

THE MANAGEMENT OF CHILDREN WITH SPINAL CORD INJURIES

**Advice for Major Trauma Networks and SCI Centres
On the Development of Joint Protocols**

With Advice for Clinicians in Acute Hospitals

Approved by the CRG in Spinal Cord Injury 26 June 2014

THE INITIAL MANAGEMENT OF CHILDREN WITH SPINAL CORD INJURIES

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With Advice for Clinicians in Acute Hospitals

This advice for children with acute Spinal Cord Injury has been produced by A Graham and A Gall based on the Adult Working Party advice established by the National Spinal Cord Injury Strategy Board.

The National Spinal Cord Injury Strategy Board (NSCISB) was established in 2010 under the aegis of the National Specialised Commissioning Group (NSCISB). On 1st April 2013 the NSCISB ceased to exist and its functions were taken over by the CRG in Spinal Cord Injury (CRG SCI), part of Specialised Commissioning, NHS England.

The purpose of the CRG is:

- To develop a specification of service for patients with Spinal Cord Injury.
- To Drive improvements in Quality through the CQUIN and QUIP processes

The NSCISB membership includes representation from:

- All NHS Senates
- Four Specialised Associations
- Four Patient representatives

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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 though the figures for adults are calculated on the basis that most adults are thought to be referred to spinal services but with children the incidence and prevalence of those under 16 is unknown in most countries including the UK

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. 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)

Introduction

The document [“Management of People with Spinal Cord Injury - NHS Clinical Advisory Groups Report August 2011”¹](#) indicates that all Major Trauma Networks should have a defined link to a named specialised SCI Centre. This document also mandates the development of joint protocols for management of acute spinal cord injury between the Major Trauma Network and the SCI Centre.

[“Management of Children with major Trauma - NHS Clinical Advisory Group Report February 2011”¹](#) contains advice offered by the NHS Clinical Advisory Group (CAG) for Children with Major Trauma to their colleagues in NHS England. It is intended to support the recommendations from the NHS Clinical Advisory Groups Report on Regional Networks for Major Trauma (September 2010) with specific reference to children involved in major trauma and should be read in conjunction with this. For the purpose of this document children are those under the age of 19 years.

The exact age of when a person requires adult services or paediatric is unclear for those in the 16-19 year age group.

The National Service Framework for children recommends best practice for paediatric service to the end of the 18th year but in practice most paediatric units for general paediatrics do not take individuals over the age of 16 years.

The purpose of *this* document is to provide a check-list of topics where protocols are required and are consistent with “[Management of People with Spinal Cord Injury - NHS Clinical Advisory Groups Report August 2011](#)”, “[Management of Children with major Trauma - NHS Clinical Advisory Group Report February 2011](#)” and with the [National SCI Pathways](#). The supplementary reports recognise that there are already established networks for seriously ill children based around Paediatric Intensive Care and the number of seriously injured children is insufficient to justify major restructuring of those networks. This advice is therefore intended to be implemented as a pragmatic overlay onto local paediatric intensive care network arrangements and the Regional Trauma Network structure for adults.

Solutions will need to be found locally; usually using the same pre-hospital networks but determining the destination Major Trauma Centre (MTC) based on on-site or supporting children’s services. Maintenance of high-quality paediatric trauma resuscitation, imaging, and emergency decision-making and surgical skills specific to trauma must not be compromised by distributing services over too many sites. To achieve the best survival rates, concentrating expertise and experience is no less important in major trauma in children than it is for adults, and indeed the low numbers of injured children increases the risk of poor outcomes due to occasional practice. There is no evidence to suggest that children following the high case-volume adult major trauma pathway with paediatric expertise on-site do less well than a low case-volume route to a children only hospital. The system of a network delivery of care to injured children should improve not only the outcomes of those severely injured children but also those with lesser injury.

The following is a check-list of the topics where Management of People with Spinal Cord Injury - NHS Clinical Advisory Groups Report August 2011 indicates clinical protocols should be agreed.

