
(4) An accident resulting in multiple trauma
(5) An accident resulting in the patient losing consciousness

And if

(6) Following injury, the patient complains of back or neck pain and appears to be guarding their back or neck
(7) The patient complains of any sensory changes or loss such as numbness or tingling
(8) The patient is unable to pass urine
(9) There is pre-existing pathology such as ankylosing spondylitis

Initial assessment under ATLS protocols is essential. Airway, breathing & circulation are the priority, with protection of any potential unstable fracture. The secondary survey is of even greater importance in a patient with impaired sensation.

Spinal Shock

At the acute stage there is total, flaccid paralysis of all skeletal muscle and loss of all spinal reflexes below the level of the lesion. This is referred to as spinal shock. It may last from several hours to several weeks depending on the severity.

Airway and Cervical Spine Control

As soon as it is feasible the patient should be placed into the neutral supine position. Remember that in ankylosing spondylitis this may be in a flexed position. For younger children the body should be elevated in order to allow the neck to remain in neutral as the larger head will otherwise cause flexion. If the patient is wearing a helmet, two people are needed for its removal. The helmet is held by the first rescuer who maintains the neck in the neutral position to the rest of the body. The second rescuer undoes the chin strap then places one hand behind the neck and the other hand is placed around the jaw to support and maintain alignment. The first rescuer then uses lateral force to spread the helmet and gently removes it.

In any injury the airway can become compromised. With a suspected spinal cord injury the patient cannot be placed in the normal first aid recovery position which does not maintain cervical alignment. The spine should be kept in alignment at all times.

Observation

- Look for evidence of breathing difficulties, obstruction or aspiration
- Listen for noisy breathing, stridor or gurgling – evidence of airway compromise

• Feel for air exchange, deformity or foreign bodies in the mouth or throat

Action
• Clear airway of any obstruction
• Remove any foreign bodies from the mouth or throat
• Oral suctioning may be necessary
• To protect a threatened airway do not hyperextend the neck; use instead the chin lift technique
• Minimise movement of the cervical spine
• Remember opiate analgesics may cause nausea with the risk of aspiration
• Consider naso-pharyngeal or oro-pharyngeal airway
• Anaesthetic consultation may be appropriate.
• Use appropriate intubation techniques with immobilisation of the spine

• NB In cervical or high thoracic injuries, during intubation severe bradycardia can occur, leading to cardiac arrest. To minimise this risk consider: pre-oxygenation, hyperventilation with ambubag, use of topical anaesthetic spray. Administration of Atropine 0.5mg (20 microgram/kg (minimum 100 mcg, maximum 600 mcg), repeat after 5 minutes if required, with maximum 1mg in a child or 2 mg in adolescent (dosing from APLS 4th edition) may be required.

Breathing, Ventilation and Weaning

In cervical and high thoracic injuries the nerves to the intercostals are paralysed, reducing the ability to breathe effectively. In high cervical lesions the diaphragms may also be affected (C3,4,5). In these high lesions the most affected function is coughing. Patients with very high lesions are breathing with the diaphragm only and have no effective cough at all. The risk of deteriorating respiratory function is extremely high due to:-

- Fatigue of innervated muscles
- Chest trauma
- Relative bronchoconstriction and high volume secretions due to unopposed parasympathetic activity in individuals with tetraplegia
- Retained secretions
- Developing V/Q mismatches from immobility
- Abdominal distension splinting diaphragm (see paralytic ileus, p. 14)
- Effects of opiate analgesics
- Ascension of the spinal lesion

Observation
Look for:-
- Presence, rate & depth of respirations, shallow or abdominal breathing
- Asymmetry of the chest
- Paradoxical breathing in cervical injuries
- The development of respiratory fatigue, i.e. shallow grunting breathing, dropping in

SaO2 despite O2 supplements
- Initial and serial measurements of vital capacity – a gradual drop in vital capacity is a sign of respiratory deterioration
- Signs of aspiration or consolidation

Action
- Continuously monitor oxygen saturation levels and check respiratory rate regularly
- Maintain Sa02 at 95% or above
- If longer term 02 is required, it should be humidified
- Monitor blood gases regularly
- Monitor the vital capacity
- Regular turning to optimise V/Q match (two hourly, mechanical bed may be utilised)
- Early, regular and frequent physiotherapy is the mainstay of treatment, including assisted cough techniques and incentive spirometry
- Chest x-ray as indicated
- Elective ventilation may be needed
- Tracheal suctioning may be needed

Circulation

Neurogenic (spinal) shock is the body's response to the sudden loss of sympathetic control. It occurs in cervical and high thoracic lesions (above T6). Incomplete injuries may not display these signs. Due to lack of vasomotor control significant hypotension results. Bradycardia occurs as a result of unopposed effects of the vagus nerve. A systolic blood pressure of 90 may be normal in these patients. Monitoring of fluid balance in patients with spinal cord injury is essential. Remember, however, that hypovolaemic shock may be present and other injuries may escape detection in the cord injured patient with sensory deprivation. In the acute phase, if other significant injuries are present, a CVP line may be of assistance.

Observation
- Hypotension
- Note: Hospital Early Warning Scores will need values adjusted for patients with a lesion above T6

Action
- Nurse patient supine
- Monitor BP
- Maintain a systolic BP of 90-l00mmHg and a urinary output of 30mls or above per hour (0.5ml/kg/hour for children).
- Administer IV fluids
    - NB Do not over-infuse. This may precipitate cardiac failure and pulmonary oedema.
- In rare instances Inotropes may be necessary to maintain a stable BP.

- A CVP line may be indicated

Observation

- Bradycardia

Action

- ECG monitoring
- Extreme bradycardia can result in cardiac syncope. If heart rate drops below, and remains below, 40 beats per minute Atropine 0.5mg may be given as IV bolus if the patient is cardio-vascularly unwell or unstable.
    - NB An abnormal vaso-vagal response can occur through stimulation such as rapid changes in body positioning, i.e. log rolling too quickly, tracheal suctioning, passing an N.G. tube etc.
    - In patients with tracheostomy, during suctioning, stimulation of vagal afferents can result in a marked vagal response, bradycardia and consequent hypoxia. Bagging with 100% O2 pre and post tracheal suction is a useful manoeuvre to minimise these effects
    - Problematic bradycardia usually resolves over a few days. Pacemakers can cause management complications in the long term (e.g. MRI scanning, electrical stimulation treatments) and should be avoided where possible
- There is a high incidence of cardiac contusion in patients with thoracic injuries with a potential for arrhythmias.

Neurological Assessment

Careful neurological assessment is absolutely essential for patient with spinal cord injury. This is very difficult to perform in young children below the age of 4 and in any child when frightened and distressed. In the first hours and days following injury the neurological level may change. An extension of the lesion by one or even two levels may be observed and it is critical that any change is monitored, to prevent any avoidable deterioration of neurological deficit. In adults neurological observations should be performed at two hourly intervals *but* this is not feasible in young children. *In children*, concentrating on a few key points may give better results in combination with attempting to establish level with MRI scan.

At the site of cord injury there will be a zone of critical ischaemia. This zone may expand with poor oxygen saturation or poor perfusion. Patients with high lesions have poor autonomic vascular control and postural hypotension may be severe and significant. In the acute phase of the injury such postural hypotension may expand the zone of critical ischaemia. Patients with acute spinal cord injury must be nursed flat.

Neurological examination should be undertaken by an experienced member of the medical team using the standardized examination recording chart published by the American Spinal Injuries Association (ASIA Chart, appendix 1). Performing this can be tedious for the patient and it is better to make one good assessment. The acutely injured patient often finds it easier to report alteration of pin prick than alteration of light touch. Sharp pin prick

also has a high prognostic significance. Test pin prick on the anterior surface of the body and the perineum. Mark the sensory level on the patient as this is very useful in subsequent review. A change from an accurately recorded level may allow diagnosis of potential complications, e.g., epidural haematoma, over distraction when using skull traction.

In the period of spinal shock formal classification of the injury is not possible.
Sacral segments have great prognostic significance for future bowel and bladder management. Careful examination of perianal sensation, deep anal pressure, tone, and voluntary anal contraction is essential *in adults* but not usually possible in younger children and has to be considered for each child as the information may be extremely unreliable. If not performed the reason for this should be documented for each individual.

Spinal surgery may be contemplated. If spinal surgery is undertaken the ASIA Chart must be carefully completed both prior to surgery and post-operatively. Remember this is, however, less reliable in the presence of spinal shock.

Steroid Therapy

A paper from the Midlands Centre for Spinal Cord Injuries has carefully reviewed all the evidence concerning the administration of high dose steroids in acute spinal cord injuries.

Some methodological weakness in the post-hoc analysis of the NASCIS II data were highlighted, including the fact that the biggest difference in outcome actually occurred between the two placebo groups (before 8 hours and after 8 hours).