SERVICE AND PROCESS

Location of initial care and protocols for transfer

- Local protocols will vary depending on the facilities and services available both in the linked SCI Centre and in the MTC with its network of Trauma Units managing children.
- They should prescribe the time frame for referral to the SCI Centre (The default for adults is 4 hours in the absence of local protocols). As the child may require specific paediatric facilities we suggest initial contact with link spinal centre within 24 hours but the referral time needs to be clinically appropriate for each child.
- Registration of patient on the SCI referral Database is required within 24 hours. Where the mechanism of injury rules out the possibility of other major trauma local protocols may mandate the transfer of a patient with isolated SCI from the

- receiving Emergency Department directly to the SCI Centre if fit for transfer and if acute paediatric facilities are integral to the spinal service.
- In most SCI Centres specialised paediatric spinal surgery is not be available. Local protocols will recognise these variations and mandate transfer to the MTC. Many paediatric patients will not be fit for transfer or the Specialised SCI Centre may not be able immediately to accept referral. Under these circumstances admission to the receiving paediatric hospital ward or PICU may be required. If this is the case then the closest collaboration on treatment strategy and day to day management should be part of a formalised network which should be subject to the normal governance arrangements.
 - All SCI Centres provide 24/7 advice for adults and, those which can, recommend advice for paediatrics. The SCIC should be part of the network and must also provide face to face outreach advice and assistance. If a spinal service cannot provide advice for paediatrics, they will refer the paediatric centre to the nearest unit which can.
 - Many children with good prognostic oncological cord impairment, medical onset impairment, post surgical repair of scoliosis or developmental disorders leading to paralysis all benefit from SCI comprehensive care and are covered by this guideline.
 - At every stage of the pathway, the importance of safeguarding children is paramount. Vulnerable children or those from areas of high social deprivation are over-represented as a group. Specific recommendations on implementation of safeguarding standards are beyond the remit of this document. Commissioners are encouraged to co-operate with local authorities, the police and Public Health, and support investment in injury prevention programmes (e.g. health visitors) as an integral part of the joined-up management of major trauma in children.

Clinical Advisory Group report summary

Relevant conclusions and recommendations from “Management of Children with major Trauma - NHS Clinical Advisory Group Report February 2011” include

1 Pre-hospital care and inter-hospital transfer

It is important that children with Major Trauma are accurately and rapidly identified so that they are able to benefit from Major Trauma Centre (MTC) care. Children are often triaged inaccurately (both over and under triaged). Triage tools for children are less reliable owing to the many variances in the physiological criteria used in common triage tools.

A UK survey revealed a geographical disparity in pre-hospital paediatric care due to variation of resources and availability of staff with key skills. Most paramedical staff receive little specific paediatric training and owing to the small number of children involved in major trauma there is a problem with de-skilling of the workforce. Transfer is a time when children are particularly vulnerable, and geographical constraints will mean that some critically injured children will have long journeys to hospital.

Evidence suggests that when children with multiple injuries are treated in a Children's MTC or at a Combined MTC they have better outcomes. Therefore the underpinning strategy is correct, but when over triage is recognised to have occurred there should be arrangements in place to treat the child at their most capable local centre when appropriate.

2 Acute care and surgery

Recognising that the acute needs of children with major injury are different to adults the CAG addressed the issues in relation to reception of children involved in major trauma (and staffing to support this); assessment, including imaging; emergency and specialist surgical interventions, including neurosurgery and spinal cord injury and critical care.

3. Ongoing care and Reconstruction

This section refers to the period of ongoing care after the first 24 hours. The effective management of this phase of care is crucial to optimising diagnostic, surgical and therapy input and resources. This clarity in management is of considerable benefit to the child's family as they face the considerable stress of providing support for their injured child.

Recommendations:

The important role of family should be acknowledged and actively supported. This may include the extended family if the child's parents were involved in the initial accident

Within any MTC, the child's care should be overseen and coordinated by a Trauma Service. A Paediatric neurosurgeon or spinal surgeon must take the lead with any child with a severe traumatic brain or spinal cord injury.

All children involved in major trauma should be admitted under the care of one of the Trauma Service consultants. This designated consultant should take responsibility for liaising with specialist centres for advice and transfer of the child as necessary.

4. Rehabilitation

For children involved in Major Trauma, rehabilitation is essential to address the physical, educational and psychosocial needs that result from their injuries and experiences. The rehabilitation of injured children is often poorly co-ordinated, with staff that are not always fully trained and competent in assessing and planning for their needs. The rehabilitation needs of children following major trauma are complex, diverse, and evolve over time, with specific patterns of difficulty which are unique to injured children (such as behavioural, learning and growth-related challenges). Children need contact with their families, schools and communities; while services should be as close to home as possible, the need to provide specialist care to a rare condition means travel is often inevitable. The educational needs of the child must be met during this period to allow full re-ablement and to reduce any loss of their future potential. Maintenance of the link with their school and peers is vital.

Informing and educating parents in paediatric intensive care has been proven to reduce post traumatic stress disorder and reported parental stress. The family environment and coping mechanisms also affect outcome. Support for parents and families throughout the process is therefore of paramount importance.

Recommendations

An arbitrary age cut off for access to rehabilitation is not beneficial to patients. Adult and paediatric services throughout the Network must agree to clearly define pathways of care for children of all ages. This includes the establishment and maintenance of locally agreed and clearly defined transition services, particularly with regard to rehabilitation, both in hospital and in the community.

The paediatric rehabilitation team should become involved with the child's care and family support as soon as is appropriate after admission, preferably during the acute phase of care. It should continue at the intensity required, and for as long as is necessary, to enable children to achieve their functional potential.

The Trauma Network Director of Rehabilitation should have experience in, or access to advice on, paediatric spinal cord injury rehabilitation.

Each Network should identify a named lead consultant in acquired paediatric spinal neurodisability. They will report directly to the Trauma Network Director of Rehabilitation regarding the rehabilitation management of injured children.

The clinical remit and geographical boundaries of children's major trauma rehabilitation networks could be aligned with existing rehabilitation networks for children with acquired brain injury (traumatic or non-traumatic).

There needs to be better liaison with children's rehabilitation and care coordinator posts throughout the trauma network with spinal cord care. They should work with multidisciplinary children's rehabilitation teams in a networked model to enable input as close to home as soon as possible.

There should be a network-wide school re-integration policy for children following major trauma and traumatic brain injury. Children's MTCs should have school services that are experienced in supporting children following major injury and that will act as liaison for school services in all Network hospitals.

Early and regular contact should be made with the local community paediatrician, general practitioner and multidisciplinary team so they can be involved in planning the long-term care of the child from an early stage. This must be an inclusive process involving all services and health professionals involved in the child's care.

Vital rehabilitation equipment, including wheelchairs and mobility devices, should be made available as soon as possible.

There should be a review of outcome measures and assessment tools for major trauma in children. Possible measures include functional independence including SCIM- spinal cord independence measure, health status, school attendance and achievement, survival, social dependency, function, mental health of parents and time out of employment for parents. There should be linked data sets for seriously injured children that run from pre-hospital to the rehabilitation phase.

A directory of children's services and resources should be developed relating to rehabilitation and ongoing care to facilitate referral and access to services within the Network and beyond.

Financial flows should encourage innovation and effective pathway development.

5 Network Organisation

Children involved in major trauma have different needs to their adult counterparts. Children's services vary throughout the country and differ from those for the adult population. When planning Networks, commissioners must be aware that there are relatively fewer children's specialists and that the numbers of children affected by major trauma are small. The underlying principle should be that the Network must ensure safe receipt and stabilisation of severely injured children, with the recognition that this acute phase of care, especially life-saving interventions, will often be provided by staff practising mainly in adult practice, albeit often with paediatric expertise.