The question of administration of high dose steroids has been debated by the British Association of Spinal Cord Injuries Specialists who concluded that **their use in the management of acute spinal cord injury is not indicated**.

There have been no clinical trials in children and no evidence that high dose steroids have any place in the management of acute traumatic spinal injured children.

Handling the Patient With a Spinal Cord Injury

Patients are frequently transferred into Emergency departments on a spinal board. Transfer onto an appropriate trolley MUST be undertaken at the earliest possible opportunity.

Ensure sufficient personnel are available for continued maintenance of spinal alignment.

Ensure all head huggers and straps are removed before transfer.

To ensure that total protection and alignment of the spine is maintained, to allow the patient to be moved, there are two techniques which can be applied.

1. Logroll
2. Multi Hand Lift

Log rolling is the method normally employed in the acute phase of the spinal cord injury management when the spine has not been stabilised. This requires sufficient *staff* to control the head, shoulder girdle, pelvis and legs. *A senior member of staff* should control the head and give the directions. The neck may be immobilised with a collar and blocks. *In children* in order to keep the head in neutral the body may need to be raised to stop flexion of the head.

In adults skull traction is preferred as it will allow side-to-side tilting more easily. Skull traction in children must be reviewed on an individual case as in young children the majority of injuries are unstable in traction as most are disco-ligamentous injuries with separation of endplate from the vertebral body.

Patients with acute spinal cord injury must be nursed flat initially. Elevation of the whole body up to 15 degrees may assist ventilation. Pressure reducing dynamic air mattresses are contraindicated in unstable injuries and turning regime should be initiated to prevent pressure ulceration. The proportionally larger size of the head in young children must be accounted for and the when the child id lying supine the body may have to be supported higher to prevent ongoing flexion deformity of the neck.

Imaging

Multiple fractures occur in 5% of cases.

In the presence of a spinal cord injury good quality *imaging* of the whole spine *is* essential. In obtunded consciousness CT of the whole cervical spine (to T4) is mandated. Local protocols should be followed in major trauma. Soft tissue swelling must not be overlooked. CT of identified fractures is required.

An MRI scan will help with prognosis, and can identify prolapsed disc, haematoma and other soft tissue lesions. Access to the patient is poor in the scanner and careful assessment of clinical condition particularly breathing is essential.

In children with spinal cord injury imaging of the whole spine is essential usually with MRI of the whole spine particularly in the young child. Areas of concern may then require localised CT. In reduced consciousness, CT of the whole cervical spine (to T4) is mandated. Young children may present without obvious bony injury of vertebrae; SCIWORA (SCI without radiological abnormality, though significant damage may be seen on MRI). A high index of suspicion is needed re disco-ligamentous injuries. A paediatric musculoskeletal radiologist is required for interpreting these scans.

Younger children will require sedation or anaesthesia for imaging.

Deep Venous Thrombosis

Patients with acute spinal cord injury are at very high risk of deep venous thrombosis. Prophylaxis is mandatory with LMWH which should start by day 3 post injury unless the patient has other injuries that make it contraindicated. LMWH should be omitted prior to spinal surgery. Younger children are at lower risk. There is no evidence or consensus on the age medical prophylaxis should be used.

Skin

The risk of developing pressure ulcers following spinal cord injury is extremely high 2,10 due to:-

- Lack of sensation – the patient is unaware that there may be a problem
- Lack of muscle activity below the level of injury
- Circulation sluggish – reducing amount of oxygen to the skin

A pressure ulcer, taking an hour or so to develop, may delay the patient's treatment by weeks and produce a permanently vulnerable scar. A pressure ulcer is a sign of neglect. The patient must be turned regularly, initially every 2 hours. Regular and routine turning not only relieves pressure but also moves static fluid within the paralysed body therefore reducing the risk of other systemic complications such as pneumonia, UTI, VTE and gastric ulceration. Thirty degrees side to side with appropriate pillow supports is sufficient.

Dynamic mattresses and other pressure relieving devices are often insufficient for the prevention of skin problems in this vulnerable population and are contra-indicated if the spinal column is unstable. A dynamic mattress is ineffective in the prevention of heel sores and the heels should be supported clear of the bed with pillows. Thermal contouring mattresses are also unable to protect the heels of SCI patients as the paralysed leg will not generate sufficient heat to convert the underlying foam to its gel form.

In children, many pressure ulcers occur due to pressure from equipment such as braces and splints as well as toys which get lost or forgotten in the bed or on the chair cushion.