A Trauma Network needs to be able to provide high quality care for all age groups. The centre of each Trauma Network could be either a Children's MTC or a Combined MTC. Where the journey time exceeds 45 minutes to a Children's MTC or Combined MTC, life-saving interventions may have to be performed at an Adult MTC or Trauma Unit, whilst always minimising the delay before transferring to the appropriate unit. There must therefore be flexibility in how local Networks make practical provision for implementing children's major trauma services whilst striving for the best possible practices and outcomes

6. Overriding essential considerations in the management of trauma in children

Formal arrangements for safeguarding of children must be implemented and organised on a regional level in accordance with guidance contained within the recommendations of the Royal College of Paediatrics and Child Health.

Psychologist or social worker support should be available to liaise with and support families throughout the child's pathway of care.

Services should be "child friendly" and children and young people should be encouraged to participate in their care and the provision of services. The 15 steps challenge programme provides guidance for this.

<http://www.institute.nhs.uk/productives/15stepschallenge/15stepschallenge.html>

Families should have information, encouragement and support to enable them to share in decisions about the child's care and to remain informed about their condition and management. Children and young people must be informed about, and have active involvement in decisions related to their own ongoing care.

Practical support such as directions and parking information, interfaith and spiritual support, social services, advice on financial support, interpreters, bereavement support and patient advice and advocacy services should all be available to families.

Arrangements should be made to provide accommodation for families during their child's ongoing care, especially in the acute phase where the geographical distances between an MTC and the family home may be particularly marked.

Families should have access to information directing them to other sources of support relevant to children's illness, including voluntary sector support groups such as The Back Up Trust, the Spinal Injuries Association, Aspire and Siblings UK.

Injury prevention programmes are an integral part of the commissioning cycle. While the clinical pathway starts at the point of injury, the commissioning cycle starts with a strategic needs assessment of the hazards within the local community, programmes to reduce the hazards or exposure to hazards, coupled with evaluation of these

programmes. Injury prevention programmes may be based on health protection, health promotion or health education strategies.

Training, Education, Audit and Governance

All MTCs and Trauma Units must have agreed written protocols for audit and governance of the referral and management pathway. These should cover both process and outcomes.

The training needs of nursing, therapy and medical staff in the acute centres must be considered.

Advice, Referral and Liaison

Advice on the medical, surgical, nursing and therapy aspects of patients with spinal cord injuries may be obtained at any time from the linked Specialised Spinal Cord Injuries Centre and with those centres managing children. Specialised Centres have outreach practitioners who are available to visit any hospital in the Region and give advice on the management of any patient with spinal cord injury. Initial contact should be made with your local spinal cord injury centre.

Referral to the SCI Centres should now be made at <https://nww.mdsas.nhs.uk/Spinal>

NHS Spinal Cord Injury Centres in England:

Specialised health care services for the management of spinal cord injury in adults are provided in eight specialist centres in England, offering support for patients sustaining spinal cord injury through the initial period of treatment and rehabilitation and on-going lifelong support. Not all SCIC's are able to admit children. The contact details and children services within the SCIC's are:

Duke of Cornwall Spinal Treatment Centre, Salisbury District Hospital, Odstock, Salisbury

Tel: 01722 336262

Paediatric Service: Unable to admit <16 years

Golden Jubilee Spinal Cord Injuries Centre, James Cook University Hospital, Middlesbrough.

Tel: 01642 850850

Paediatric Service: All ages of children and young people admitted for initial management and ongoing rehabilitation

London Spinal Cord Injuries Centre, Royal National Orthopaedic Hospital NHS Trust, Stanmore

Tel: 020 8954 2300

Paediatric Service: All ages of children and young people admitted for initial management and ongoing rehabilitation

Midlands Centre for Spinal Injuries, Robert Jones & Agnes Hunt Orthopaedic Hospital, Oswestry

Tel: 01691 404655

Paediatric Service: Most children and young people can be admitted for initial and ongoing rehabilitation. Do not admit ventilated children.

National Spinal Injuries Centre, Stoke Mandeville Hospital, Aylesbury

Tel: 01296 315000

Paediatric Service: All ages of children and young people admitted for initial and ongoing rehabilitation in dedicated children's' centre.