It is absolutely contra-indicated to allow a patient to sit or lie on a pressure ulcer.
The liaison staff from the linked Specialised Spinal Cord Injuries Centre would be pleased to visit any ward to provide advice and demonstrations of correct skin care.

Observation

- Check all pressure areas for signs of skin breakdown
- Red Marks are significant and must be protected from pressure

Action

- Heels vulnerable when lying supine. Heels should be supported clear of the bed with pillows. Dynamic and thermal contouring mattresses are inadequate for prevention of heel sores
- Subsequent pressure relief must be carried out 2-hourly.
- Side-to-side turning of minimum 30°

Paralytic Ileus

Paralytic ileus is common in spinal shock. There is a risk of vomiting/aspiration. Ileus usually occurs immediately in thoraco-lumbar injuries but can be delayed for anything up to 48 hours in cervical injuries. Abdominal distension may impede breathing by splinting the diaphragms. Gastric dilatation may occur even if bowel sounds are present.

Observation

- Listen to abdomen for presence of bowel sounds
- Observe for abdominal distension

Action

- Nil-by-mouth
- Pass naso-gastric tube – free drainage (beware possible bradycardia)
- If abdomen is distending due to the build-up of gas, undertake digital rectal examination and decompression to avoid over-distension of the bowel.
- Re-commence nutrition when ileus resolves

Stress Ulceration

Stress ulceration and gastric haemorrhage is common in acute spinal cord injury. Prophylactic use of Proton Pump Inhibitors or Ranitidine or other similar preparation is indicated. Continue use of gastric protection initially upon commencement of feeding until prophylactic anticoagulation is completed, usually 12 weeks post injury.

Bladder

The bladder is flaccid during spinal shock and therefore it is important to avoid over-distension as this can have an adverse effect on the patient's longer term management. Over-distension damages the myo-neurenteric plexus in the bladder wall and this damage can be permanent. All patients should be managed with a urethral catheter on free drainage initially. Urinary output should be monitored hourly until the patient is stable. If there is a prolonged delay before admission to the Specialised Spinal Cord Injuries Centre can be arranged, further advice on bladder management may be obtained from the Centre as the patient may require anticholinergic medication and procedures to prevent further

secondary complication. In the acute situation urethral catheterisation should not be attempted in the presence of priapism. Under these circumstances suprapubic catheterisation should be considered in the Emergency Department but requires strict asepsis and should only be performed by suitably trained individuals.

Bowel

The spinal cord injury may create two types of problems with bowel control, usually depending on the level of damage to the spinal cord.

- Upper Motor Neurone Damage (Thoracic Level 12 and above) (spastic/reflexic bowel). Reflex activity is maintained, the bowel will contract and empty when stimulated. Anal sphincter tone is maintained.
- Lower Motor Neurone Damage (Usually Lumbar Level 1 or below) (flaccid/areflexic bowel). Although peristalsis will return, these movements are quite ineffective without the support of the spinal reflex. Faecal retention and overflow of faecal fluid may occur and the anal sphincter will be flaccid.

Action

- Daily insertion of glycerine suppositories 15 – 30 minutes prior to rectal examination and evacuation if the rectum is full.
- In young children if the bowel is emptying spontaneously, even if not predictably, using suppositories or digital evacuation is not necessary.
- When bowel sounds return, passage of flatus occurs or bowels move then aperients may be started:
    - Senna Tablets 7.5mg or Syrup 7.5mg in 5mls (usually I5 mgs on alternate evenings) and
    - Docusate 100-200 mg b.d.
    - If the above regime is not successful consider: Movicol 1 sachet b.d. & Bisacodyl Tablets 10mg (alternate nights)

Upper motor neurone (reflex) bowel

- Continue rectal examination and digital evacuation daily
- Commence suppositories on mornings after aperient
- Anal digital stimulation to trigger reflex and ensure rectal emptying. CHECK digitally that emptying is complete

Lower motor neurone (flaccid) bowel

- Continue daily rectal examination
- Digital removal of faeces is essential in these patients
    - The recent guidance from the National Patient Safety Agency mandates all NHS trusts to develop a policy on digital removal of faeces. It states that failure to meet this aspect of care is neglectful and in breach of the Nursing and Midwifery Council Code of Conduct 11,12.
    - Do not use the Flexi-seal system for managing 'diarrhoea' except in the case of actual c.difficile. Its prolonged use in neurogenic bowel conditions is contraindicated by the manufacturer and can severely affect sphincter

competence and reflex activity. Most 'diarrhoea' in SCI is usually the result of impaction with overflow or overstimulation of the gut with aperients or high-fibre feeds.