Princess Royal Spinal Injuries Centre, Northern General Hospital, Sheffield

Tel: 0114 2715644

Paediatric Service: Children <16 years admitted to Sheffield Childrens Hospital and SCIC offer advice and support. >16 admitted to the SCIC.

Mersey Regional Spinal Injuries Centre, Southport & Formby Hospital, Southport

Tel: 01704 547471

Paediatric Service: All ages of children and young people admitted for initial and ongoing rehabilitation

Yorkshire Regional Spinal Injuries Centre, Pinderfields General Hospital, Wakefield

Tel: 0844 8118110

Paediatric Service: Most children and young people can be admitted for initial and ongoing rehabilitation.

CLINICAL MANAGEMENT

Patient Assessment

Think Spinal Injury

Following an injury the potential for a spinal cord injury to exist must be considered. Children 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..

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

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 greater importance in a patient with impaired sensation.

Spinal Shock

At the acute stage there may be 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. The return of the bulbo-spongiosus (previously referred to as the bulbo-cavernosus) reflex denotes the end of the spinal shock period.

Airway and Cervical Spine Control

As soon as it is feasible the patient should be placed into the neutral supine 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.

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
- Obtain early anaesthetic consultation.
- Use appropriate intubation techniques with immobilisation of the spine. 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 20 microgram/kg (minimum 100 mcg, maximum 600 mcg), repeat after 5 minutes if requires, 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 diaphragm 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
- Effects of opiate analgesics
- Ascending spinal cord 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, irritability in the younger child
- Initial and serial measurements of vital capacity if child is able - 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 SaO₂ at 95% or above
- If longer term O₂ is required, it should be humidified
- Monitor blood gases regularly
- Monitor the vital capacity if child able
- 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
- Voluntary vital capacity should exceed > 15 ml/kgf: if it is less than this consider the need for ventilation. Tracheostomy avoids excessive neck movements as occur during endo-tracheal intubation
- Tracheal suctioning may be needed
- Weaning should be undertaken on the ventilator free principle, preserving the ventilator tidal volume. Further advice is available from RISC²

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

lower systolic blood pressure may be compatible with good urinary output and cannot be used as sole indicator of perfusion. Monitoring of fluid balance in patients with spinal cord injury is essential. However, hypovolaemic shock may also 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. The PEWS can be used to track changes over time.

Action

- Nurse patient supine
- Monitor BP
- Maintain a normotensive systolic pressure and an adequate urinary output for age and size. aiming 0.5ml/kg/h
- Administer IV fluids
- NB Do not over-infuse. This may precipitate cardiac failure and pulmonary oedema.
- In some 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. Atropine may be given as IV bolus if the patient is 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. Although the gold standard expects neurological observations should be performed at two hourly intervals this is not feasible in young 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.

Neurological examination should be undertaken by an experienced member of the medical team using the standardised examination recording chart published by the American Spinal Injuries Association (ASIA Chart, appendix). 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 recovery as well as bowel and bladder management. Careful examination of perianal sensation, deep anal pressure, tone, and voluntary anal contraction is important 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

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 adult 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 support surface **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, the recommended technique which can be applied. Is the

1. Logroll

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 nurses to control the head, shoulder girdle, pelvis and legs. The senior nurse should control the head and give the directions. It may be used in combination with Patslide and sliding sheets.

The neck may be initially immobilised with a collar or sand bags;
In order to keep the head in neutral the body may need to be raised to stop flexion of the head.

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.

MASCIP have produced an excellent illustrated guide for adults which may be consulted³.

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 when the child is lying supine the body may have to be supported higher to prevent ongoing flexion deformity of the neck

Imaging

Imaging 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. The ATLS protocols should be followed in major trauma. Soft tissue swelling must not be overlooked. CT of identified fractures is required. 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.

The exact timing of performing imaging has to be reviewed as access to the patient is poor in the scanner and careful assessment of clinical condition is needed. Younger children will require sedation or anaesthesia for imaging.