Joint Mobility

After the initial period of spinal shock, patients can develop spasticity to a larger or lesser extent. This can quite rapidly result in joint contracture. Such joint contractures can be very disabling if they prevent proper seating in a wheelchair or if a later partial neurological recovery occurs but the joints involved are too stiff to allow use to be made of the returned muscle power.

Passive movement and positioning is very important. Patients will require daily input from the physiotherapy and occupational therapy teams. The shoulders are particularly affected in cervical lesions. The development of frozen shoulder is almost universal and can be prevented by correct passive mobilisation techniques and positioning which must start from the day of admission. Abduction, flexion and external rotation are particularly prone to limitation of movement. Shoulder pain is often a feature of cervical cord injury and can be reduced by appropriate stretching and mobilisation techniques.

The elbows have obvious tendency to fixed flexion deformity and stretching is required.

In the hand flexion deformity of the interphalangeal joints can occur and requires regular passive stretching. On occasion reflex sympathetic dystrophy is seen and this is best addressed early with passive stretching.

In the lower limbs flexion contracture and adduction with internal rotation of the hip can occur. When respiratory function is satisfactory, periods of prone lying can assist.

Fixed flexion deformity of the knee is also seen but equinus deformity of the ankle is very common and requires early and regular stretching, and "blocking" with pillows.

Foot drop splints are associated with pressure ulcers.

Passive stretching can, and should, be undertaken by all health care professionals involved with the patient. Nursing staff have a significant role to play in positioning of the arms and shoulders and can also undertake some passive stretching exercises, which should be an integral part of turning regimes, and whilst undertaking other routine nursing care.

Spinal Surgery

Spinal surgery comprises two components; decompression of the neural tissues and

reduction and stabilisation of the spine. Conservative management is also appropriate in some injuries and should also be considered if the requisite skills are available.

The role of decompression in the management of patients with spinal cord injury has yet to be fully determined. There is no conclusive evidence that decompression of the injured spinal cord improves either the rate or completeness of any neurological recovery.

Most incomplete lesions demonstrate significant improvement with time whether treated operatively or conservatively. Preliminary results of the Surgical Treatment of Spinal Cord Injury Study (STASCIS) showed 24% of patients who received decompressive surgery within 24 hours of their injury experienced a 2-grade or greater improvement on the American Spinal Injury Association (ASIA) scale, compared with 4% of those in the delayed-treatment group.

A systematic review and a meta-analysis indicate that surgery at less than 24 hours is safe, that urgent reduction (4 hours) is mandated in bifacetal dislocation (e.g. rugby injuries) and that many surgeons believe that early (<24 hours) decompression is an option for the patient with an incomplete injury.

The evacuation of a compressive haematoma or large central disc prolapse requires urgent management. If traction is used for stabilisation or the reduction of dislocation regular neurological assessment is vital as the injured cord is particularly vulnerable to distraction. In young children traction should be initiated with minimal weight and ideally with immediate imaging available to avoid over-distraction.

Patients with acute spinal cord injury are autonomically dysfunctional and surgery does carry a risk of neurological deterioration if oxygenation and blood pressure are not precisely controlled or if post operative oedema and swelling creates any further anoxic insult to the injured tissues. This is of particular importance in the cervical spine where the difference between a C5 lesion and a C6 lesion is very substantial in terms of independent living.

Benefits of stabilisation surgery are the protection of the neural tissues, reduction of pain, easier patient handling, earlier mobilisation within physiological restrictions, reduction of respiratory complications and reduction in late deformity with better posture and balance.

There is evidence to suggest that unreduced fracture dislocations or gross kyphotic deformities may be associated with an increased incidence of post traumatic syringomyelia. Meta analysis of stabilisation indicates that it reduces complications, length of stay and hospital costs. Other than the potential for neurological deterioration complications of surgery include infection, poor wound healing, and the complications of mis-placed or inadequate instrumentation. As most of the achievable objectives of spinal surgery are those of stabilisation then the aim of surgery should be to provide sufficient stabilisation to allow a patient to mobilise without external support. There is little value, for example, in cervical spine surgery that still requires the use of a halo vest. Spinal stabilisation techniques employed need to result in the optimum short-term and long-term outcomes and independence for SCI patients. These may differ from those employed in vertebral column

fracture without spinal cord injury. These patients represent the most vulnerable patients and only experienced spinal surgeons should undertake stabilisation surgery. The appearance of avoidable general complications such as pressure ulcers will negate any benefits of spinal stabilisation. It is preferable, if facilities exist, that spinal stabilisation in these patients should be undertaken from a bed in a spinal cord injuries centre.

Anaesthesia

Anaesthesia in this group of patients is extremely demanding. Autonomic dysfunction produces significant lability of blood pressure and it is preferable that an anaesthetist experienced in the management of spinal cord injured patients should undertake anaesthesia. The treatment of correct fluid balance is difficult and CVP measurements are indicated. Care should be taken when turning the patient from prone to supine (e.g. when coming off the table) as the external pressure on the capacitance vessels is removed and these vessels may have no tone. This can result in a sudden catastrophic fall in the venous return to the heart.

Mobilisation

In patients with spinal cord injury the most important consideration is the provision of optimal conditions for neurological improvement and the prevention of further deterioration. Any spinal cord injury will have an area of cord tissue at critical levels of ischaemia which surrounds an area of necrosis. Any factor increasing this ischaemia has the potential to cause a deterioration of neurological function and, on occasion, this can be permanent.

Patients with high lesions (above T6) will have very significant postural hypotension and this can exacerbate poor perfusion in the critical zone. Mobilisation requires a graduated and carefully monitored approach. Simply allowing a patient with an acute cord injury to sit without such a programme is unacceptable.

Mobilisation should initially be undertaken using a tilt table, TEDS and abdominal binder in the presence of an appropriately qualified practitioner. Medication with ephedrine or midodrine may be necessary. During gradual tilting, measurements of blood pressure are required together with monitoring of neurological function particularly at the levels adjacent to the injury itself. Significant hypotension or appearance of increasing deficit indicates return to the recumbent position. The definition of hypotension depends on the age and size of the child and their resting blood pressure.

Patients vary significantly in the degree of postural hypotension and in any influence on neurological function. In some cases it can be some weeks before elevation to vertical sitting position may be safely achieved.

Autonomic Dysreflexia

Patients with a lesion at or above T6 are prone to autonomic hyper-reflexia (dysreflexia). Common precipitants include blocked catheters or rectal examination, instrumentation and operation – thus a general anaesthetic is still necessary for spinal patients even if they have no apparent sensation. A stimulus causes reflex sympathetic over-activity below level of cord lesion, leading to vasoconstriction and systemic hypertension. The hypertension stimulates the carotid and aortic baroreceptors leading to increased vagal tone and bradycardia. Peripheral vasodilatation, which would normally relieve the hypertension, cannot occur because of the injured cord. Blood Pressure continues to rise until cause removed.

Danger – can result in intracranial haemorrhage

General causes:

- Bladder distension
- Bowel distension
- Pressure ulcers
- Ingrown toenails
- Childbirth
- Fissure in ano

Symptoms:

- Pounding headache/fullness in head
- Profuse sweating
- Tightness in chest
- Anxiety. A very young child may express pain or anxiety through irritability or lethargy