Venous Thrombo-embolism

Prophylaxis is mandatory with low molecular weight (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. The preferred regime of the Linked Spinal Cord Injuries Centre should be followed if possible and this can be obtained from the Centre.

Younger children are at lower risk. There is no evidence or consensus on the age medical prophylaxis should be used. Most SCIC's give LMWH in older children but there are no guidelines and no evidence on the age where LMWH should be used

Skin

The risk of developing pressure ulcers following spinal cord injury is extremely high⁴ due to:-

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

A pressure ulcer may delay the patient's treatment by weeks and produce a permanently vulnerable scar.

The patient must be turned safely and regularly to relieve pressure on the dependent area. This also allows an opportunity for inspecting the skin.

Thirty degrees side to side is 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. The heels should be supported clear of the bed with pillows.

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 lay on a pressure ulcer.

The liaison staff from the linked Specialised Spinal Cord Injuries Centre will visit any ward to provide advice and demonstrations of correct skin care.

Observation

- Check all pressure areas for signs of skin breakdown. Important areas that are often neglected include the occiput and heels.
- Red Marks are significant and must be protected from pressure

Action

- Heels should be supported clear of the bed with pillows.
- Subsequent pressure relief must be carried out regularly; the exact timing depends on the clinical condition of the child and their skin. This can be affected by pyrexia, body weight and also presence of moisture.
- 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 initially
- 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. Commence bowel regime using paediatric suppositories to encourage peristalsis.
- Re-commence nutrition as early as possible and consider parenteral nutrition if absorption of foodstuffs is delayed.

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 and continued until prophylactic anticoagulation is completed, usually 12 weeks post injury.

Bladder

The bladder is flaccid during spinal shock. It is important to avoid over-distension as this can cause permanent damage. 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 complications.

In the acute situation urethral catheterisation should not be attempted in the presence of priapism. Under these circumstances suprapubic catheterisation should be undertaken in the Emergency Department. A number of devices are available for this purpose. Ultrasound control can be helpful.

Bowel

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

- Upper Motor Neurone Damage

- Usually Thoracic Level 12 and above
- Spastic / reflexic bowel.
- Reflex activity is maintained; the bowel will contract and empty when stimulated.
- Anal sphincter reflexes and tone are maintained.
- Lower Motor Neurone Damage
 - Usually Lumbar Level 1 or below
 - Flaccid / areflexic bowel.
 - Although peristalsis will return, these movements are relatively 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 paediatric 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. Please discuss each patient with your SCIC. When bowel sounds return, passage of flatus occurs or bowels move then laxatives may be started:

Upper motor neurone (reflex) bowel

- Continue rectal examination and digital evacuation daily
- Commence suppositories approximately 8 hours after laxatives, depending on timing of bowel routine
- 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 for those who need this. It states that failure to meet this aspect of care is neglectful and in breach of the Nursing and Midwifery Council Code of Conduct^{5,6}.

Joint Mobility

After the initial period of spinal shock, patients can develop spasticity to a variable 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 chronic regional pain syndrome 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 often 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. Over stretching of limbs must also be avoided. Parents can be taught these stretches.

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. Benefits and risks of surgery should be evaluated and discussed.

The role of decompression in the management of patients with spinal cord injury has yet to be fully determined⁷⁻¹⁰. There is no conclusive evidence that decompression of the injured spinal cord improves either the rate or completeness of any neurological recovery. 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 bifacetral 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 over-distractation. In young children traction should be initiated with minimal weight and ideally with immediate imaging available to avoid over-distractation.

These patients represent the most vulnerable patients and only experienced spinal surgeons should undertake stabilisation surgery.

Anaesthesia

Anaesthesia in this group of patients is extremely demanding. Only general comments are made here. 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. Hypotensive periods during anaesthesia need to be avoided to reduce the risk of further neurological loss. 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 and hypotension needs to be avoided to maintain perfusion.