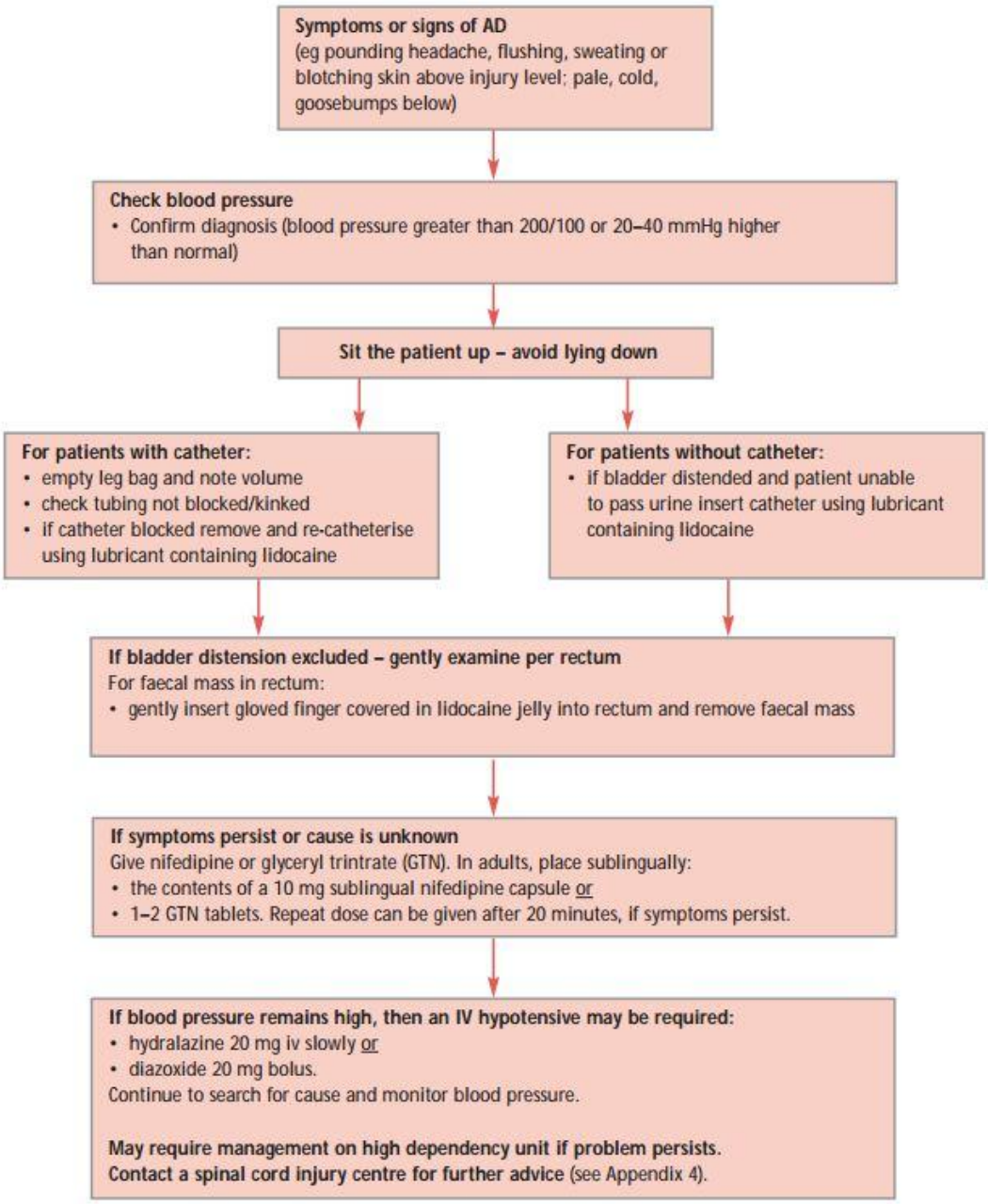
Signs:

- Hypertension and bradycardia. (Occasionally cardiac dysrhythmia)
- In children BP elevation more than 15mmHg more than the child's baseline (this is less for younger children and should not be used as absolute measure).
    - Above lesion
        - Pallor initially, then flushing and/or blotching
        - Sweating in area above and around the lesion
        - Pupillary dilatation
    - Below lesion
        - Cold peripheries
        - Pilo erection
        - Contraction of bladder and large bowel
        - Penile erection and seminal fluid emission

Treatment (see fig 1):

1. Take heart rate / BP
2. Tilt bed head up
3. Loosen clothing
4. Remove cause - unkink catheter, check for blockage, catheterise if no catheter in situ
5. For 13 yrs and under
    a. BP>15-30mmHg above baseline perform bladder management step
    b. BP>30mmHg above baseline, consider medication and perform bladder management
6. For over 13 years
    a. BP>20 mmHg above baseline to 150, perform bladder management
    b. BP>170 mmHg consider medication and perform bladder management
7. Adults: Sublingual Nifedipine 10 mg bitten or GTN sublingual
    a. Paediatrc: Sublingual Nifedipine 0.25-0.5mg/Kg dose every 4-6 hours
8. DO NOT USE ASPIRIN OR NSAID for analgesia afterwards.

Fig 1. Management of patients with autonomic dysreflexia (AD).



Reproduced from: Royal College of Physicians, British Society of Rehabilitation Medicine, Multidisciplinary Association of Spinal Cord Injury Professionals, British Association of Spinal Cord Injury Specialists, Spinal Injuries Association. *Chronic spinal cord injury: management of patients in acute hospital settings: national guidelines. Concise guidance to Good Practice series, No 9.* London: RCP, 2008.

Patient Advice and Adjustment

Experiencing a spinal cord injury is very frightening for the patient and their families, and, as patients are usually full cognitively aware and maintain capacity, frequently produces extreme emotional reactions. Understanding this, and ensuring the provision of meaningful emotional support is important. What the patient most wants is certainty, but of course this can rarely be immediately provided. Spinal shock in the first days will make neurological assessment difficult and many practitioners in the acute setting will have little or no experience of the long-term outlook following modern spinal cord injury rehabilitation.

Although certainty over the neurological prognosis is not possible, the provision of a definite plan of treatment to the patient is of enormous benefit, allowing them to have better understanding and a feeling of control.

Early discussion with the linked spinal cord injury centre will provide information on the proposed treatment after transfer, and will also provide advice on patterns of recovery in generic terms. Make full use of psychological & psychiatric support services (& play specialists for children).

Information in support of the care for those people identified with pre-existing psychiatric conditions can usually be obtained through local liaison psychiatry teams and the patient's General Practitioner.

Pre-existing cord injury

Patients with existing spinal cord deficits may present with subsequent injuries, acute illness or for elective surgical procedures. The management of the cord deficit will need to continue. These patients remain extremely vulnerable and strict attention to management of skin, bladder and bowel is essential. These are "expert patients" in the true sense of the word and will be very knowledgeable on the management of their condition. All staff should listen to these patients when they give advice on their own management. The SCI Centre which routinely follows up the patient should be contacted . Where this is not possible, the linked SCI Centre will be pleased to offer advice and will be able to arrange a visit from an outreach worker.

Valuable Guidance is available in the publication by the Royal College of Physicians 19. In brief, specific areas to consider are:

- Medication - established spinal cord injured patients frequently are on significant numbers of medications including aperients, anti-spasmodics, bladder agents, pain management drugs etc. In some of these, for example Baclofen and Gabapentin, sudden cessation can lead to dangerous side effects. Interference with normal established bowel regime and associated digital and pharmaceutical prescriptions can give rise to major problems with bowel management.

- Intrathecal Baclofen Pumps, anterior root stimulators and other intra-canal devices. Care will need to be taken when considering MRI scanning and during surgery, when Baclofen pumps should be switched off.
- Patients with lesions above T6 will be at risk of autonomic dysreflexia
- Pressure ulcers are the most frequent and the most disabling of all the avoidable complications. Regular turning is essential at all times. It is never acceptable to allow the patient to rest weight on a pressure ulcer.
- When using plaster cast immobilisation for fractures in insensiate limbs, there is a high risk of skin break-down. Any external splintage must be extremely well padded and removable. The skin must be inspected daily.
- The skeleton in the paralysed area will be grossly osteoporotic and this should inform any plans for internal or external fixation in orthopaedic management.
- Spasm may be a major obstacle and management may need to be addressed. This may be done on a local basis for example with Botox or by manipulation of systemic anti-spasmodics.

Pre-operative action plan.

- Bladder and bowel care. Distension must be prevented to avoid autonomic Dysreflexia
- Ensure free urinary drainage by catheterisation if necessary.
- Check bowel programme and confirm empty rectum prior to theatre.
- Respiratory care. Measure vital capacity and blood gases.
- Thermoregulation is impaired: monitor rectal temperature.
- Avoid over-transfusion

Transfer to the Spinal Centre

Decisions to transfer and planning for it should take place between senior staff in the transferring and receiving units. Travel time should be estimated; battery reserve of monitors and infusion pumps and capacity of oxygen cylinders driving pneumatic ventilators should be calculated and skin care be planned for the duration of the journey.

A properly immobilised spinal injured patient can be transferred at normal road speeds. Sudden acceleration and deceleration should be avoided.

Accompanying Personnel

As a minimum, an experienced nurse and doctor, preferably an anaesthetist for cervical patients, should escort the patient. A paramedic crew will be required.

Transfer Checklist

- Ensure patient is fit for Transfer (mechanical and physiological stabilisation)
- Immobilisation of the spine is adequate and secure
- Long bone fracture immobilisation

- Airway is clear and can be maintained during transfer (intubate if PaCO2 is >5.5 KPa or if respiratory failure is likely to develop during a prolonged transfer)
- Supplemental oxygen is being administered and ventilation is adequate whether spontaneous or assisted
- Voluntary vital capacity should exceed > 15 ml/kg: elective ventilation if incipient or frank respiratory failure
- *Consideration of* chest drainage if pneumothorax or haemothorax before transfer
- IV is patent and infusing at desired rate
- Naso-gastric tube is in situ, draining freely.
- Indwelling urinary catheter is in situ and draining freely
- Skin is protected from injury and apparatus or debris which may cause pressure ulcers is cleared away
- Level of Spinal Cord Injury is documented
- Records and x-rays accompany the individual, or images have been transferred using Image Exchange Portal or decrypted CD.
- Other injuries – thorax, abdomen, pelvis etc. are documented and stabilised
- Any head injury documented and monitored
- Notify time of departure to Specialised Centre