Suxamethonium is contra-indicated

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 gradual sitting up, TEDS and abdominal binder (where available sizes exist) in the presence of an appropriately qualified practitioner. Medication with ephedrine may be necessary. During gradual tilting, measurements of blood pressure are required together with monitoring of neurological function when possible. 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

Autonomic Dysreflexia

Patients with a lesion at or above T6 are prone to autonomic hyper-reflexia (dysreflexia).

A stimulus causes reflex sympathetic over-activity below the 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. This is a life threatening emergency and can result in intracranial haemorrhage and arrhythmias.

General causes:

- Bladder distension
- Bowel distension
- Pressure ulcers
- Ingrown toenails
- 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
Irritability

Signs: 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)

Bradycardia, occasionally cardiac arrhythmia

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

Treatment

Algorithms exist for management in children < 13 and >13yrs. Contact your SCIC if you want more information.

- A. Take heart rate / BP
- B. Tilt bed head up
- C. Loosen clothing
- D. Repeat observations
 - For 13 yrs and under
 - BP>15-30mmHg above baseline perform bladder management step
 - BP>30mmHg above baseline, consider medication and perform bladder management
 - For over 13 years
 - BP>20mmHg above baseline to 150, perform bladder management
 - BP>170mmHg consider medication and perform bladder management
- E. Bladder management
 - Un-kink any catheter
 - Change blocked catheter
 - Catheterise if no catheter in situ
- F. Medication Sublingual Nifedipine 0.25-0.5mg/Kg dose every 4-6 hours
- G. Bowel management
 - Use local anaesthetic gel and gently evacuate any stool

If symptoms and signs persist escalate and transfer to appropriate level of care.
The link SCIC can advise on further management

Patient Advice and Adjustment

Experiencing a spinal cord injury is very frightening for the child and their family. Understanding this, and ensuring the provision of meaningful emotional support is

important. What the family and/or child most needs is certainty, but this can rarely be immediately provided.

Although certainty over the neurological prognosis is not possible, the provision of a definite plan of treatment to the family is of enormous benefit, allowing them to have better understanding and a feeling of control. Early discussion with the linked SCIC will provide information on the proposed treatment after transfer, and will also provide advice on patterns of recovery in generic terms. Centres normally have in-house psychology / psychiatry / play specialist services, which can also provide advice and support for acute emotional management of newly injured patients and families.

School and Reintegration

Social and educational needs of the child must be explicitly addressed in the paediatric spinal pathway. This must include early planning and timely and appropriate provision of assessments and tailored interventions for the social, psychological and educational needs

Transfer to the Spinal Centre

Decisions to transfer and planning for it should take place between senior staff in both 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.

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- as for any multi trauma child

- Ensure patient is fit for Transfer (mechanical and physiological stabilisation) (Local Fit for Transfer Protocol)
 - 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

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
The environmental temperature must be maintained
- 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

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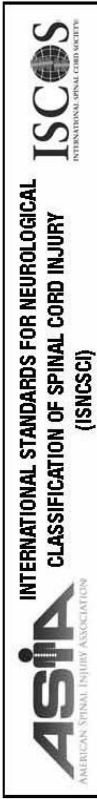
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Appendix 1 ASIA chart

Appendix 2 Example of Regional Quick Guide

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



RIGHT

UER
(Upper Extremity Right)

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

LER
(Lower Extremity Right)

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

(VAC) Voluntary anal contraction (Yes/No)

LEFT

UEL
(Upper Extremity Left)

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

LEL
(Lower Extremity Left)

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

(VAC) Voluntary anal contraction (Yes/No)

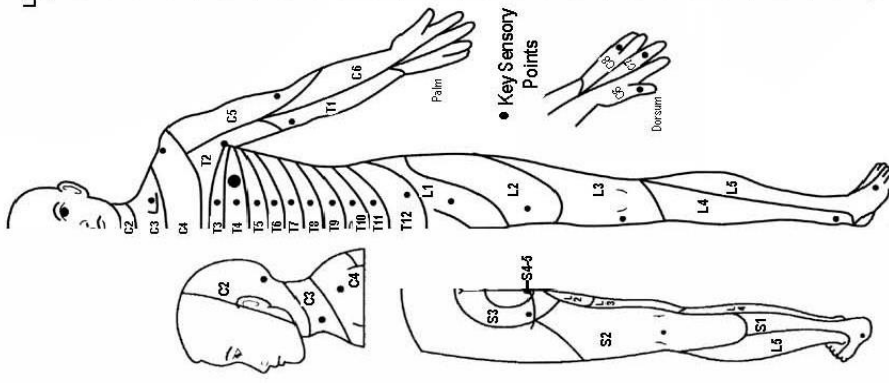
Comments (Non-Key Muscles? Reason for NT? Pair?)

SCORING ON REVERSE SIDE

0 = total paralysis
 1 = palpable or visible contraction
 2 = active movement, gravity eliminated
 3 = active movement, against gravity
 4 = active movement, against some resistance
 5 = active movement, against full resistance
 5* = normal corrected for pain/disease
 NT = not testable

SCORING ON REVERSE SIDE

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



MOTOR SUBSCORES

UER + UEL = UEMS TOTAL (50) LER + LEL = LEMS TOTAL (50)

MAX (25) (25) MAX (25) (25)

RIGHT TOTALS (50) **LEFT TOTALS** (50)

(MAXIMUM) (MAXIMUM)

SENSORY SUBSCORES

RLT + LLT = LT TOTAL (112) RPP + LPP = PP TOTAL (112)

MAX (56) (56) MAX (56) (56)

NEUROLOGICAL LEVELS

1. SENSORY R L
 Steps 1-5 for classification as on reverse

2. MOTOR R L
 SENSORY MOTOR

3. NEUROLOGICAL LEVEL OF INJURY (NLI)

4. COMPLETE OR INCOMPLETE?
 Incomplete = Any sensory or motor function in S4-5

5. ASIA IMPAIRMENT SCALE (AIS)
 (Do not count level with any sensation)

Muscle Function Grading

- 0** = total paralysis
 - 1** = palpable or visible contraction
 - 2** = active movement, full range of motion (ROM) with gravity eliminated
 - 3** = active movement, full ROM against gravity
 - 4** = active movement, full ROM against gravity and moderate resistance in a muscle specific position
 - 5** = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person
 - 5*** = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disuse) were not present
- NT** = not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal range of motion)

Sensory Grading

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

Non Key Muscle Functions (optional)

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

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

ASIA Impairment Scale (AIS)

A = Complete No sensory or motor function is preserved in the sacral segments S4-5

B = Sensory Incomplete Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body

C = Motor Incomplete Motor function is preserved below the neurological level**, and more than half of key muscle functions below the neurological level of injury (NLI) have a muscle grade less than 3 (Grades 0-2)

D = Motor Incomplete Motor function is preserved below the neurological level**, and at least half (half or more) of key muscle functions below the NLI have a muscle grade ≥ 3

E = Normal If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade

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

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



INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY



Steps in Classification

The following order is recommended for determining the classification of individuals with SCI

- 1. Determine sensory levels for right and left sides.**
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation
- 2. Determine motor levels for right and left sides.**
Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5)
Note: In regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal
- 3. Determine the neurological level of injury (NLI)**
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively
The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2
- 4. Determine whether the injury is Complete or Incomplete.**
(i.e. absence or presence of sacral sparing)
If voluntary anal contraction = No AND all S4-5 sensory scores = 0 AND deep anal pressure = No, then injury is **Complete**
Otherwise, injury is **Incomplete**

5. Determine ASIA Impairment Scale (AIS) Grade:

Is Injury Complete? IF YES, AIS=A and can record ZPP (lowest dermatome or myotome on each side with some preservation)

NO →

Is Injury Motor Complete? IF YES, AIS=B

NO → (No-voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)

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

NO →

AIS=C

YES →

AIS=D

If sensation and motor function is normal in all segments, AIS=E

Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply

