PICU

**Welcome to the BUMCT STICU SCI Protocol Handbook:**

This handbook is designed to give all healthcare providers a quick reference for all our SCI guidelines. The guidelines and flowcharts were designed by a multidisciplinary team of intensivists, spine surgeons, nurses, pharmacists, WOCNs, physical and occupational therapists, nutritionists, and respiratory therapists. We researched and assimilated all the best evidence available using all the available published evidence, our own experience, and protocols designed by spinal cord injury associations and centers, both nationally and internationally. The guidelines and papers we referenced are all available on our google drive. Selected references are included in some sections. The handbook is designed to be followed by the bedside nurse. The handbook should stay at the bedside throughout the patient's stay in our hospital. We expect the bedside nurse to review the handbook and orders and help the primary team and ancillary services keep up with the orders appropriate to that patient's current needs in the flowcharts. The bedside nurse should advocate for the teams to follow the flowcharts as much as possible. We understand that all patients are different and sometimes patients will not be appropriate for a particular component of our recommendations. We expect that decisions to deviate from the protocols will be active, informed decisions rather than omissions.

We hope this set of protocols will help everyone deliver the best possible care to our SCI patients for the best possible long term outcomes.

Sincerely,
The SCI Protocol Workgroup

Jayne Levengood, MSPT
Madeline Johnston, PharmD
Hillary Heater, BSN, RN, CCRN
Brian Kopp, PharmD
Jeffry Scott, RRT
Kevin Marr, RRT, CFPT, BSIT, MBA
Allison Miller, RRT
Linda Bohlin, RRT
Anne Miros, RRT
Rachel Rickert, RN
Mario Lluria, RN, BSN, CWOCN
Kitra Henker, RN
Mellissa Davis, RN
Chanak Chantachote, MD
Tanya Anand, MD
Mary Meer, RD
Patty Barcelo-Sanders
John Hurlbert, MD, PhD, FRCSC, FACS
Lynn Gries, MD FACS

**Augmentation of Mean Arterial Pressure (MAP pushes):**

Many current spine surgical guidelines recommend maintaining a mean arterial blood pressure greater than 85mmHg. This recommendation has its origins in two observations. The first is that cerebral perfusion has a level of autoregulation across a wide range of blood pressures which is frequently lost during a traumatic brain injury. Animal models suggest the spinal cord has a similar autoregulatory mechanism. It is inferred that if the cerebral autoregulation can be lost during injury, the spinal autoregulation can be lost after injury as well. The second form of evidence was the documentation of prolonged (7-14 days) cardiovascular abnormalities after spinal cord injuries resulting from a myriad of events including but not limited to disruption of the autonomic nervous system. In 1997, a group of investigators sought to better manage these events with intensive support, monitoring and resuscitation. They noticed that with monitoring, resuscitation and support of blood pressure, a cohort of patients did much better than expected in terms of their neurologic outcome. Further cohort and case-control reports also suggested improved outcomes with maintenance of MAP >85 for 7 days post-operatively. Despite the fact that all of the data suggesting improved outcomes with MAP augmentation is Class III evidence, it is the current recommendation of most large spine societies to recommend intensive care, hemodynamic monitoring and vasopressor support as needed. Limited data suggests no benefit to MAP pushes in penetrating SCI.

We recommend levophed as the best pressor in this setting and would avoid phenylephrine, vasopressin and dopamine. Care should be given to make sure the patient remains euvolemic during this period. Pressors are no substitute for euvolemia. **Young healthy patients tend to have an augmented GFR on MAP pushes and need meticulous attention to their volume status and replacement of their urine output with IV fluids to maintain euvolemia.**

References:

Ryken, TImothy et al "The Acute Cardiopulmonary Management of Patient with Cervical Spinal Cord Injuries", Neurosurgery, 72:84-92 2013

Vale, Fernando et al , Combined medical and surgical treatment after acute spinal cord injury: results of a prospective pilot study to assess the merits of aggressive medical resuscitation and blood pressure management, Journal of Neurosurgery 87;2, 1997

Readdy W, et al**Complications and outcomes of vasopressor usage in acute traumatic central cord syndrome** J Neurosurg Spine. 2015 Nov;23(5):574-580. doi: 10.3171/2015.2.SPINE14746. Epub 2015 Jul

Readdy, W et al, **Failure of Mean Arterial Pressure Goals to Improve Outcomes Following Penetrating Spinal Cord Injury**, *Neurosurgery*, Volume 79, Issue 5, 1 November 2016, Pages 708–714,

## Pharmacologic therapy of Acute Spinal Cord Injury:

Recommendations:

Administration of methylprednisolone is not recommended.

Rationale for recommendations:

Administration of methylprednisolone for treatment of acute SCI remains controversial in some circles. The face value of the NASCIS trials would suggest that MP offers some improvement in motor or sensory function. However, critical review of the trials and subsequent studies suggest the benefits seen are more likely secondary to incomplete data and random events.

There have been a number of MP-focused clinical trials, including two key multi-center, randomized, double-blind, placebo-controlled, clinical trials: National Acute Spinal Cord Injury Study 2 (NASCIS 2) and NASCI 3. An earlier NASCIS 1 study of MP generated no significant results.

In NASCI 2, 162 acutely injured patients received a MP bolus of 30 mg per kilogram of body weight followed by infusion of 5.4 mg per kilogram per hour for 23 hours. These patients were compared to 171 patients given placebo (Bracken et al, *N Engl J Med*, 322, 1990). Motor and sensory function was assessed at admission and after six weeks and six months. The investigators concluded that patients treated with MP within eight hours of injury had improved neurological recovery. Side effects included GI bleeding, wound infections, and delayed healing. The study also evaluated a second drug naloxone, which did not improve neurological function.

Before the results were published in a professional journal, the US National Institutes of Health disseminated them through announcements and faxes to emergency-room physicians and the news media. Though this was done to help the acutely injured as soon as possible, it essentially created a standard of care before other experts could critically evaluate the results.

There were problems with the NASCIS results once the article was published. The cohort was initially 487 patients. An arbitrary 8 hour therapeutic window was imposed in a post hoc fashion without a specific rationale. This excluded 291 patients from the analysis entirely. The final comparisons were between only 66 MP treated patients and 69 controls. Although testing was done on both sides of the body, only the right sided results were reported. The patients excluded from the primary results by the 8 hour window were shown to have a detrimental effect from steroid administration. This would suggest that the positive results were as likely secondary to chance as timing. Functional outcomes were not reported. Serious complications were higher in the MP treated group. In other words, the NASCIS 2 study showed little if any statistically significant benefits from high-dose MP, and modest benefits were only demonstrated in a patient subgroup when study data was micro-analyzed in a challenged post-hoc fashion.

NASCIS 3 compared the efficacy of a 24-hour MP dose with a 48-hour dose of MP or the non-glucocorticoid tirilazad, which was included to ascertain if it had MP's effectiveness without possessing MP's steroid-related side effects (Bracken et al, JAMA 277(2), 1997). Based on the results of the previous NASCIS 2 study, all 499 acutely injured subjects were initially given 30-mg/kg dose of MP within eight

hours of injury. Then, patients were randomized to receive 1) a 5.4-mg/kg infusion of MP for 24 hours, 2) the same dose for 48 hours, or 3) 2.5 mg/kg of tirilazad every six hours for 48 hours.

Follow-up assessments were again carried out at six weeks and six months. The investigators concluded that if MP is initially administered within three hours of injury, the regimen should be continued for 24 hours; if initiated three to eight hours after injury, the regimen should be continued for 48 hours. Patients treated with tirilazad for 48 hours had comparable improvement to the patients treated with the 24-hour MP regimen. MP-associated side effects were greater in patients treated for 48 hours.

**Controversy:** A growing number of critics believe that MP has been promoted as a standard of care for acute injury based on results obtained through the use of questionable statistical procedures. Some of the published articles that challenge the use of MP as a treatment standard include, but are not limited to, the following:

1) Dr. Shanker Nesathurai (Massachusetts, USA) stated that neither NASCIS 2 or 3 convincingly demonstrated MP's benefits. "There are concerns about the statistical analysis, randomization, and clinical benefits... Furthermore, the benefits of this intervention may not warrant the possible risks." (*J Trauma* 45, 1998)

2) Dr. Deborah Short and colleagues (United Kingdom) extensively reviewed the scientific literature to evaluate the evidence in support of MP's use (*Spinal Cord*, 38, 2000). They concluded: "The evidence produced by this systematic review does not support the use of high-dose methylpredinisolone in acute spinal cord injury to improve neurological recovery. A deleterious effect on early mortality and morbidity cannot be excluded by this evidence."

3) Dr. W.P. Coleman et al (Maryland, USA) strongly criticized both NASCIS 2 and 3 for methodological weaknesses and the lack of data that could be critically reviewed by others (*J Spinal Disord* 13(3), 2000). For example, they stated: "The numbers, tables, and figures in the published reports are scant and are inconsistently defined, making it impossible even for professional statisticians to duplicate the analyses, to guess the effect of changes in assumptions, or to supply the missing parts of the picture. Nonetheless, even 9 years after NASCIS II, the primary data have not been made public...These shortcomings have denied physicians the chance to use confidently a drug that many were enthusiastic about and has left them in an intolerably ambiguous position in their therapeutic choices, in their legal exposure, and in their ability to perform further research to help their patients."

4) Dr. R.J. Hurlbert (Alberta, Canada) concluded: "The use of methylprednisolone administration in the treatment of acute SCI is not proven as a standard of care, nor can it be considered a recommended treatment. Evidence of the drug's efficacy and impact is weak and may only represent random events. In the strictest sense, 24-hour administration of methylprednisolone must still be considered experimental for use in clinical SCI. Forty-eight-hour therapy is not recommended." (*J Neurosurg* 93(1 suppl), 2000)

5) In perhaps one of the most potentially damning criticisms, Dr. Tie Qian and colleagues (New Jersey, USA) suggested that high-dose MP therapy may damage muscles through **acute corticosteroid myopathy** (ACM) and that functional improvement attributed to MP may merely be due to the recovery of muscle damage caused by this extremely high dose of MP (*Med Hypothesis* 55, 2000). The investigators noted that under the NASCI 3 clinical protocol, a 75-kg acutely injured individual could

receive nearly 22 gm of MP, which is the "highest dose of steroids during a 2-day period for any clinical condition."

6) In a recent report, Qian and colleagues (Florida, USA) assessed the possibility that high-dose MP could cause ACM-related muscle damage (*Spinal Cord*, 43, 2005). Specifically, five acutely injured patients who received the high-dose MP treatment regimen were compared with three control patients, who did not meet the requirements for MP treatment (i.e., 2 gunshot injuries and 1 arrived at hospital 8 hours after injury). ACM was assessed by muscle biopsy and electromyography (EMG). Muscle biopsies indicated that four of the five MP-treated patients had muscle damage consistent with ACM. EMG studies supported these findings. In the controls, muscle biopsies were normal, and EMG's did not suggest myopathy. The investigators concluded that "the improvement of neurological recovery showed in NASCIS may be only a recording of the natural recovery of ACM, instead of any protection that MP offers to the injured spinal cord."

7) Studies carried out in rats by Dr. Y. Wu et al (USA) further documented the muscle-damaging nature of MP when used as a treatment after SCI. In this study, rats were experimentally injured at the thoracic T9-T10 level and treated with either MP or a placebo control. Seven days after injury, both body and muscle weight was significantly reduced in the MP-treated rats compared to controls. The investigators concluded that MP caused substantial muscle atrophy both above and below the the level of injury.

8) Dr. Yasuo Ito et al (Japan) compared the outcomes of patients who had been administered high-dose MP as part of their acute-injury care to those who had been identically treated but without MP. Specifically, between 2003 and 2005, all patients with cervical injuries were treated with the standard high-dose MP protocol. The following two years, all similarly injured patients were treated without MP. Other than MP administration, treatment was the same in both groups. The MP-treated group included 38 patients (30 men; 8 women) with an average age of 55 years. The non-MP treatment group included 41 patients (33 men; 8 women) averaging 60-years old.

Neurological improvement was observed in 45% and 63% of MP-treated and non-MP-treated patients, respectively. In other words, MP-treated patients apparently fared worse. In addition to less improvement, the MP-treated patients had a significantly greater incidence of pneumonia. Specifically, 50% of the MP-treated patients developed pneumonia compared with only 27% of the non-MP-treated patients. The investigators concluded that they "found no evidence supporting the opinion that high-dose" MP "administration facilitates neurological improvement in patients with spinal cord injury." They also added that MP "should be used under limited circumstances because of the high incidence of pulmonary complications."

9) In a 2011 published study, **Dr. M. Aomar Millan** and colleagues (Spain) retrospectively compared the outcomes of acutely injured patients treated with MP with patients not treated with the drug between 1997 and 2007. Using the ASIA impairment scale described in the appendix, neurological function was measured at ICU admission and discharge. No statistically significant differences in neurological recovery were noted between the groups. In addition, the MP-treated patients had more medical complications, such as hyperglycemia (i.e., high blood sugar) and gastrointestinal bleeding.

10) In 2012, **Dr. P. Felleiter** and associates (Switzerland) published the results of a retrospective study which compared the neurological outcomes of two groups of patients with SCI treated at different times. In the earlier time period (2001-2003) in which MP-treatment prevailed, 96% of 110 patients

received MP. In contrast, reflecting the concerns about MP use that emerged over time, only 23% of of the later group (2008-2010) of 116 patients received MP. Given the large difference in the numbers treated with MP, one would expect much more improvement in the earlier group if MP had substantial effectiveness. Unfortunately, this was not the case. There were no statistically significant differences in neurological outcomes between the two groups.

The American Association of Neurological Surgeons, the Congress of Neurological Surgeons, the Consortium for Spinal Cord Medicine/Paralyzed Veterans of America and the British Association of Spinal Cord Injury Specialists have published consensus statements clearly stating administration of MP in acute SCI is not recommended.

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Hurlbert, RJ et al Pharmacological Therapy for Acute Spinal Cord Injury, Neurosurgery 72:3 March 2013

http://www.sci-therapies.info

Early Acute Management in Adults with Spinal Cord Injury: A Clinical Practice Guideline for Healthcare Professionals, Consortium for Spinal Cord Medicine/Paralyzed Veterans of America, May 2008

## SCI Protocol Respiratory Flowcharts and Guidelines:

**Atelectasis Flowchart**

**Secretion Management flowchart**

**Ventilator Weaning protocols #1 and #2**

**Early Tracheostomy flowchart**

*None of these guidelines addresses oxygenation nor ventilation specifically. Use of the flowcharts should assist in optimizing gas exchange.Clinicians at the bedside should use their experience and judgment to manage oxygenation and ventilation issues while following the flowcharts simultaneously. Extubation and weaning protocols assume normal gas exchange and ABGs should be used during the weaning process simultaneously to guide decisions.*

# Spinal Cord Injury Non-Intubated
# Atelectasis/ Pulmonary Recruitment Protocol

C1-C4 very high likelihood of tracht ventilator. Use extreme caution

Check Vital Capacity with Wright's Spirometer

≥ 10 cc/kg IBW

PEP Therapy
I.S.
Aerobika

Recheck VC in 4°

9 - 5 cc/kg IBW

METANEB q4°

Recheck VC in 4°

≤ 5 cc/kg IBW

Big Turn Bed w/ percussion and check NIF

- 20 or better

METANEB q2° x 2 and Reassess Secretion management

Recheck VC in 4°

- 19 or worse

Consider Intubation

METANEB

Wright's Spirometer

# Intubated/ Non-Intubated Spinal Cord Injury Secretions Flowchart

Default 7% [illegible] Albuterol Nebulizers q4°

Expect profuse secretions with high SCIs in the first 1-5 days

Cough assessment
Start quad cough teaching as soon as cooperative

Effective: mobilizes and clears

Reassess q4°

Follow appropriate Atelectasis/VC Flowchart

Weak: mobilizes but doesn't clear

Add cough assist q4°

Ineffective or Absent

**Patient receives:**
- Big turn bed and auto percussion
- Cough assist
- Quad cough if cooperative

Are secretions thick?

Yes

Change HTS to 10%
Consider Bronchoscopy
suction q1°
high turns

No

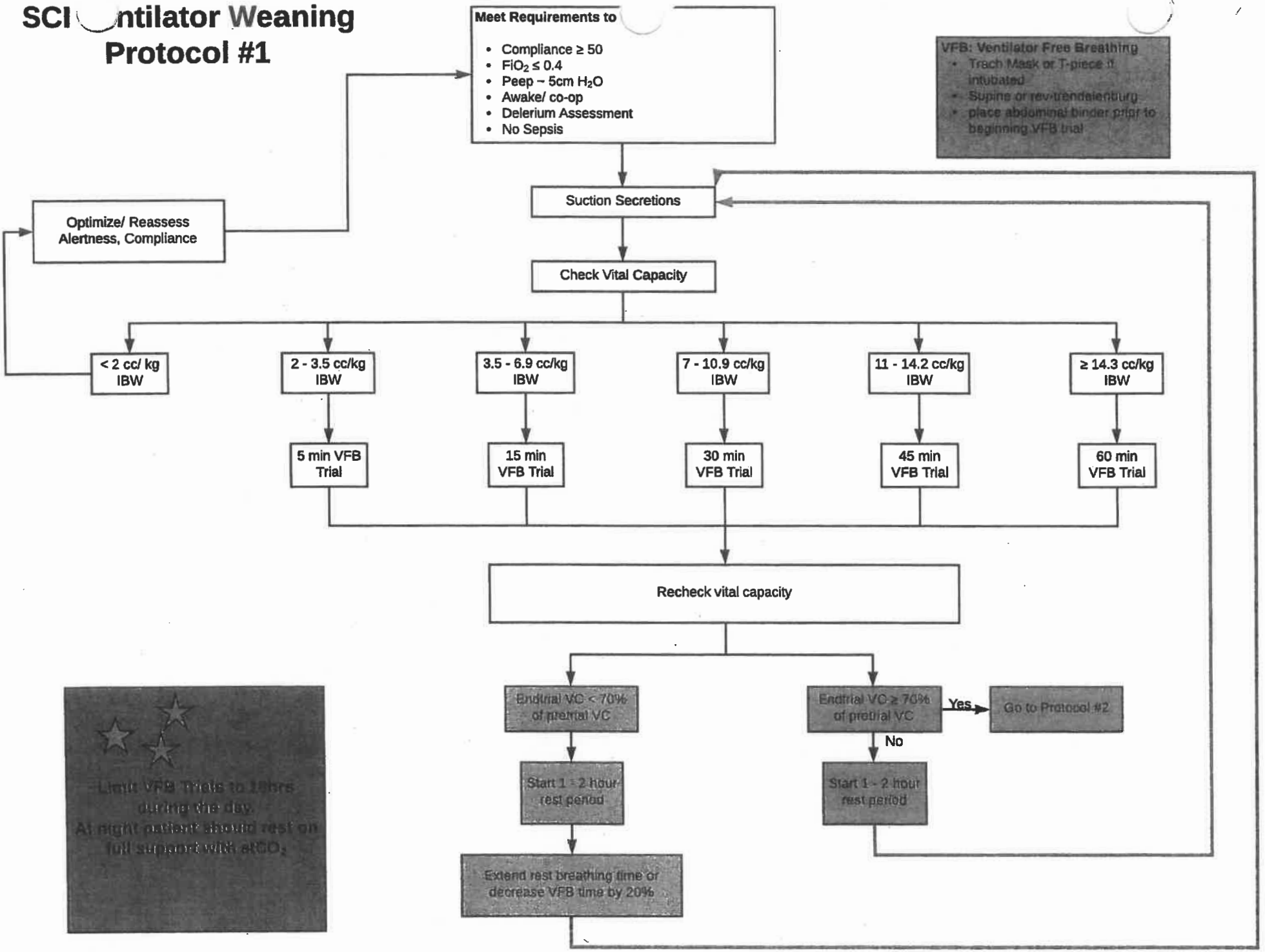
Suction q4° + PRN

Reassess q4°

METANEB

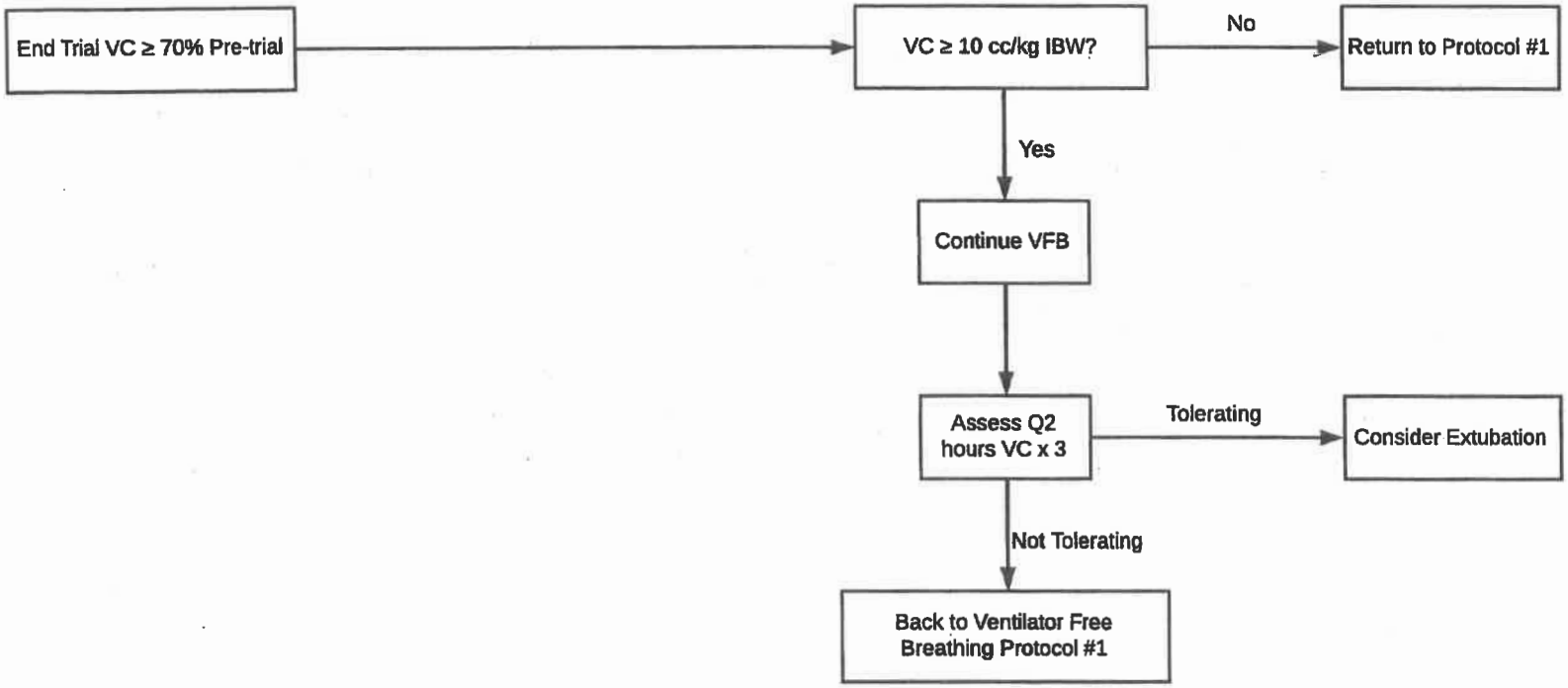
Cough Assist

# SCI Ventilator Weaning Protocol #1

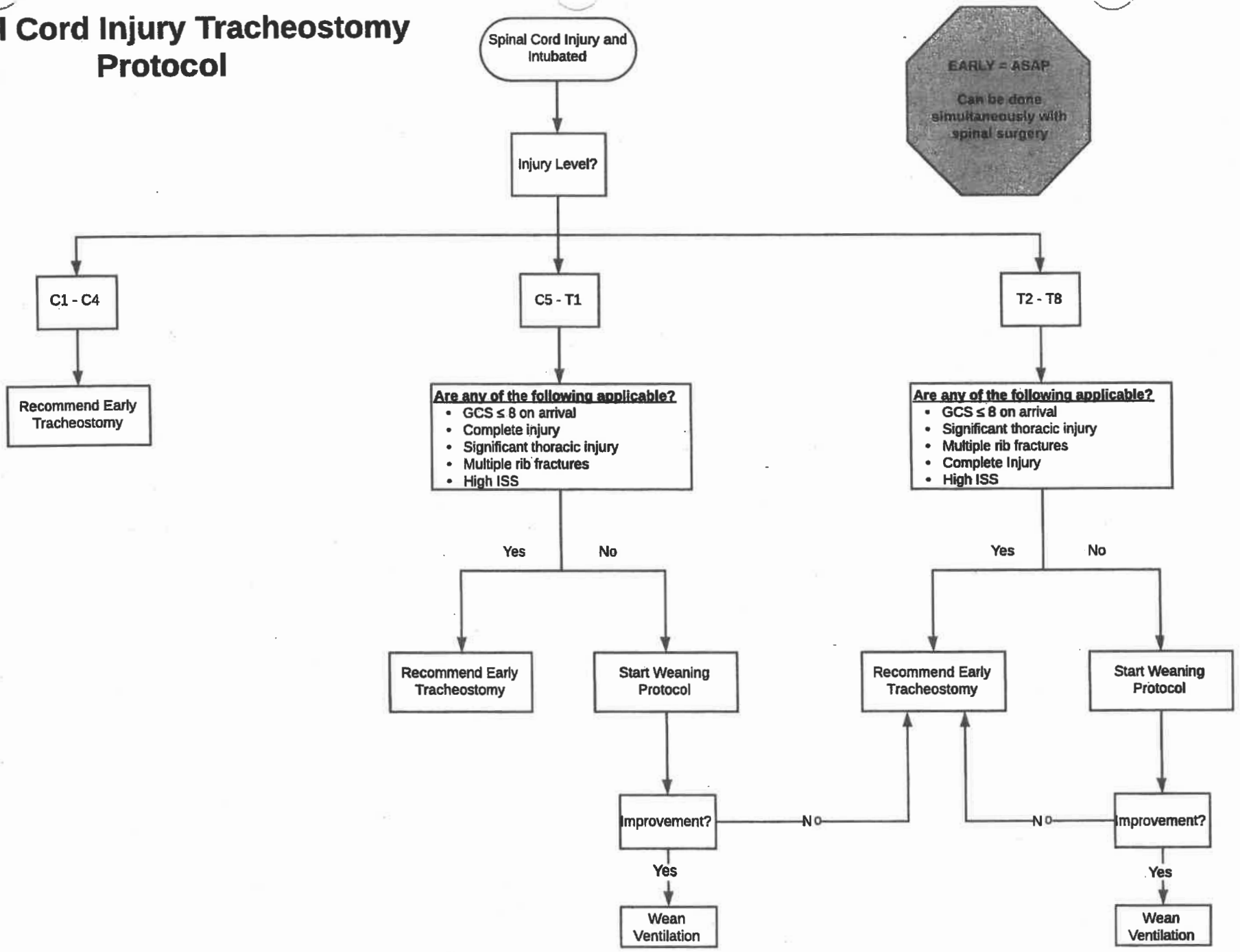


# Ventilator Weaning Protocol #2

The higher the injury, the higher chance of atelectasis derecruitment post-extubation. Consider another 12 - 24 hours in VFB trial loop.



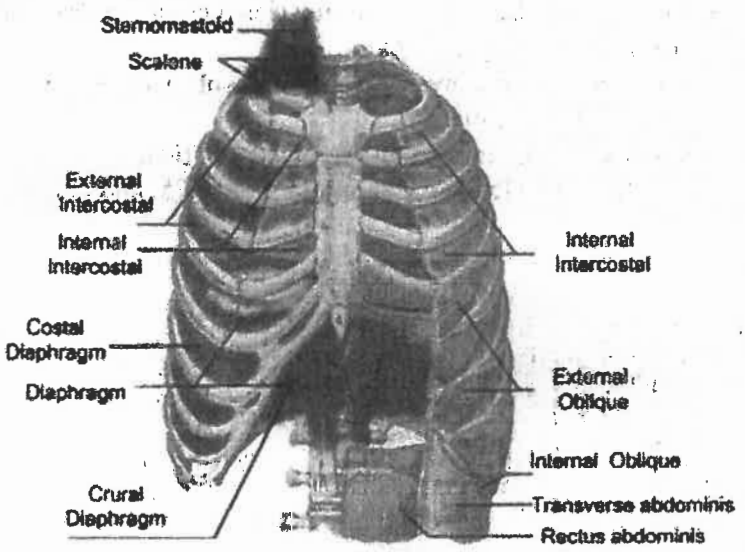
# Spinal Cord Injury Tracheostomy Protocol



# RESPIRATORY SYSTEM

## NORMAL FUNCTION

Normal respiratory function consists of coordination of different muscle groups to allow adequate chest wall expansion and passive collapse. Chest wall expansion creates a negative pressure in the space between the chest wall and lung (pleural space); this leads to lung expansion. This facilitates the absorption of oxygen and expulsion of carbon dioxide.
The major muscle groups responsible for inspiration include the diaphragm, external intercostals, sternocleidomastoid.
The major expiratory muscle groups include the internal intercostals, and multiple abdominal muscle groups as indicated below.
Accessory muscles of breathing (normally not involved with low inspiratory effort) include sternocleidomastoid and scalene muscles




**Innervation of major inspiratory muscle groups**

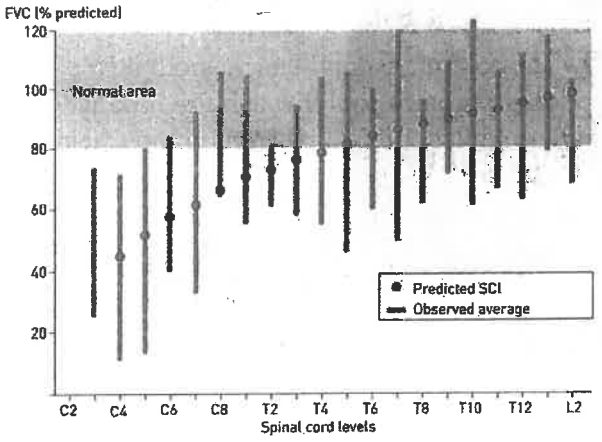
1. Diaphragm - C3-C5
2. Intercostal muscles – T1- T12
3. Sternocleidomastoid muscle –CN XI

**Compliance** is a term that describes the ease of expansion of the chest wall and lungs, i.e. the greater the volume expansion for each unit change in pressure, the more compliant the chest wall/lungs are, and the easier it is for someone to take a breath. This is shown by the equation of $\Delta V / \Delta P = C$. The less the volume changes with each unit change in pressure, the harder it is to take an adequate breath. In spinal cord injury, the compliance changes, affecting the patient's ability to take that breath.

## WHEN SPINAL CORD INJURY OCCURS

### Background

- In acute tetraplegia, 75 – 80 % of the patients need invasive mechanical ventilation (invasive MV).
- Caudal to C4 the need is approximately 60 %
- About 65 % of patients with injuries at levels from T1 to T12 may have severe respiratory complications
- Respiratory dysfunction immediately following spinal cord injury is due to flaccid paralysis of respiratory muscles both inspiratory and expiratory.
- The degree of dysfunction is directly related to the level of cord injury.
    - This leads to uncoordinated or paradoxical breathing
- A restrictive ventilatory defect with otherwise normal lungs or gas diffusion is present.
- Paralysis or flaccidity of abdominal wall muscles increase abdominal wall compliance and negatively impacts chest wall expansion.
- Feedback mechanism can be disrupted and as a result patient may not feel sob, and may become tachypneic when failing.
- The three independent risk factors that predicted a patient requiring endotracheal intubation are, Injury Severity Score (ISS)>16, an injury above C5, and quadriplegia

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Cervical Injuries

- In patients with cervical cord lesions (C2–C8) VC is reduced to 49 to 69% of predicted,
- Low cervical cord injuries will have lost all intercostal activity.
- High cervical injuries may also lose diaphragmatic and scalene activity. Ventilation failure is rapid in these circumstances.

Thoracic/Lumbar Injuries

- Those with thoracic and lumbar cord lesions will usually (T1–L5) have normal VC
- Lumbar cord injuries will lose some expiratory abdominal activity.
- Thoracic cord injuries will additionally lose intercostal activity and will frequently be complicated by rib fractures and pulmonary contusions.

- Autonomic disruption following on from cord injuries causes excessive bronchial secretions and a tendency to bronchoconstriction.

## CONSIDERATIONS AFTER SPINAL CORD INJURY

1. **Changes in Ventilatory Patterns:** The prevalence of OSA in SCI patients has been shown to be as high as 55% in men and 20% in women from 50 randomly selected quadriplegics with C3–C8 lesions.
- Vent management of SCI patient with minimal parenchymal abnormalities is different than in patients with ARDS. In these patients, there is a benefit for high tidal volume ventilation because of the change in respiratory mechanics. These
- Alveolar hypoventilation is heightened during sleep and even more so during REM sleep.
- There is a high risk of nocturnal hypoxemia in those with C4–C6 lesions.
- Sudden onset of life-threatening delayed apnea can occur weeks after SCI, with risk factors consisting of diffuse cord lesions, bradycardia, and prior transient respiratory distress.

2. **Compliance** - The innervation to the respiratory muscles suffers depending on the level of injury. The higher the injury on the spinal cord, the more muscle groups are affected, making the chest wall less compliant, stiffer, with the patient finding it harder to take that deep breath. The patient may be able to compensate initially, however, will tire out over time without assistance.

3. **Atelectasis and Pneumonia** – impaired respiratory muscle function leading to weak lung expansion. This is worse during the first few days after injury when muscles start to fatigue, secretions accumulate, and compliance decreases.

4. **Secretions**: Hypersecretion of mucus occurs within 1 hour after injury in about 40% of patients. This combined with a weak cough and bronchospasm and leads to mucus plugs within the first five days [6]

5. **Tracheostomy:** A number of retrospective studies showed characteristics in which early tracheostomy is beneficial
    a. Injury above C5
    b. ISS >16
    c. Quadriplegia
    d. Forced vital capacity <500mL

6. **Early mobility** - Inactivity is associated with pressure ulcers, chronic pain, upright positioning protocols, orthostatic hypotension management

7. **Speech and Swallow** – Swallowing dysfunction and dysphagia can occur in up to 40% of quadriplegic patients. Complications of not recognizing this dysfunction is pneumonia, chemical pneumonitis, and airway obstruction.

# MANAGEMENT

## Vent Management

- **Vent Management:**
  - Start with high tidal volumes 12 mL/kg of ideal BW, (can advance up to 20 mL/kg), as long as the peak airway pressures does not exceed 30 cm H20
  - Respiratory rate can be set at 8-10 breaths/min
  - A Volume control setting is recommended
  - Obtain baseline ABG

## Lung Expansion

**Table 3**
**Lung expansion interventions**

| Lung Expansion Interventions | Lung Expansion Interventions (with Endotracheal Tubes) |
|---|---|
| Deep breathing and voluntary coughing | Intermittent positive pressure breathing |
| Assisted coughing techniques (quad cough) | Sigh breaths |
| Glossopharyngeal breathing | Mechanical insufflation-exsufflation treatment |
| Incentive spirometry | Tidal volumes >20 mL/kg |
| Chest physical therapy | Oral gastric tubes for decompression |
| Continuous positive airway pressure | Fiber optic bronchoscopy with bronchoalveolar lavage |
| Bi-PAP | |
| Supine or Trendelenburg positions | EzPAP positive airway pressure system |
| Use of abdominal binders | Acapella |

## Secretion/ Management

- Frequent suctioning
- deep vein thrombosis prophylaxis, gastrointestinal prophylaxis, use of an endotracheal tube with subglottic secretion drainage, and oral care with chlorhexidine gluconate solution

## Swallow Assessment

- **Management:** Evaluate swallowing function prior to starting oral diet.

## Early Mobility

- **Management:**
  a. lower limb compression devices
  b. abdominal binders
     i. may increase vital capacity by 16%
  c. Physical Therapy/Occupational therapy
     i. passive range of motion assistance.
     ii. dangling at the bedside and bed mobility and transfer training.

d. Orthotic Devices
    i. Resting Hand Splints
    ii. Ankle foot orthoses

**Weaning Starting Parameters**

- A **minimal vital capacity** of **150 mls** is adequate to start weaning.
- Secretions should be cleared **prior** to starting weaning trial
- Weaning trials should be performed in the **supine position**
- Weaning trials should be performed during the **day time.** Spinal cord injured patients can have significant REM sleep hypoventilation.
- To asses safe VFB overnight requires either PaCO2 or TcCO2 monitoring.
- Off ventilator cuff deflation during VFB for fast weaners should be considered.
    - enables speech but also reduces micro-aspiration, restores laryngeal and pharyngeal reflexes leading to resumption of safe swallowing.

**Instructions**

Based on initial vital capacity measurement all ventilator support is removed for a specified time and then re-instituted for a rest period. The common term for this is **ventilator free breathing (VFB).**

Weaning progression is achieved by increasing VFB time by specified amounts dependent on the previous day's results.

It is important that the patient is not fatigued which can be estimated by re-measuring the VC at the end of the VFB period. If it is less that 70% of the pre-weaning VC then either the rest period should be extended or the VFB time reduced.

Suggested VFB times based on VC are:

1. If VC is less than 250 mls, start with 5 minutes VFB.

2. If VC is less than 500 mls, start with 15 minutes VFB.

3. If VC is greater than 750 mls, start with 30 minutes VFB

On VENT rest should be at least 1-2 hours. Trials of VFB can be repeated during day time hours, as appropriate to patient status.

For Example:

If a patient with a VC of 200 mls successfully achieves 3 episodes of 5 minutes VFB with 2 hour rest periods on day 1, with an end VFB VC of 180 mls, then increase the VFB time by 20% (to 6 mins) for day

2. If day 2 is satisfactory increase by 20% (8 mins) for day 3.

The initial aim is for VFB up to 18 hours during daytime, but for ventilation at night, as

## SIGNS OF IMPENDING RESPIRATORY FAILURE

- Hypoxia with increase in respiratory rate
- Decrease in vital capacity to less than 15cc/kg ideal body weight
- Decrease negative inspiratory force to less than 20cm $H_2O$
- Hypercarbia
- Fatigue
- Tachycardia

**Treatment:**

- Recognize early
- Requires intubation and mechanical ventilation
- If intubation necessary for more than 5 days consider tracheostomy

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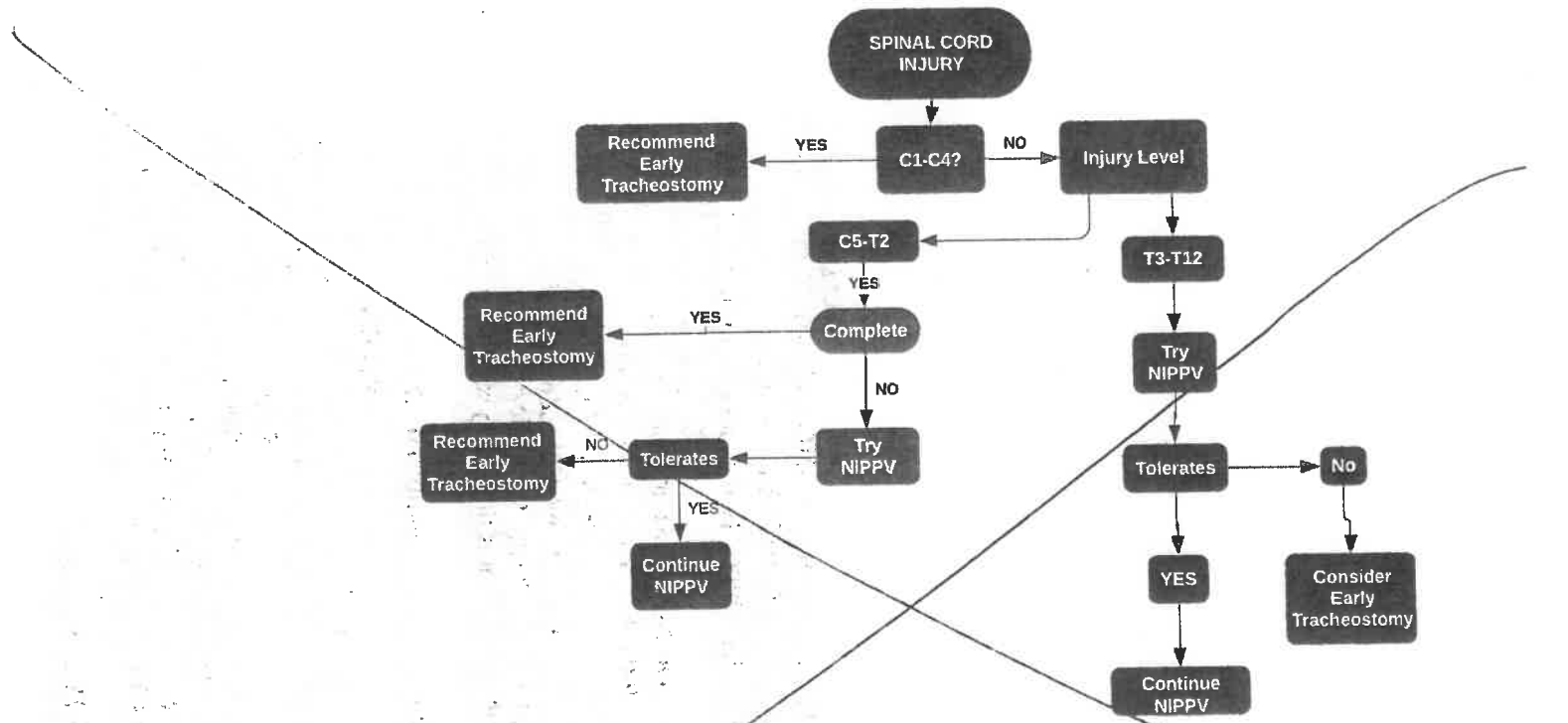
# Spinal [illegible] Injury Tracheostomy Protocol

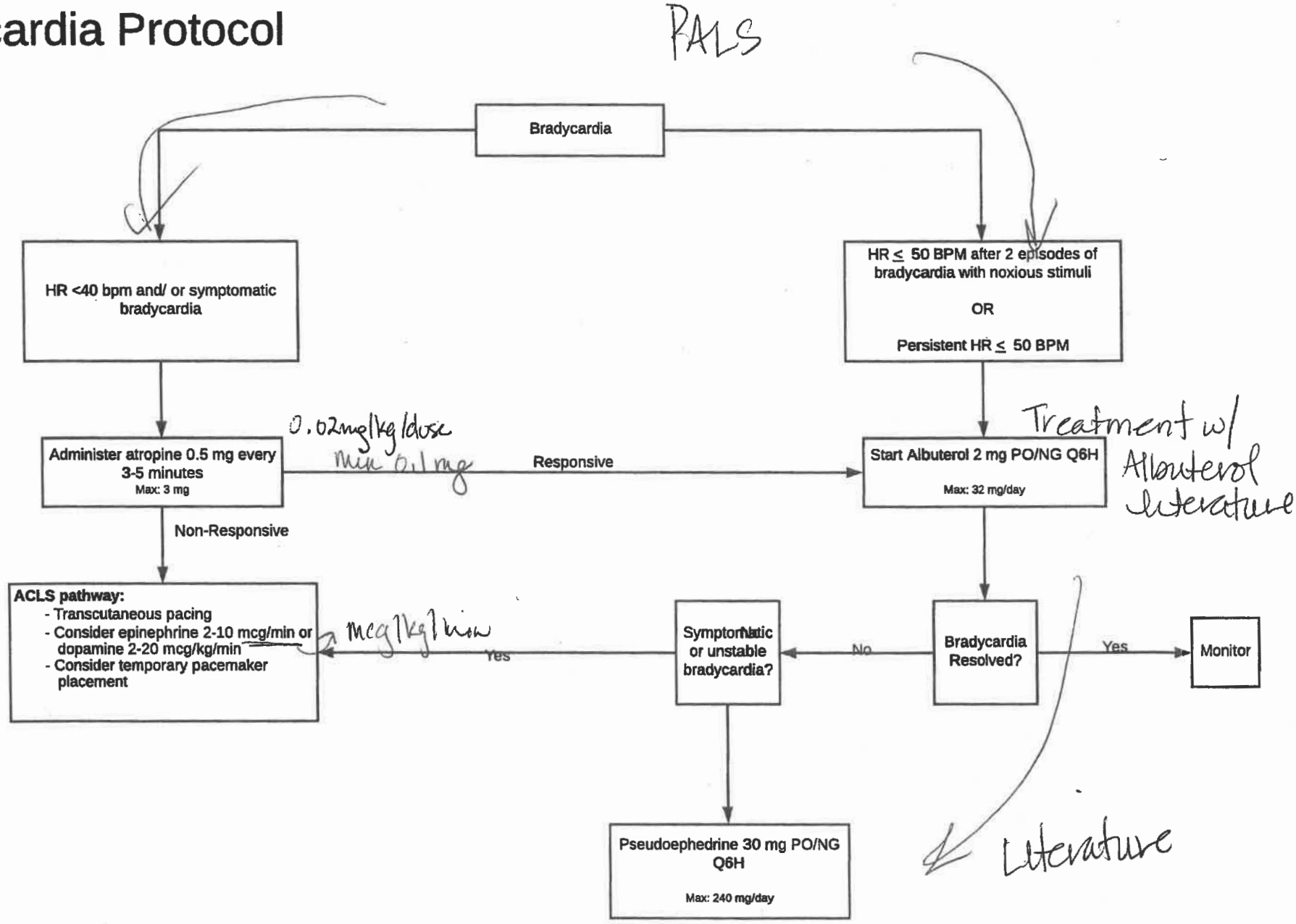
Tanya Anand | February 3, 2019



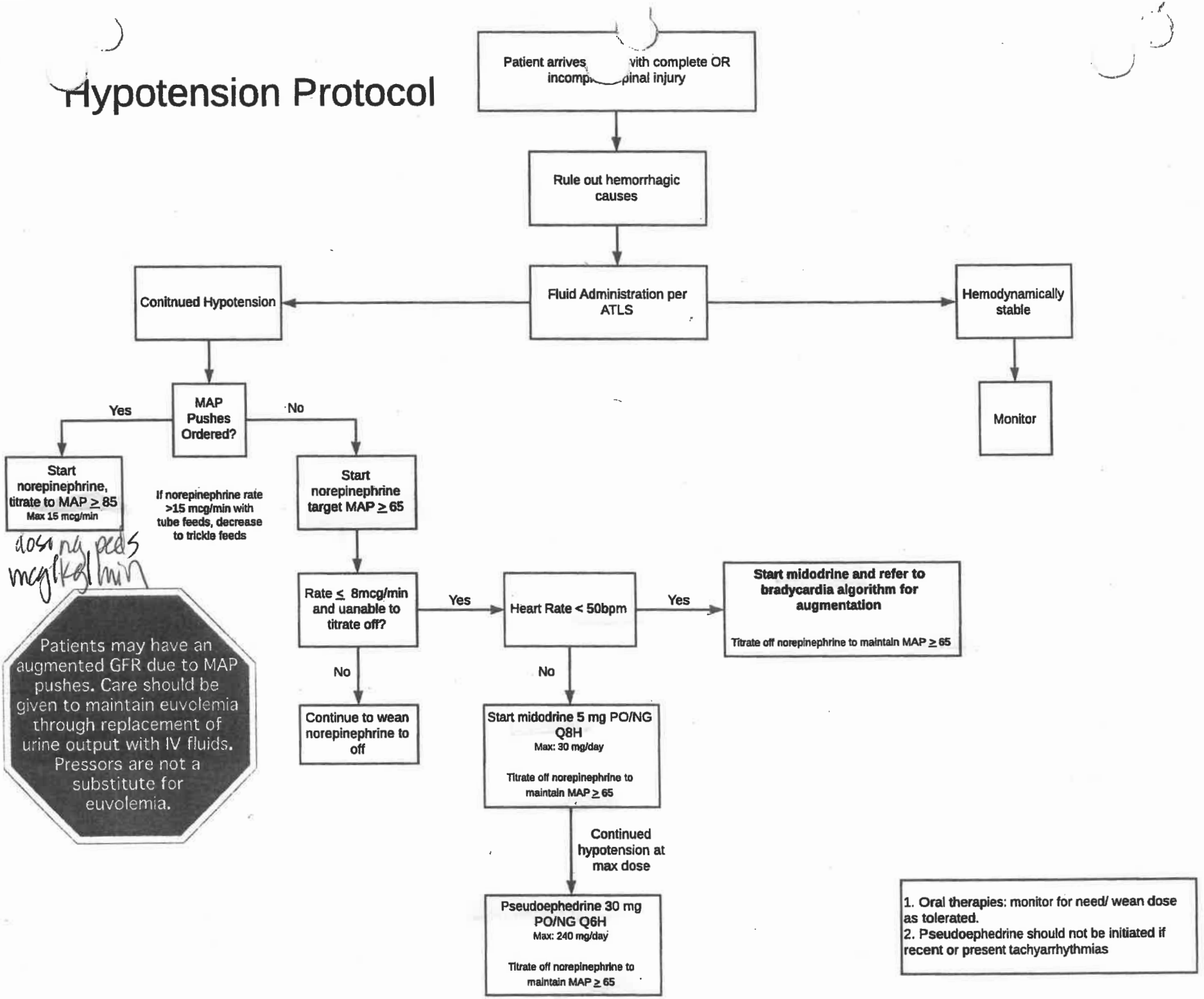

**Failure of NIPPV**

- Hypercapnia ($pCO_2 > 45$)
- Tachypnea
- Oxygen Saturation < 92%
- Vital Capacity <1500mL

# Bradycardia Protocol



# Hypotension Protocol




1. Oral therapies: monitor for need/ wean dose as tolerated.
2. Pseudoephedrine should not be initiated if recent or present tachyarrhythmias

# Cardiovascular System

## Normal Cardiovascular Function

There are two branches of the autonomic nervous system that are involved in cardiovascular control: the parasympathetic nervous system (PNS) and sympathetic nervous system (SNS). The SNS releases epinephrine and norepinephrine resulting in increased heart rate, contractility of the heart, and vascular tone. In contrast, the PNS increases the resting potential and decreases rate of depolarization resulting in decreased heart rate. Innervation of the heart by both of these systems allows for balanced regulation of the cardiovascular system.

## Acute Spinal Cord Injury

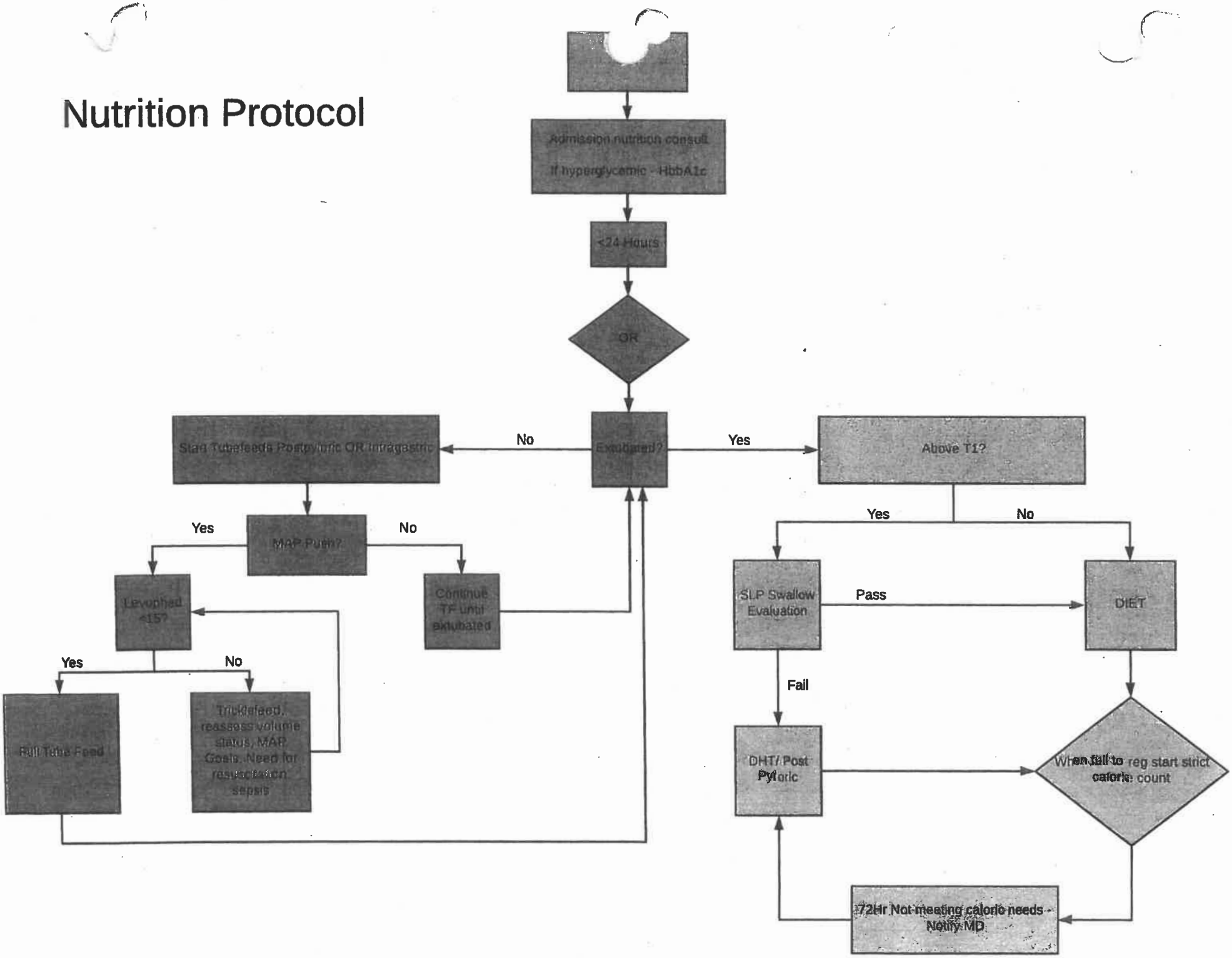
Injury to the spinal cord at the cervical or high-thoracic (>T6) levels often results in impairment of the sympathetic fibers due to their location within the spinal cord. This results in an unopposed parasympathetic tone characterized by decreased contractility, heart rate, and peripheral vascular tone (i.e. hemodynamic instability).[1,2] In these patients, vasopressors should be initiated if they remain hypotensive after fluid administration to ensure perfusion to the spinal cord and vital organs.[3] Agents with alpha and beta agonism should be selected to provide both vasoconstriction and heart rate support. Initiation of oral agents should be considered in those who become hypotensive with weaning of norepinephrine at a rate $\leq$ 8 mcg/min (or equivalent). Midodrine is an oral alpha-1 agonist used as adjunct therapy for vasopressor weaning and blood pressure augmentation.[4,5] Pseudoephedrine, a direct alpha- and beta-adrenergic agonist, may be considered in patients who do not respond to midodrine.[6]

The acute phase of spinal cord injury (SCI) can last up to 8 weeks, with the most common arrhythmia being bradycardia. Persistent bradycardia, defined by a HR $\leq$ 60 bpm, occurs in 66-100% of patients with cervical injury and 13-33% with thoracic injury.[2] While tracheal suctioning, hypoxia, and turning causes tachycardia in a normal patient, these actions often trigger episodes of transient bradycardia in patients with SCI.[1] Patients with acute SCI should be closely monitored for persistent bradycardia, as sinus arrest is the most common type of cardiac arrest in this population. Atropine remains the drug of choice for treatment of acute episodes of bradycardia due to its inhibition of acetylcholine at parasympathetic sites and rapid onset of action. In patients with persistent bradycardia, oral albuterol should be initiated for its beta-agonistic effects. Use of this agent in spinal cord injury may result in fewer episodes of symptomatic bradycardia and need for pacemaker placement.[7,8] In patients who fail albuterol, pseudoephedrine may be considered in those without hypertension or recent tachyarrhythmias.[6] Patients with persistent bradyarrhythmia resulting in symptoms such as hypotension, altered mental status, or chest discomfort should be managed according to the ACLS bradycardia algorithm. All pharmacologic efforts should be pursued to avoid temporary pacemaker placement. Expert consultation for transvenous pacing should be considered when dopamine and/or epinephrine are ineffective.

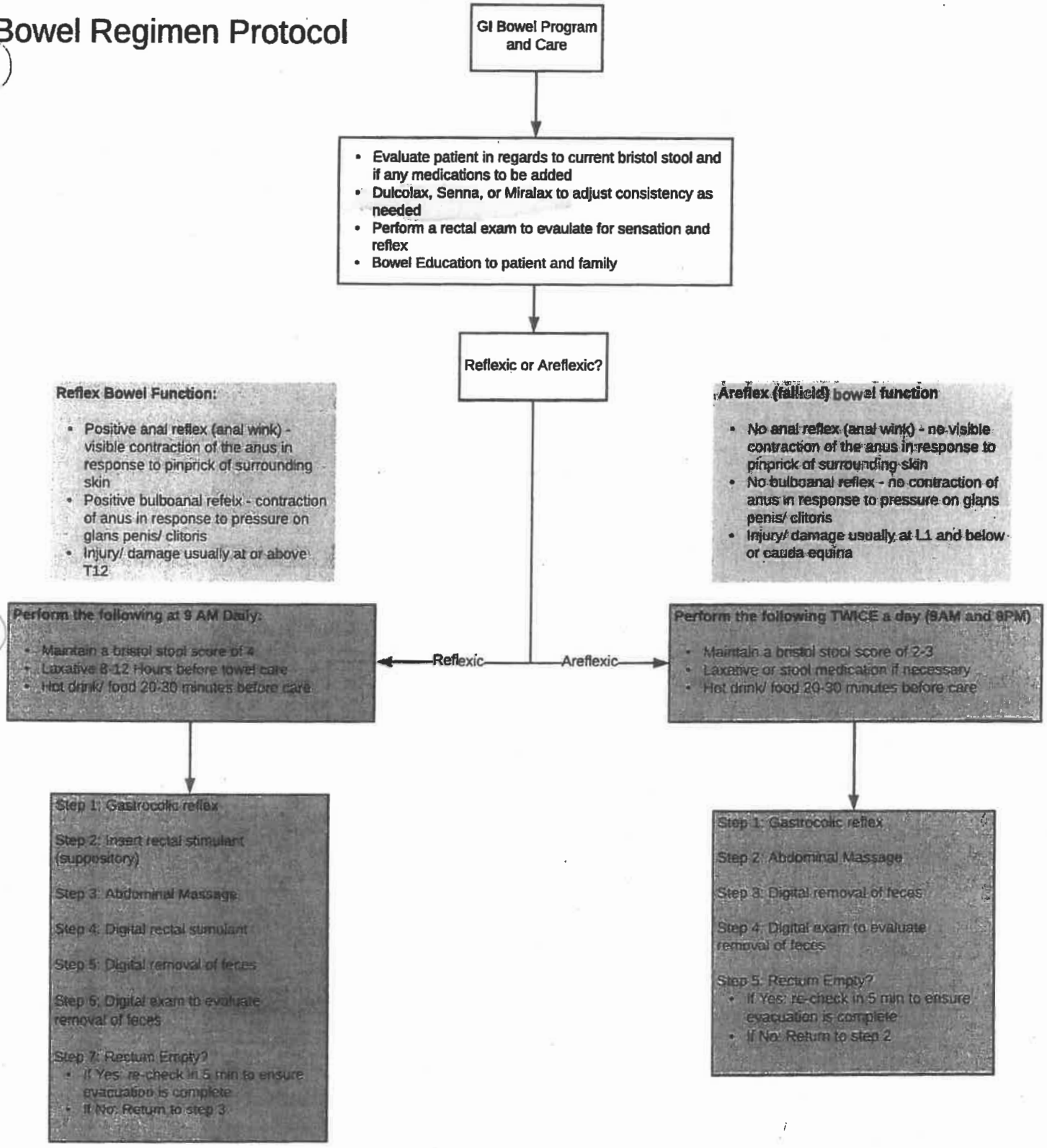
References:


1. Furlan JC, Fehlings MG. Cardiovascular complications after acute spinal cord injury: pathophysiology, diagnosis, and management. *Neurosurg Focus*. 2008;25(5):E13.
2. Manogue M, Hirsch DS, Lloyd M. Cardiac electrophysiology of patients with spinal cord injury. *Heart Rhythm*. 2017;14:920-27.
3. Ryken TC, Hurlbert RJ, Hadley MN, et.al. Chapter 7: The acute cardiopulmonary management of patients with cervical spinal cord injuries. *Neurosurgery*. 2013;72(3):84-92.
4. Levine AR, Meyer MJ, Bittner EA, et al. Oral midodrine treatment accelerates the liberation of intensive care unit patients from intravenous vasopressor infusions. *Journal of Critical Care*. 2013;28:756-62.
5. Poveromo LB, Michalets EL, Sutherland SE. Midodrine for the weaning of vasopressor infusions. *Journal of Clinical Pharmacy and Therapeutics*. 2016;41:260-65.
6. Wood GC, Boucher AB, Johnson JL, et al. Effectiveness of pseudoephedrine as adjunctive therapy for neurogenic shock after acute spinal cord injury: a case series. *Ann of Pharmacotherapy*. 2014;34(1):89-93.
7. Rollstin A, Carey MC, Doherty G, et al. Oral albuterol to treat symptomatic bradycardia in acute spinal cord injury. *Intern Emerg Med*. 2016;11:101-05.
8. Evans CH, Duby JJ, Berry AH, et al. Enteral albuterol decreases the need for chronotropic agents in patients with cervical spinal cord injury-induced bradycardia. *J Trauma. Acute Care Surg*. 2014;76(2):297-302.

# Nutrition Protocol



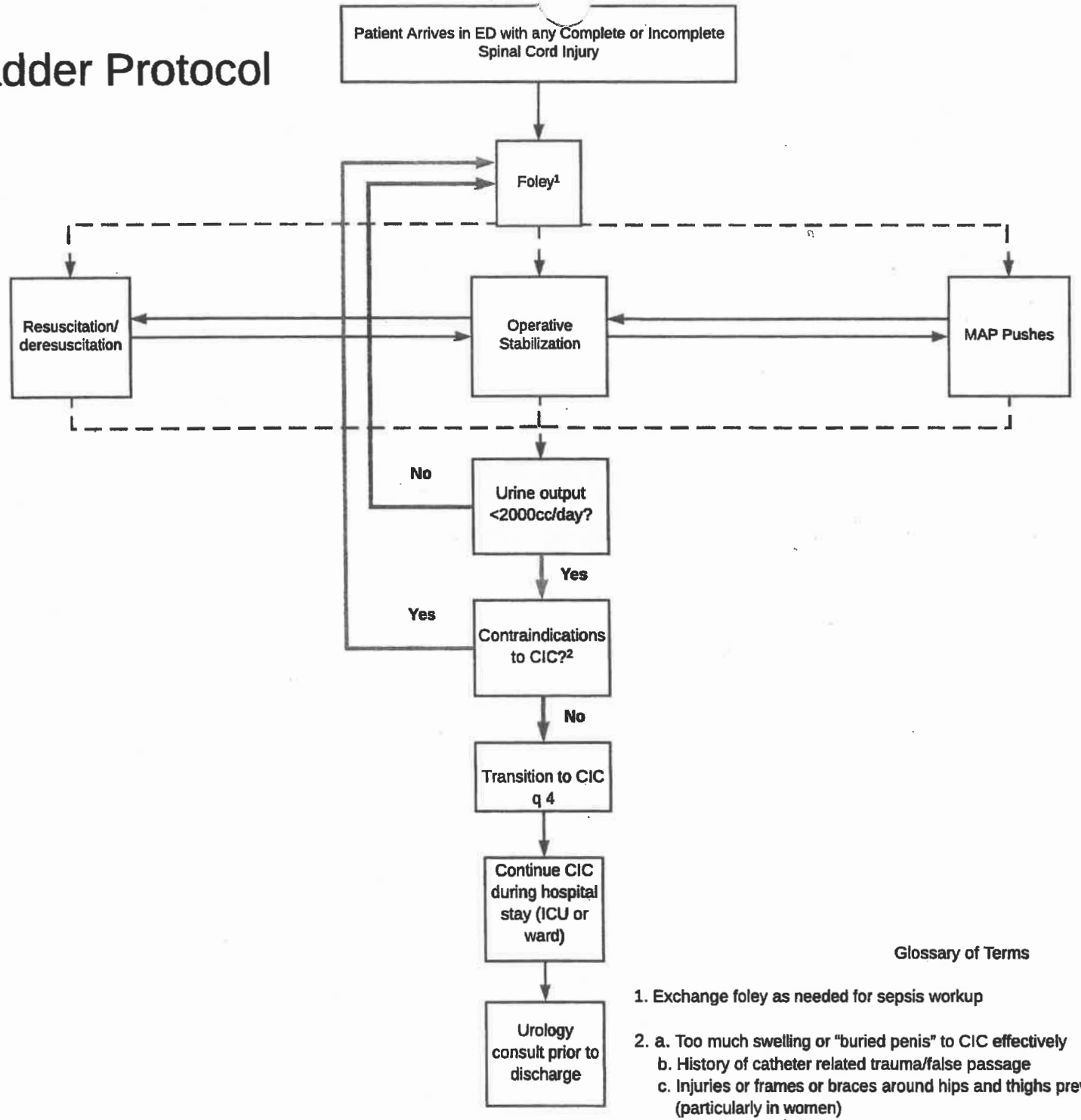
# Bowel Regimen Protocol




**Notes:**

- Metamucil: Supplies fiber to add bulk, making it easier to move stool through the bowel.
- Colace: Keeps the water content of the stool high, keeping it softer and easier to use.
- SDulcolax: Increases the muscle contractions, helping the stool to move along.

# SCI Bladder Protocol

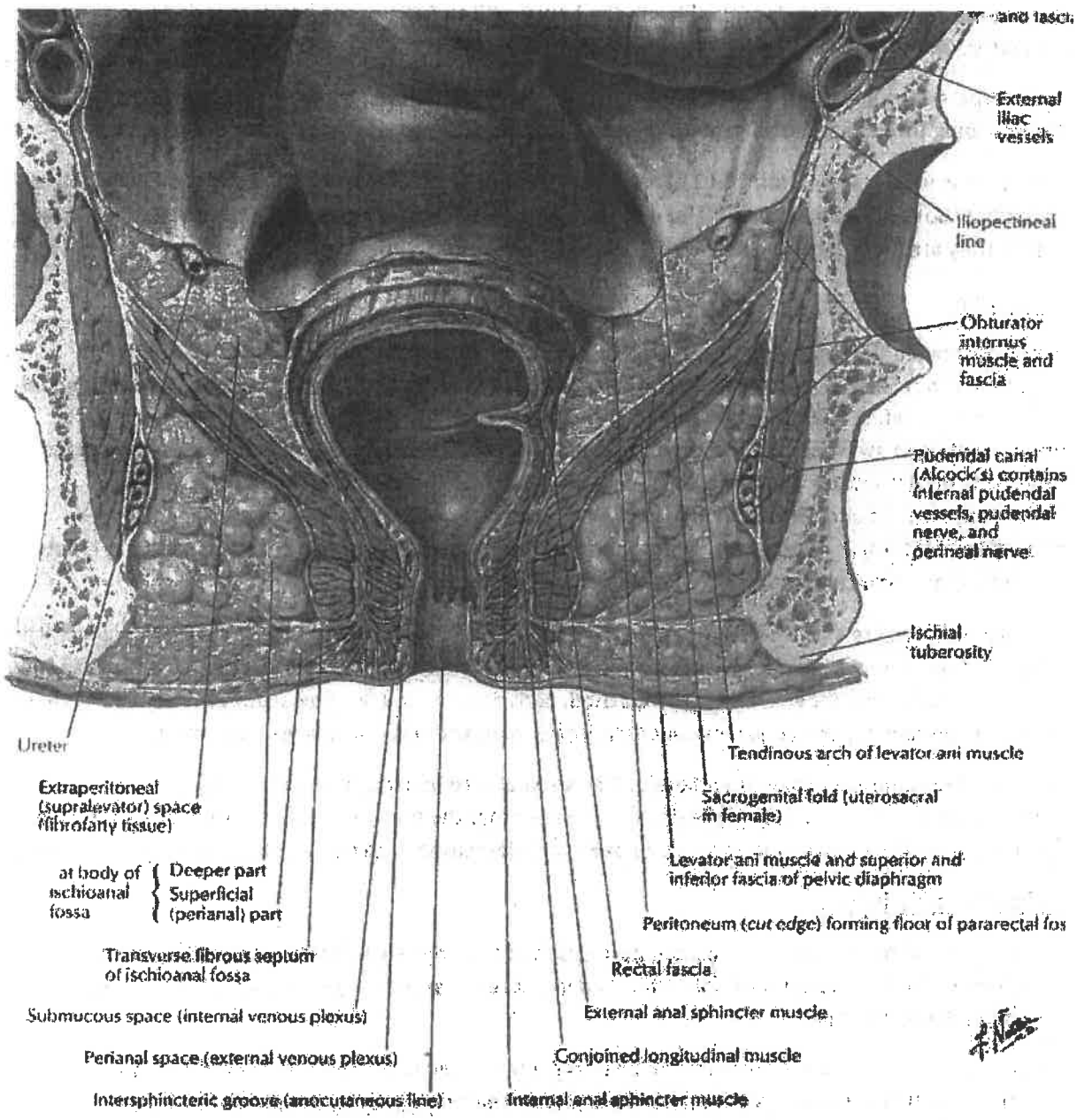



Glossary of Terms

1. Exchange foley as needed for sepsis workup

2. a. Too much swelling or "buried penis" to CIC effectively
   b. History of catheter related trauma/false passage
   c. Injuries or frames or braces around hips and thighs prevent q4h access to urethra (particularly in women)

## Normal and Abnormal Bowel Function:




## Normal bowel:

The last 20 cm of the large intestine is the rectum where stool is stored prior to evacuation. The most distal 2-5cm of the rectum is the anal sphincter. It is actually two distinct sphincters, internal and external. The internal anal sphincter is smooth muscle and has inherent tone and is under reflex control even if normal external control is eliminated. The external sphincter is made of striated muscle, is not tonically contracted, and is under both reflex and voluntary control. In the absence of external innervation it will be areflexic.

Innervation to the bowel is complex but a simplified version is as follows:

The enteric nervous system is embedded in the bowel wall and allows the bowel muscle to perform peristalsis, pushing succus and stool forward towards the anus.

Parasympathetic input comes from the vagus nerve (ascending through transverse) and sacral roots S2-4(descending through anus). In general this increases motility and relaxes sphincters.

Sympathetic input comes from T6-L2 nerve roots. This usually decreases motility and tone and contracts sphincters. Both sympathetic input and parasympathetic input have an effect on the enteric system and in turn they are also affected by centers in the brain and spinal cord.

Defecation:

In normal bowel, this is a reflex activity under voluntary control. Mass movements propel stool to rectum which relaxes and fills with little pressure. Once the rectal pressure rises, this triggers the rectal-anal inhibitory reflex and the internal sphincter relaxes. With more filling a signal is sent back to the brain resulting in awareness of the need to empty to bowel. The external sphincter starts to contract reflexively until a socially appropriate time to defecate, then the sphincter is voluntarily relaxed, abdominal muscles and diaphragm contract which increase pressure in rectum, causing increased relaxation of internal sphincter and the stool is evacuated. The rectum then contracts until it is empty. The sphincters then contract and the process begins again.

Neurogenic bowel results after damage to the brain, spinal cord or conus medullaris/cauda equina. The portion of the nervous system injured changes the type of neurogenic bowel. In general, injuries to the brain and spinal cord above an intact conus medullaris result in a *reflex bowel dysfunction*. Injuries at or below L1 can damage the conus medullaris/cauda equine and result in *areflexic bowel dysfunction*.

It is useful to remember that immediately after a spinal cord injury, the bowel, like the bladder, has a short period of spinal shock or areflexia. It is common that the first 24-48 hours after injury to the high spinal cord that the bowel and anus are relaxed with decreased motility before regaining reflex function.

Reflex bowel dysfunction:

The patient will have impaired or absent perception of the need to defecate, impaired or absent voluntary control of the external sphincter, and intact reflex arcs through conus medullaris/cauda equine in the anorectum.

Gradually increasing tone in the external anal sphincter, pelvic floor, and colon wall (think post SCI spasticity) resulting in less effective peristalsis, and increased segmental peristalsis (inefficient propulsion), increased transit time. This can also lead to anorectal dyssynergia in which the anus and the rectum are not on the same team. When the rectal contracts, the anus does not relax as it should and vice versa. Usually this leads to constipation although intermittent uncontrolled evacuation can occur. Residual reflex activity can be used to aid in bowel management.

Areflexic bowel dysfunction:

The patient will have impaired or absent perception of the need to defecate and impaired or absent voluntary control of the external sphincter. Reflex arcs and autonomic nerves through conus medullaris/cauda equine in the anorectum are absent or impaired. No spinal cord mediated peristalsis

occurs in the sigmoid and rectum. External sphincter is flaccid. Internal sphincter has reduced tone, pelvic floor is relaxed and sigmoid/rectum descends into pelvis, anorectal angle is decreased and opens the rectal lumen. Both fecal incontinence and constipation are common. Usually no residual reflex activity to aid in bowel management. Manual evacuation of bowels more common. Bowels must be emptied much more frequently to avoid incontinence.

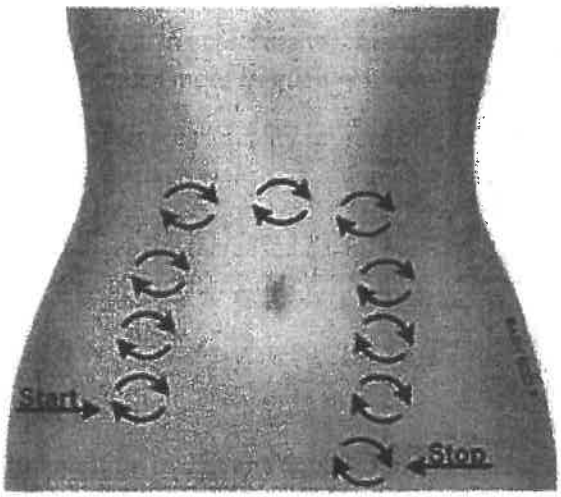
There are few high quality sources of evidence on the optimal bowel management after SCI. Variability in injury levels as well as variation amongst individuals may make this more difficult. However, complications of a poorly managed bowel program are fecal leakage/incontinence, constipation, abdominal pain, increased risk of pressure sores, hemorrhoids, fissures, rectal prolapse, autonomic dysreflexia, and stercoral perforation. All of these result in decreasing quality of life for the patient.

## Tools include:

Optimization of diet and liquids: Aim for Bristol stool scale 4 consistency

Taking advantage of the gastrocolic reflex, if present: Data suggests this is equivocally present in SCI patients but it is still useful if present. The patient should receive intragastric food or drink 15-30 minutes prior to planned defecation.

Abdominal massage: Used by 20-30% of patients and there is some data to suggest a measurable response in the rectum from abdominal massage.




Constipation Massage Path

Massage should be done with the heel of the hand or a tennis ball starting in the RLQ and proceeding around the abdomen in a clockwise direction. Massage should be medium firm in small circles.

Rectal stimulatory suppositories/enemas: These are used by over 70% of people with neurogenic bowel and ***cannot*** be replaced by oral preparations. Stimulant suppositories activate any anorectal reflexes present. Bisacodyl is the most commonly used.

Oral laxatives and stool softeners: These should be used as needed to maintain Bristol stool scale 4 consistency. They ***cannot*** stand alone as neurogenic bowel management and should only be used as needed for a given patient's diet and medications.

Digital Rectal Stimulation: This is used in conjunction with a stimulant suppository and most people need both. A gloved finger is inserted and the rectal wall gently massaged in all four quadrants for 20-30 seconds per wall. Signs of activation of the reflex include passage of stool or gas, relaxation of the external sphincter and occasionally contraction of the internal sphincter(a sign of colonic activity).

The finger is then removed so reflex defecation can occur. Stimulation should be repeated every 5-20 minutes until defecation is complete, and/or rectal vault is empty, or digital stimlulation no longer prompts then reflex. If stool is still present, it should be removed manually.

Digital disimpaction: this is digital removal of stool and should be used in early acute SCI when bowel is still areflexic to prevent over distention. Overdistention, as in neurogenic bladder, can lead to impaired reflex function after return of reflexes and permanent damage can occur.

References:

Callaghan, B., Neural pathways for colorectal control, relevance to spinal cord injury and treatment: a narrative review, Spinal Cord,(2018) 56:199-205

## Genitourinary System:

**Normal Bladder Function:** When the bladder and sphincter are functioning normally, they are controlled by sympathetic, parasympathetic and somatic pathways. A simplified description of its function is as follows: The bladder muscle (detrusor muscle) is designed to fill (relax) and empty (contract) in concert with the urinary sphincter which contracts to hold urine in the bladder and relaxes to release it. Most people empty their bladder at a volume of 300-500 cc and this repeated action takes a total of only several minutes of every day. Therefore, the bladder is usually in a slowly relaxing state and the sphincter is usually contracted. When a socially appropriate time arises in a person with a full bladder, the cerebral cortex releases the pontine micturition center to signal the sacral nerve complex to contract the detrusor muscle and relax the sphincter. Voiding ensues. Then the bladder returns to its filling state, where the sphincter is contracted and the detrusor relaxed. The cycle repeats.

**Acute Spinal Cord Injury**: Immediately after complete or incomplete spinal cord injury, the GU system suffers from the same spinal shock as other autonomic systems. The bladder becomes flaccid as does the sphincter and is atonic and nonfunctional. Over time, lower reflexes return. Time to return of reflexes is variable, average is around 6 weeks. Unfortunately, the reflex contraction of the detrusor (to empty) is frequently no longer coordinated with relaxation of the sphincter. This is called Detrusor Sphincter Dyssynergy or DSD. When the sphincter and detrusor are no longer working together, the bladder can overdistend. This can lead to such overdistention of the bladder that the actin and myosin fibers are permanently stretched beyond their limit and the muscle cannot regain its emptying function. The other risk is that the high pressure created by the overdistended bladder and contracted sphincter can cause reflux of urine up the ureters and back into the kidneys, causing upper urinary tract infections and renal damage.

Regaining control over bladder function is critical to the patient with a SCI. It is important to their health through of prevention of UTIs, pyelonephritis, kidney injury, penile urethral destruction from poorly maintained catheters, and skin breakdown from perpetual wetness. It is also critical to the patient's psychological wellbeing. Control of urine output with release of urine at socially appropriate times is a task we usually learn as children and failure to maintain control can be embarrassing, socially isolating, and psychologically devastating. Therefore, appropriate treatment of bladder dysfunction after SCI is crucial to the patient's future longevity, mental health and quality of life.

Complete versus incomplete Spinal Cord Injury patients: There is significant evidence that both complete and incomplete SCI patients have lower urinary tract dysfunction. This includes ambulatory SCI patients. . The ability to walk should not give the health care team a false sense of security about SCI related urinary dysfunction. Do not treat anyone with any new SCI as if they were normal patients with intact GU systems.

Protocol and Flow chart explanation:

**Resuscitation and Deresuscitation:**

A foley should be placed immediately on arrival using aseptic technique. The foley should remain in place until the period of resuscitation and deresuscitation from trauma and all major surgeries is over. It is appropriate and encouraged to exchange the foley for workups of fever or leukocytosis.

**Post Deresuscitation:**

Once the deresuscitation is complete and the daily urine output is under 2000cc per day, the foley should be removed and intermittent straight catheterization (CIC) should begin. A condom catheter should never be used at this stage. CIC should start as soon as possible for two reasons. Firstly, CIC has slight to moderate benefit over indwelling catheters in prevention of UTIs. Secondly, intermittent distention and release of the detrusor muscle at healthy, moderate volumes may help avoid detrusor overactivity and DSD and assist with return of bladder function in the future. (Gretzer) No patient with a complete or incomplete SCI should transition to condom catheter or voluntary urination without a urology consult.

**Preparation for discharge:**

We can maintain good foley or CIC care and technique while the patient is in the ICU or on the floor. Presumption that this level of care will continue in the next phase of care at home, in a skilled nursing facility, or rehab facility is dangerous. Health care providers, patients and patients' families will vary on their understanding of the importance of continuing this care. They may also fail to understand the impact of removal of the catheter or cessation of CIC in SCI patients. Our reconstructive urologists see these patients in the subacute and chronic setting and have a real-time sense of what level of care different institutions in Southern Arizona can provide. Therefore, a urology consult ***just prior to discharge*** is necessary to:

- assess the risks and benefits of the bladder management plan as the patient moves to the next stage of recovery
- adjust the GU protocol for the level of care at the next institution
- discuss the bladder management plan with the patient and their family and begin their education on potential treatments in the outpatient setting
- plan the intensity of urology follow-up the patient will require based on their extent of injury, comorbidities, future rehabilitation location, and socioeconomic issues.

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**Lower urinary tract** dysfunction in the neurological patient: clinical assessment and management.
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Acute spinal cord injury--do ambulatory patients need urodynamic investigations?

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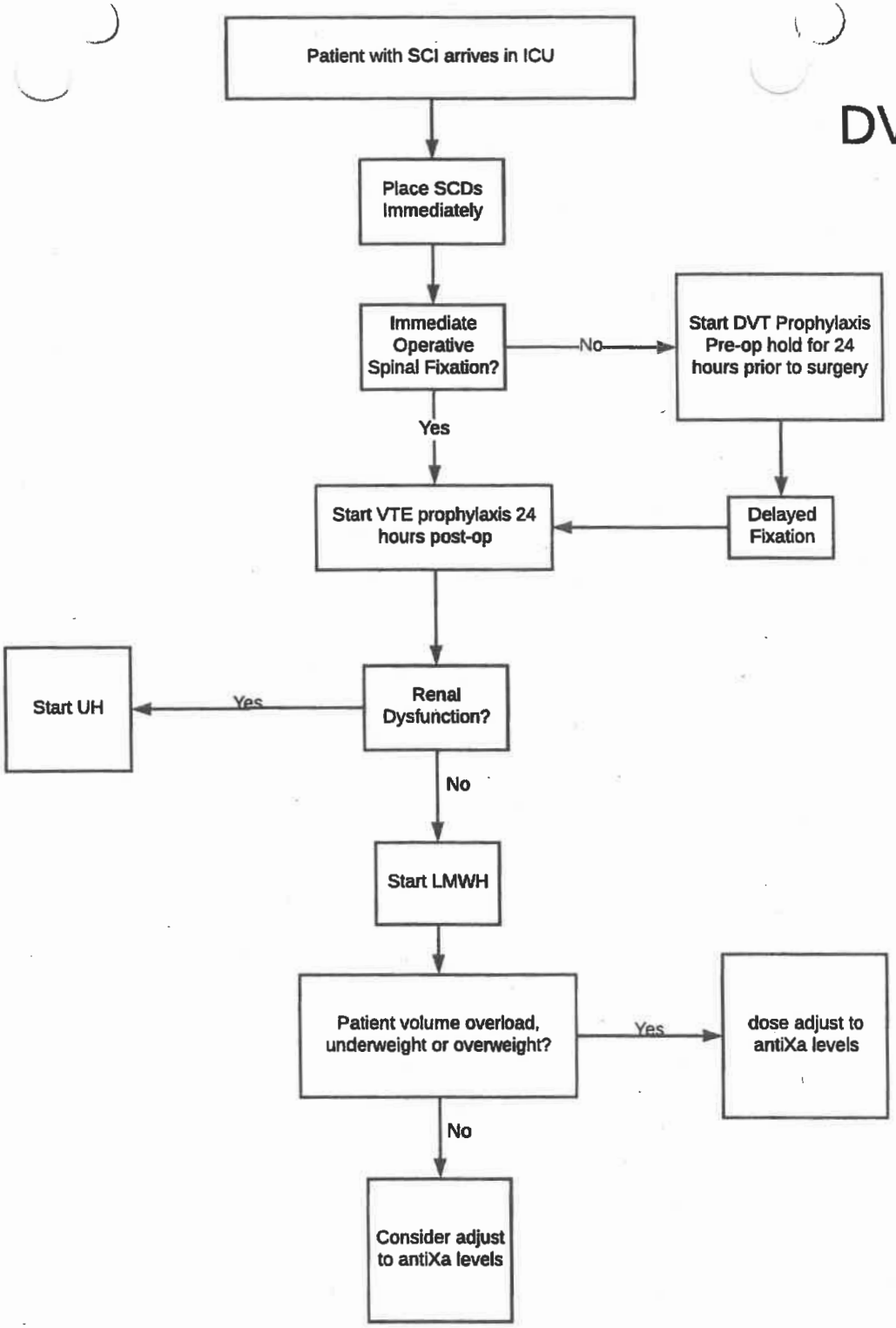
# Bristol Stool Chart

| | | |
|---|---|---|
| Type 1 |  | Separate hard lumps, like nuts (hard to pass) |
| Type 2 |  | Sausage-shaped but lumpy |
| Type 3 |  | Like a sausage but with cracks on its surface |
| Type 4 |  | Like a sausage or snake, smooth and soft |
| Type 5 |  | Soft blobs with clear-cut edges (passed easily) |
| Type 6 |  | Fluffy pieces with ragged edges, a mushy stool |
| Type 7 |  | Watery, no solid pieces. **Entirely Liquid** |


Start Skincare Protocol immediately on admission:

1. On sacrum and bony prominences: Moisture Barrier cream apply q 6 h and each episode of incontinence and/or place sacral foam dressing
2. Elevation of heels
3. Q2h turns to 30 degrees
4. Skin checks q shift
5. Start high flow low air loss mattress immediately after spine stabilization
6. Try to keep post-operative collars or braces off while in bed under 30 degrees and supine unless strictly specified otherwise

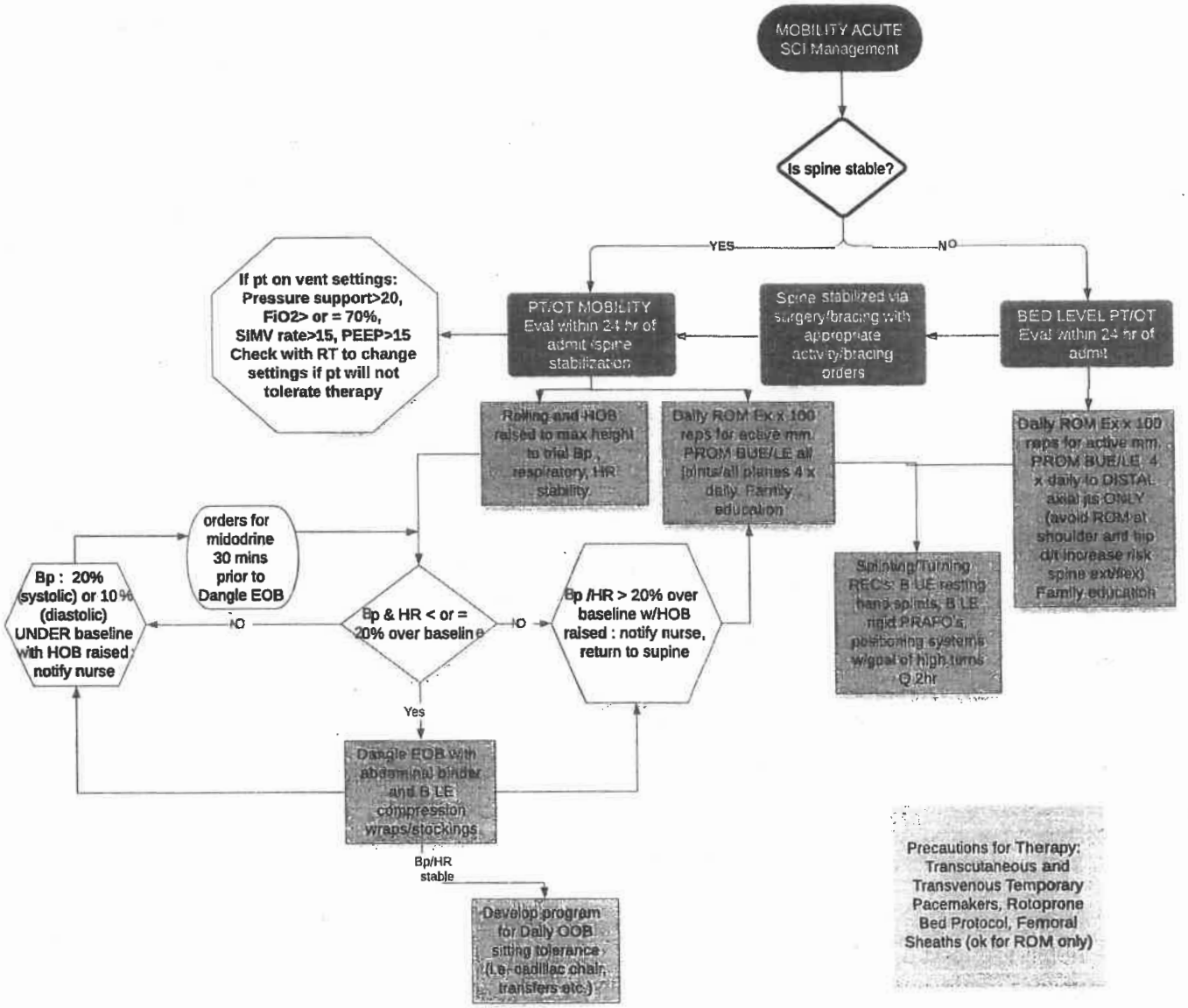
# DVT Prophylaxis Protocol




Note: IVC filters not recommended as VTE prophylaxis esp. in high T spine or C spine injuries

# Mobility Flowsheet

Jaime Levengood | March 11, 2013



## Braces and Collars:

Prior to surgical stabilization, the patient should remain in the brace or collar in the spine neutral position.

Post-operatively, most braces and collars are ordered at the spine surgeon's preference to support the repair for a number of weeks, but the stabilization is not dependent on the collar or brace. Post-operative braces and collars are not mandatory and some spine surgeons will opt not to brace certain injuries post-operatively.This is different from spine injuries for which the brace or collar is the definitive therapy and no surgery is planned.

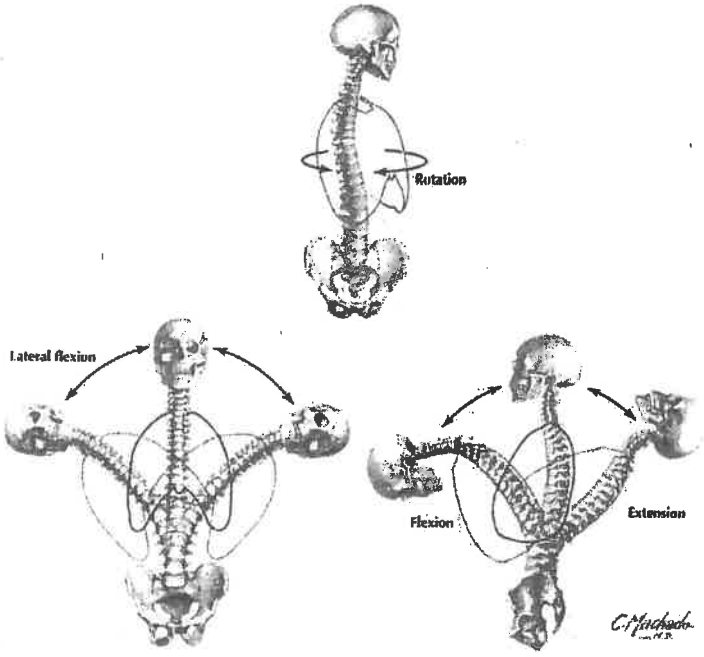
If the SCI patient has a post-operative collar or brace, they should have the brace/collar off while in bed and with HOB less than 45 degrees. If they are in a high turn or have HOB greater than 45 degrees, the collar or brace should be donned prior to the high turn or upright position.

Pads on braces and collars should be examined twice a day and washed or exchanged as needed. If a brace or collar fits poorly, the spine service and/or the orthotic manufacturer should be contacted for adjustments.

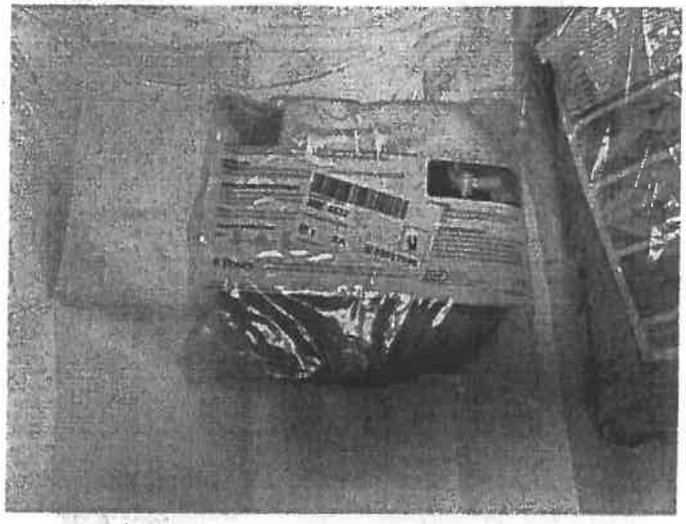
**Positioning and skin care in the patient with an unstable spine:**

If the patient has an unstable spine which will require a halo or surgery:

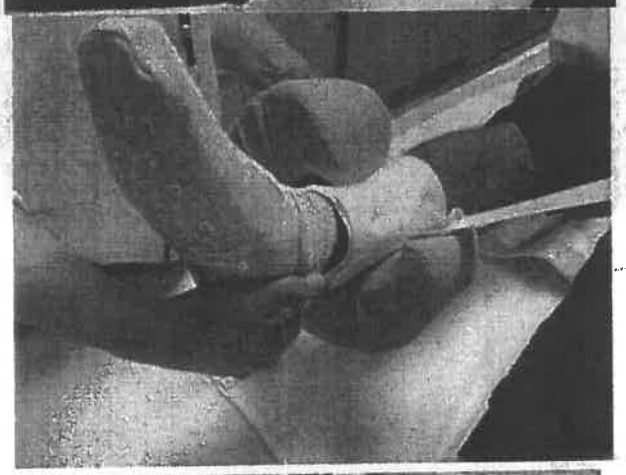
The spine should remain in a neutral position until it is stabilized.
Neutral is not the same as no log rolls, no turns, totally supine. Neutral means the patient can be turned or rolled as long as the spine does not bend or rotate out of neutral alignment.

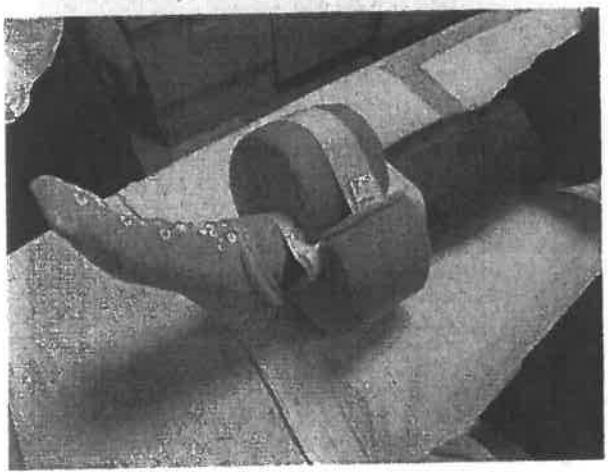


# Turns and pressure relief pack for SCI patients:



What's in the pack:
Two large Posey wedges
One medium Posey wedge
One draw cloth
Ankle rolls: these come in medium and large

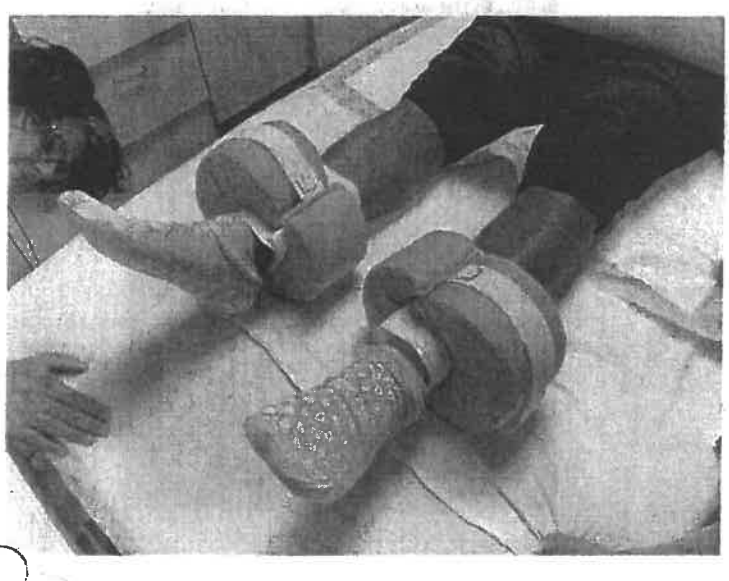




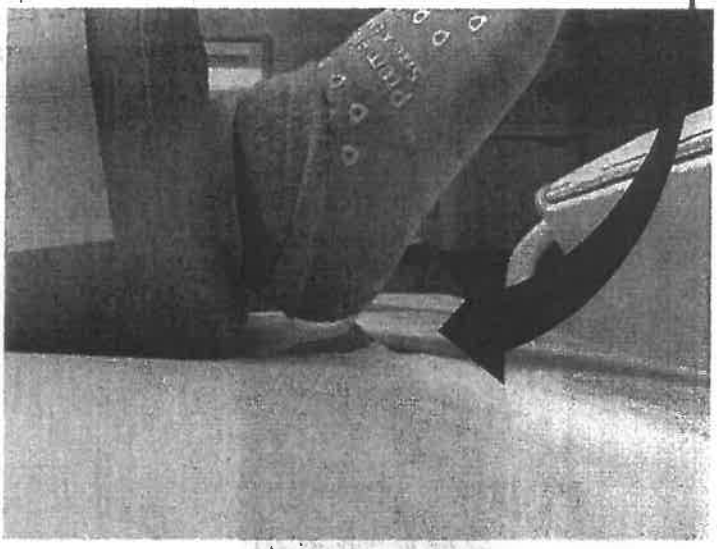
Use the ankle rolls instead of the PRAFOs when the patient is not supine.

How to apply the ankle rolls:
Wrap the lower leg with the protective cloth.
Wrap the ankle roll around the ankle

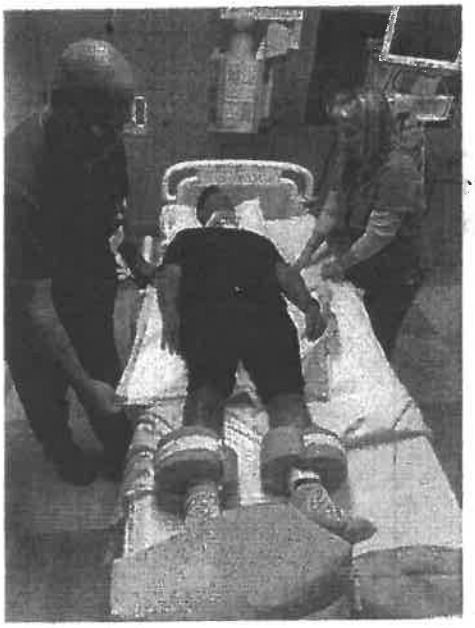
Done.



Both rolls in place and heels floating



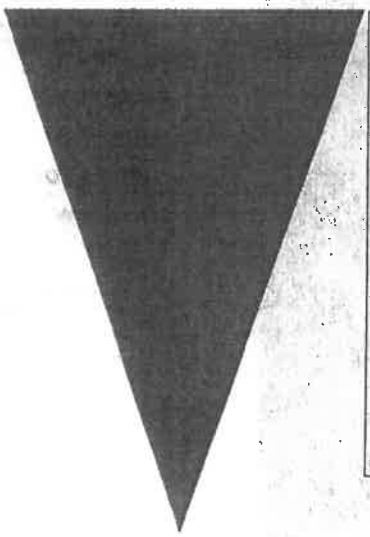
# Ready for your turns?



Place the draw cloth so the head and top are oriented correctly. Draw cloth can be washed in separate laundry and returned to the patient. They are single patient only.

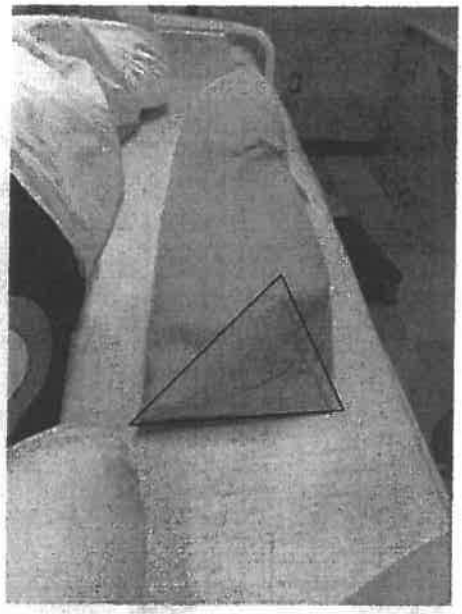
"Head"

"Top side"

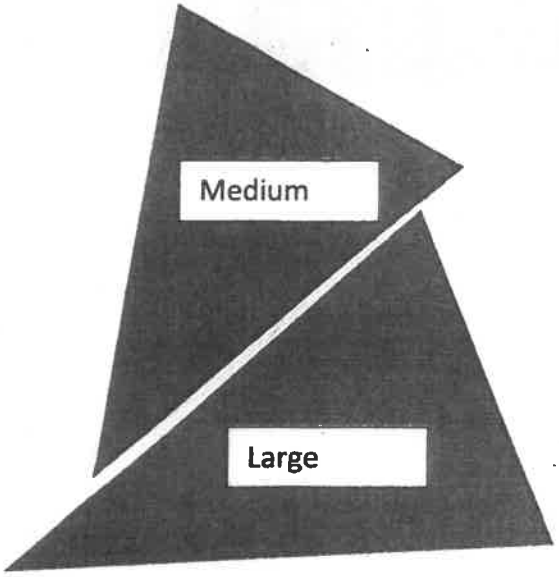



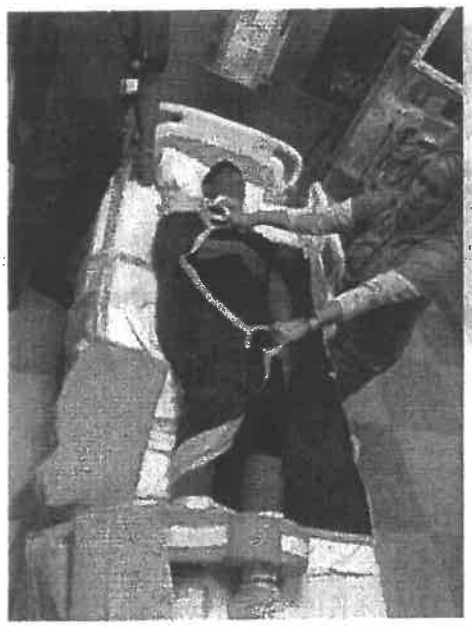
The Posey wedges have a specific natural triangular shape.

The long pointy end should "point" under the patient.



The pointy ends go under the patients.
We have found it works best with the two large wedges as the bottom layer and the medium as the top layer.
We placed the medium centered around the lower abdomen and hips for best effect..

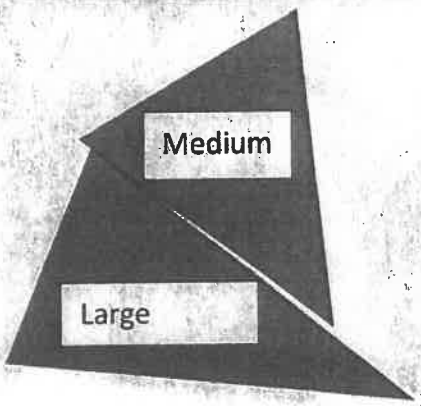




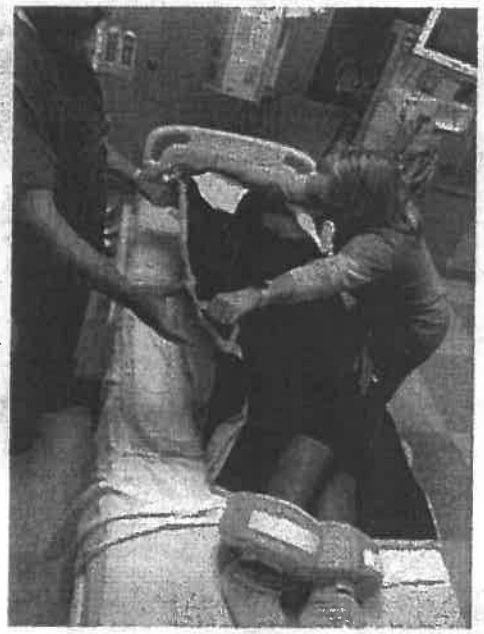
Roll the patient up using the handles of the draw sheet.

Large wedges first....

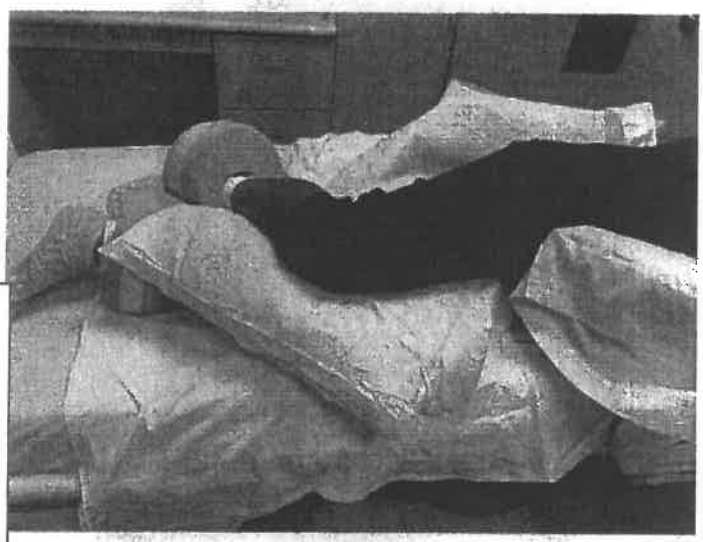
Then medium wedge on top. Point of the wedge toward the patient

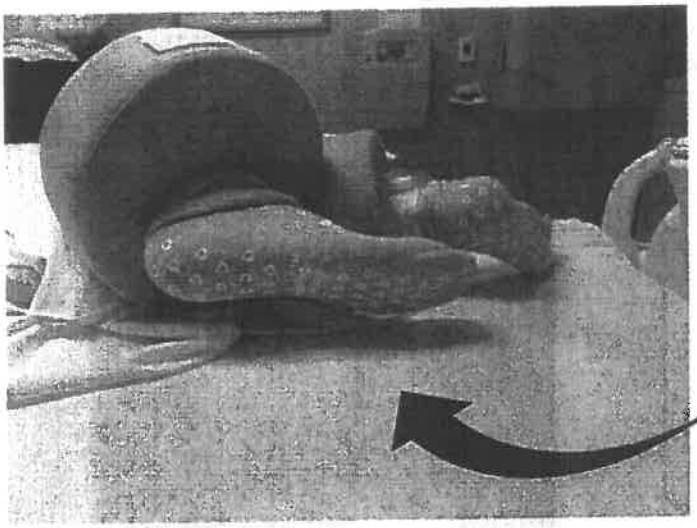


Let the draw sheet drape back down



Bring the top leg forward and pad the space between the knees

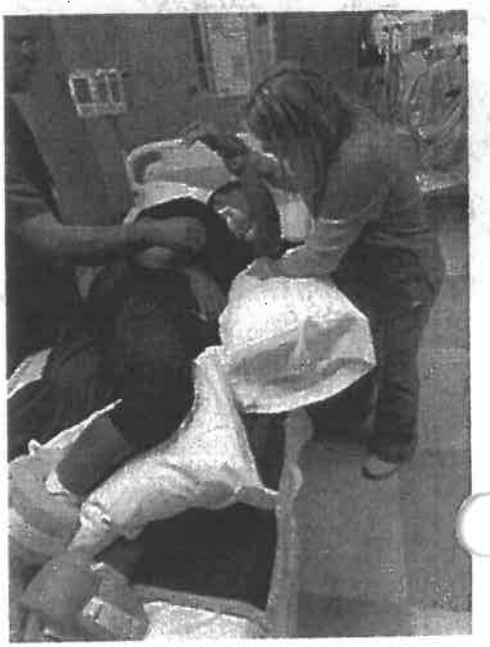




Feet and ankles still floating!

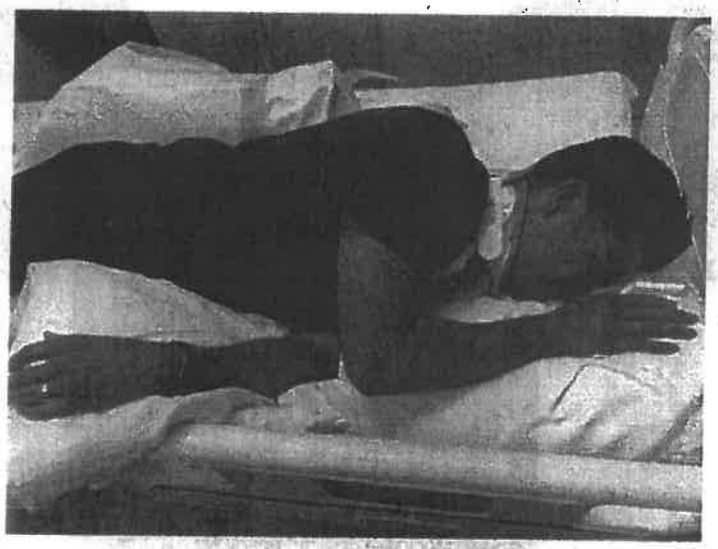
This shoulder is now pinched under the body.

Bring the lower shoulder forward and pad it for comfort.



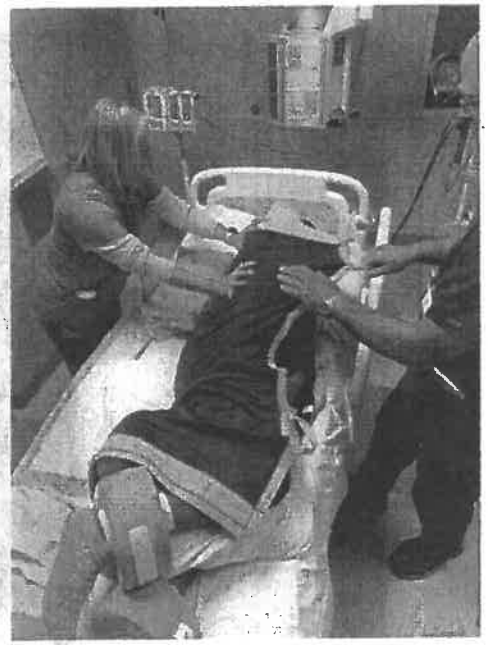
Final result: Beautiful turned position!

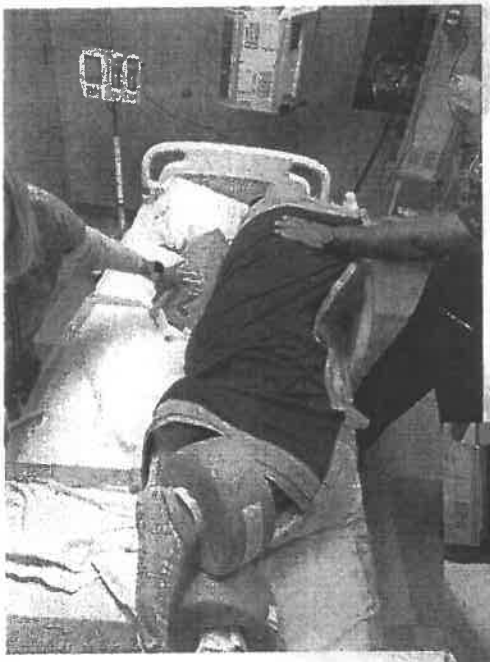
Alternate arm position for the patient who will not reach for tubes.



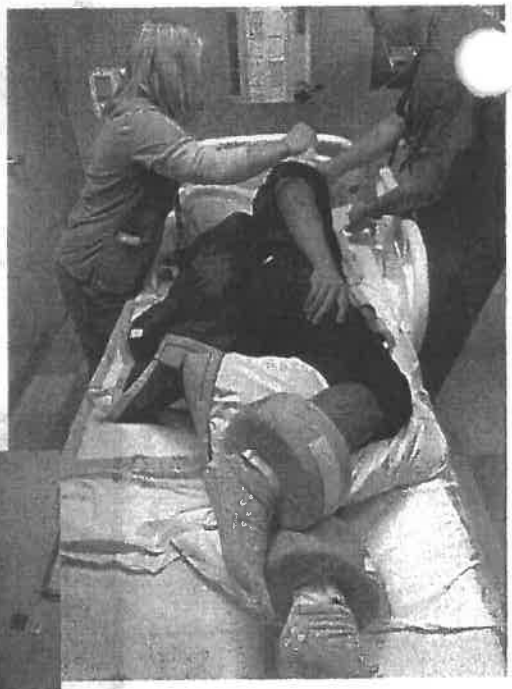
# Very high turn:

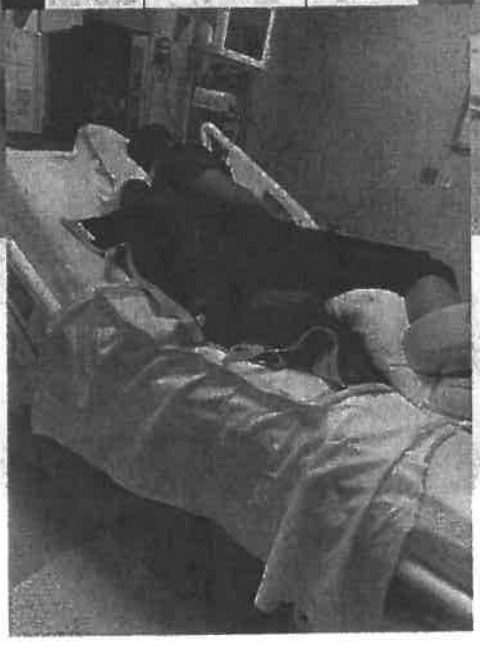
Once again roll up and place wedges deep under patient with pointed end towards the patient

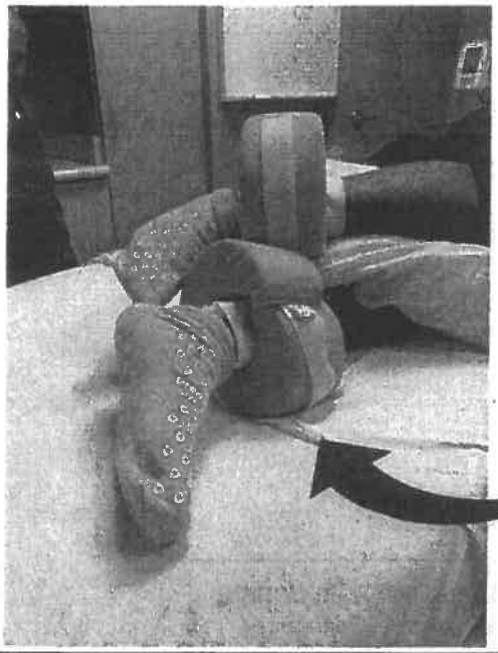




True lateral is easy and great for his sacrum!

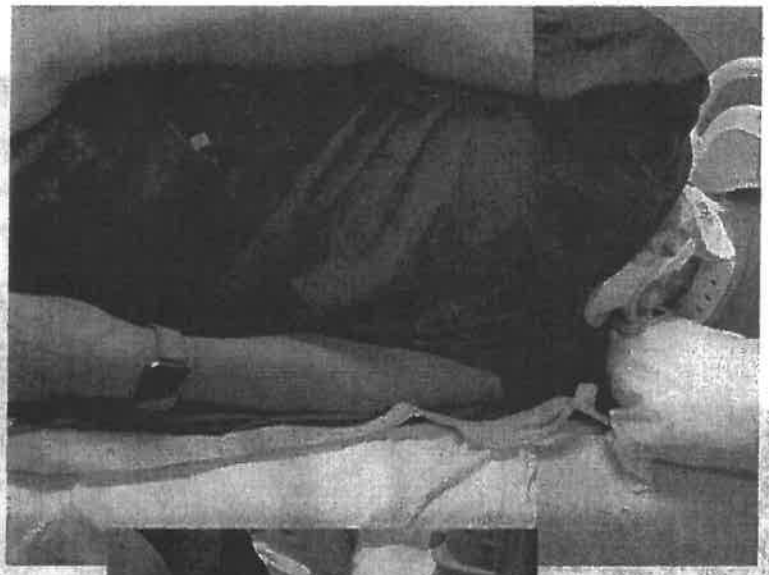






Once again bring the leg forward and make sure the feet are floating.

Then move on to freeing and padding the arms.



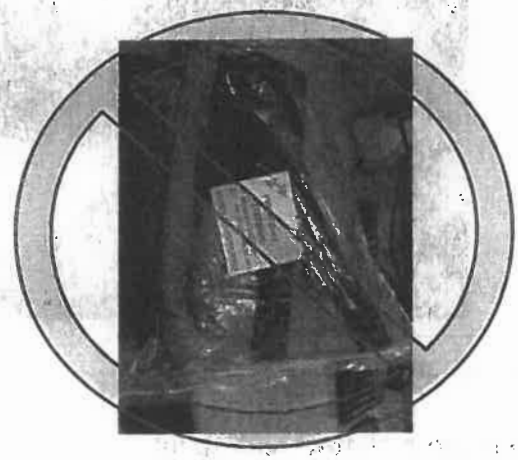
Pinched arm needs to move forward...

See how shoulder is positioned anteriorly?

Pad lower or dependent arm

Several different ways to position upper arm depending on patient's level of injury, cooperation, mental status and habitus

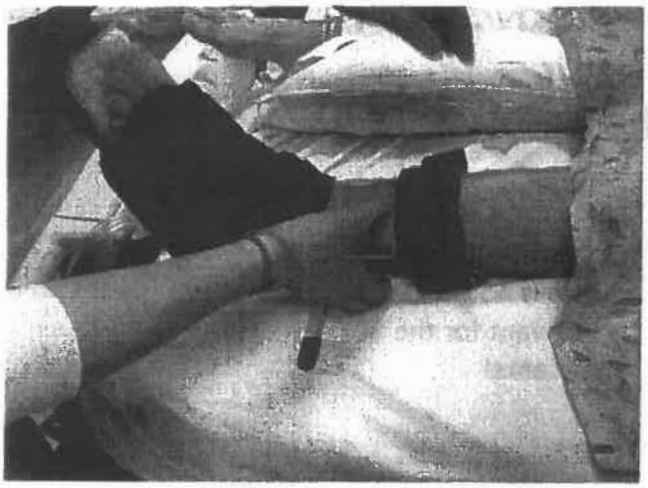
# PRAFOs and Cockup splints:

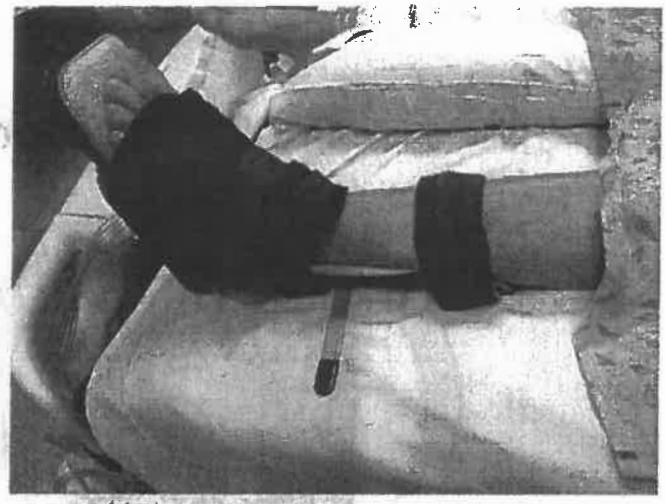


This is not the PRAFO we want for the SCI patients!

The is the rigid PRAFO we use for the SCI patient! How to order:
DME/Non Med
"Hangar Consult for rigid PRAFOs"

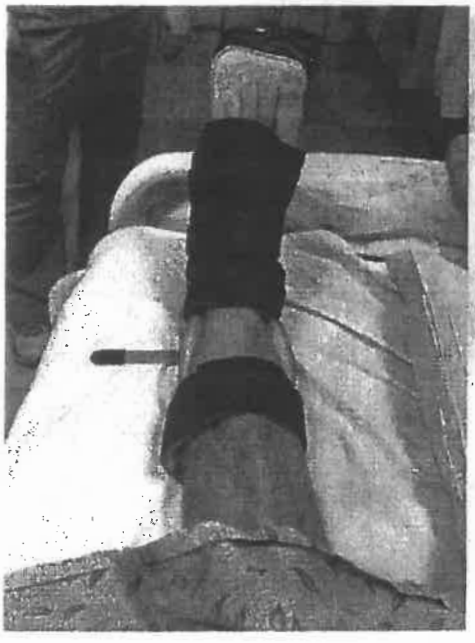
To apply the rigid PRAFO:
Open it all the way and place foot in splint.





Close Velcro wraps around foot and push kickstand out **laterally.**
Plantar surface of foot should be in contact with splint everywhere. Most of the heel should not touch splint at all.

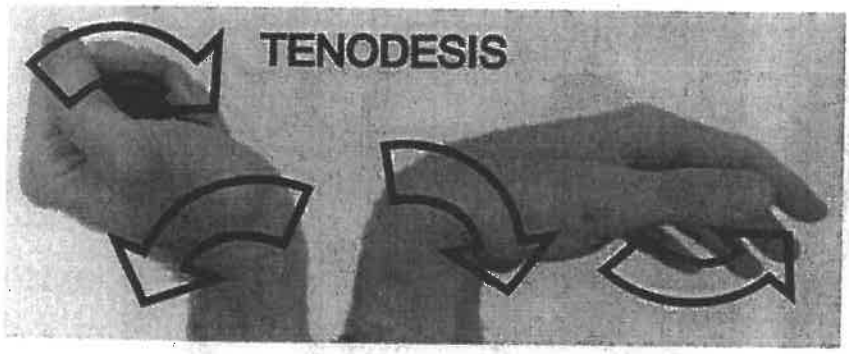
Notice heel floating away from splint.



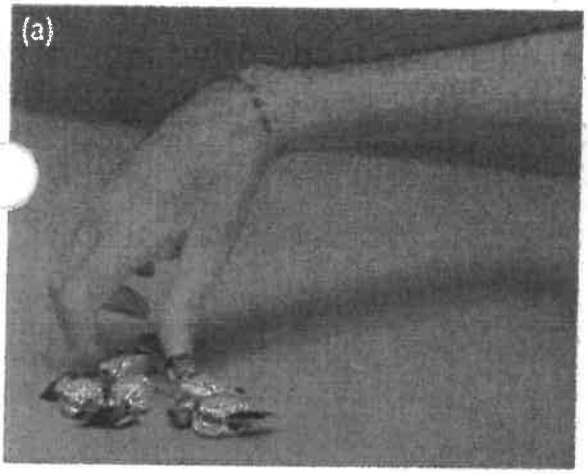
Done!

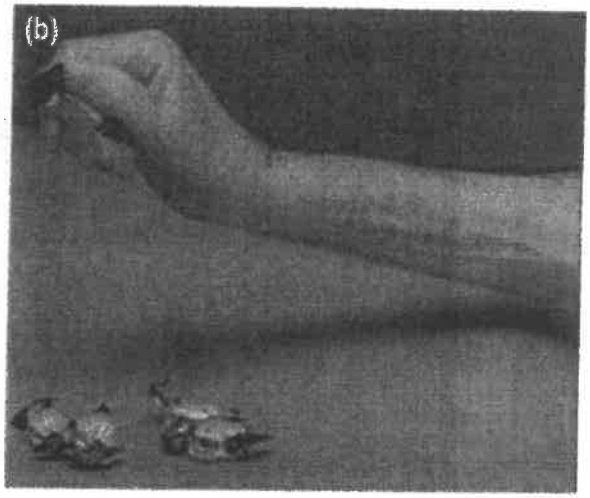
Q: How long do you leave these on?
A: Your therapist should make recommendations for an on/off schedule, but in general it is recommended these be worn two hours on, two hours off.

## Why are these resting hand orthoses so important?

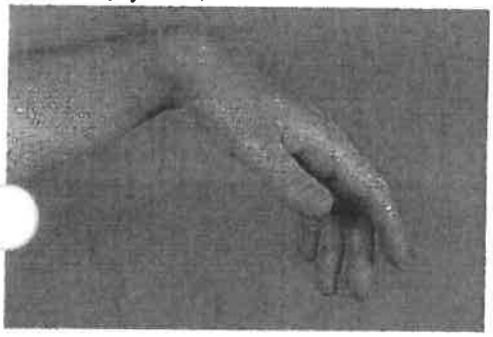



Tenodesis is the natural tendency of the fingers to curl or flex when the wrist is extended.

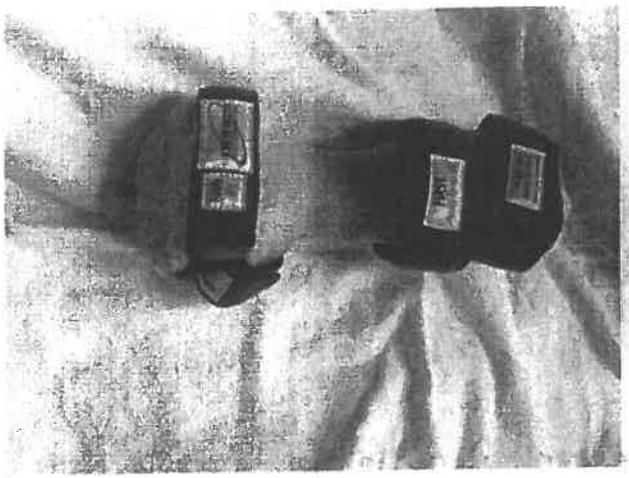


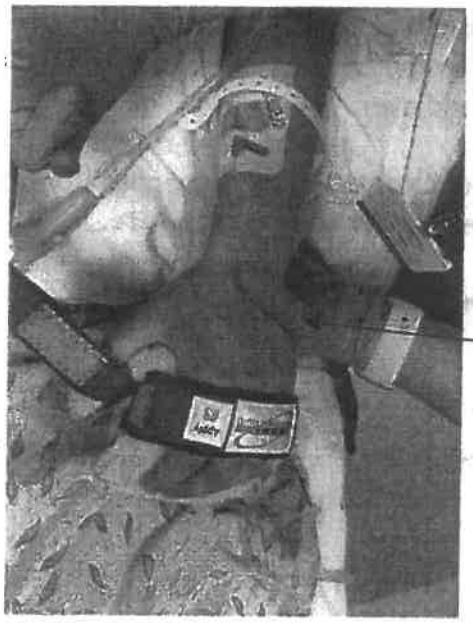

This allows for a patient to grasp an object even if they have a spinal cord injury and cannot control their hand/finger, but can control their wrists.
Maintaining wrist extension with the use of Resting Hand Orthoses is a way to prevent wrist flexors from contracture. If contracture occurs, patients are unable to extend the wrist and thereby use wrist extension to grasp. As a result, patients then are unable to perform self care activities.



# Resting Hand Orthoses:



These are the Leeder Resting Hand Orthoses we want!
How to Order:
DME/Non-med
"Hangar Consult for Leeder Resting Hand Orthoses"



It's easiest to start at the fingers and work towards the elbow when placing the straps.

Mold patient's hand to splint as you close straps so there is total contact between the palmar surface of the hand and the splint.

See the thumb pushing the wrist down into the splint and the palm onto the splint.

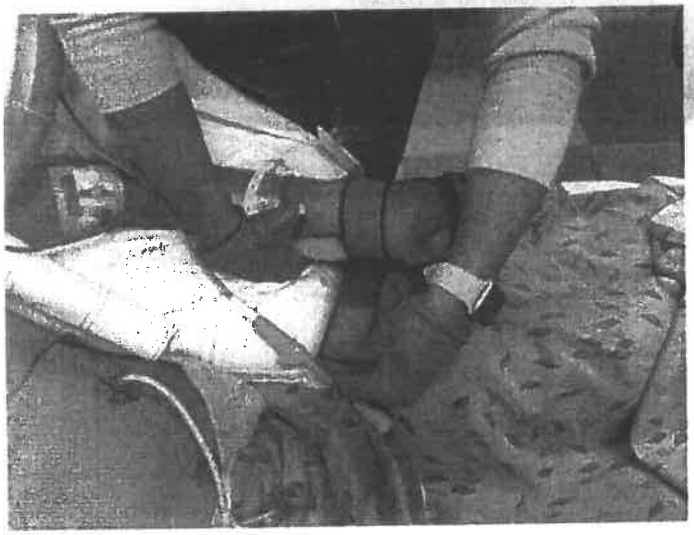
Wrap thumb strap second.

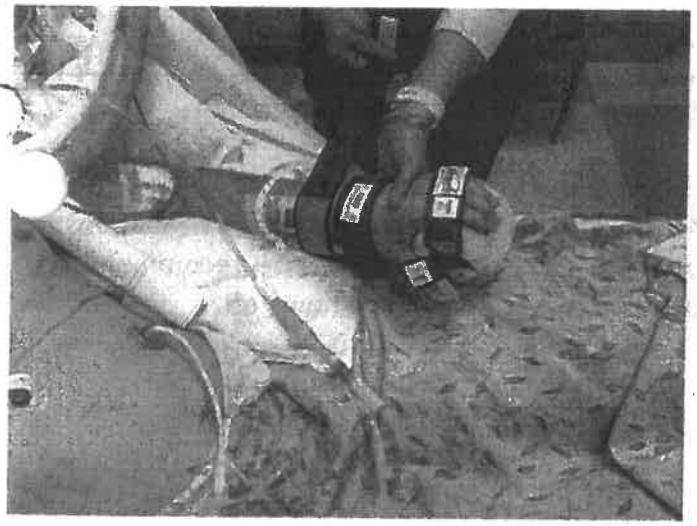
Wrist strap is somewhat unintuitive....
Start by wrapping strap *under* the brace first, then go around and over.

When done correctly, the strap goes from medial to lateral across the wrist as seen here.

Then you see the Velcro appear on top.

You know you have it right if you see first the Velcro on the top and then the words.





Repeat with remaining strap.

Notice how all the labels are on top of the straps when you have done it correctly.

Done!

Q: How long do you leave these on?
A: Your therapist should make recommendations for an on/off schedule, but in general it is recommended these be worn two hours on, two hours off.

**Mobility Team**

Consists of Patient, Family, Physicians, Nursing Staff, Physical Therapy, Occupational Therapy, Speech Therapy

Purpose: 1. Assist in developing interventions that will facilitate recovery

2. Assist in prevention of secondary complications

3. Assist in identification of barriers to recovery

4. Assist with patient and family education and discharge planning

Goals: 1. Improve patient function

2. Prevent the effects of musculoskeletal deconditioning

3. Minimize complications of bed rest

4. Provide realistic recommendations for equipment and discharge

5. Promote patient and family education and participation

6. Improve patients' quality of life

**Expectations of Functional Ability based on level of Spinal Cord Injury:**

**C3/4 Complete:** No Voluntary movement of diaphragm, postural, or peripheral mm. Vent dependent.

| Task/Activity | Expected Functional Outcome | Equipment |
|---|---|---|
| Positioning | Total Assist | High turn air mattress with Q2 hr turns, Power tilt-in-space wheelchair with postural and head control systems, B UE/LE resting splints to prevent contractures |
| Bed mobility | Total Assist | Turn and position system |
| Transfers | Total Assist | Mechanical Lift |
| Mobility | Total Assist | Power tilt-in-space with ventilator tray and specialized head/postural/lateral control systems (sip and puff system may be optional to promote independence) |
| Toileting | Total Assist | N/A |
| Showering/grooming/dressing | Total Assist | N/A |
| Eating/feeding | Total Assist | Drinking system attached to w/c may promote independence |

**C3-6 complete:** Voluntary movement limited to diaphragm and upper back mm with preservation of shoulder elevation, retraction, partial protraction and partial extension/abduction/adduction. No grip function or trunk stability. May develop tenodesis to assist with UE function.

| Task/Activity | Expected Functional Outcome | Equipment |
|---|---|---|
| Positioning | Total Assist | High turn air mattress with Q2 hr turns, Power tilt-in-space wheelchair with postural and head control systems, B UE/LE resting splints for overnight use to prevent contractures, B wrist cock-up splints during day to assist with UE function |
| Bed Mobility | Total Assist | Turn and position system |
| Transfers | Total Assist | Mechanical Lift |
| Mobility | Manual Wheelchair: dependent<br>Power Wheelchair: independent with specialized systems | Manual: lightweight rigid or folding frame with high back and lateral support<br>Power: tilt-in-space with specialized postural/lateral control systems (specialized hand control systems with use of cock-up splint to promote independence) |
| Toileting | Total Assist | N/A |
| Showering/grooming/dressing | Total Assist | Mobile shower chair with custom padded seat, tilt-in-space function and padded are rests |
| Eating/Feeding | Total Assist for set-up, then independent with eating equipment | Wrist cock-up brace<br>Adaptive feeding equipment<br>Drinking system |

**C5-C8 Complete:** All or most triceps function present. Wrist flexion and extension present. Most/all finger flexion and extension present permitting grasp and release functions or have tenodesis present to assist with UE function. No trunk stability.

| Task/Activity | Expected Functional Outcome | Equipment |
|---|---|---|
| Positioning | Independent | Hi-low hospital bed with pressure relieving mattress or overlay, B UE/LE resting splints for overnight use to prevent contractures, B wrist cock-up splints during day to assist with UE function |
| Bed mobility | Moderate Assist to Independent | Hi-low hospital bed with rails |
| Transfers | Minimal assist to independent with lateral or "T-bone" style | May require use of slide board |
| Mobility | Manual: independent<br>Power: independent | Lightweight rigid or folding frame manual wheelchair with modified push rims and trunk support |

| | | |
|---|---|---|
| | | Power : recommended for long distances |
| Toileting/showering | Minimal Assist to Independent | Mobile shower commode with side cut-out for access, adaptive equipment |
| Grooming/dressing | Minimal Assist to Independent | May need adaptive equipment |
| Eating/feeding | Independent | May need adaptive equipment |

**T1-T5 Complete:** Upper extremity function present. Partial abdominal/back support present. Little trunk stability.

| Task/Activity | Expected Functional Outcome | Equipment |
|---|---|---|
| Positioning | Independent | Hi- low hospital Bed with pressure relieving mattress or overlay, , B LE resting splints for overnight use to prevent contractures, |
| Bed mobility | Independent | Hi-low hospital bed with rails Ensemble bed with rails |
| Transfers | Independent: lateral or "T-bone" style | Slide board may be required |
| Mobility | Minimal assist to Independent | Ultra-lightweight rigid or folding frame manual wheelchair with lateral support and/or higher back(ex. "quickie" wheelchair) |
| ing/showering | Minimal assist to Independent | Shower seat with lateral support, Over toilet aid with padded seat, adaptive equipment |
| Dressing/grooming | independent | Adaptive techniques/equipment |
| Eating/feeding | Independent | N/A |

**T6-T10 complete:** Upper extremity function present. Abdominal and back muscle functions present. Good trunk stability

| Task/Activity | Expected Functional Outcome | Equipment |
|---|---|---|
| Positioning | Independent | pressure relieving mattress or overlay, , B LE resting splints for overnight use to prevent contractures, |
| Bed Mobility | Independent | Ensemble bed side rails may be required |
| Transfers | Independent with lateral or T-bone style | Slide board may be required |
| Mobility | Independent with good to excellent wheelchair skills | Ultra-lightweight rigid or folding frame manual wheelchair (ex. "quickie" wheelchair) |
| Toileting/showering | Independent | Shower seat, Over toilet aid with padded seat, adaptive equipment |
| Grooming/dressing | Independent | Adaptive equipment |
| Eating/Feeding | Independent | N/A |

**T10-L1 Complete:** Upper extremity function present. Abdominal and back muscle functions present. Good trunk stability. Some hip flexor and adductor function. Some standing possible. Non-functional walking possible.

| Task/Activity | Expected Functional Outcome | Equipment |
|---|---|---|
| Positioning | Independent | Pressure relieving mattress overlay, B LE resting splints for overnight use to prevent contractures, |
| Bed Mobility | Independent | Ensemble bed with rails if needed |
| Transfers | Independent lateral or T-bone style, squat pivot<br>May do some standing<br>Moderate to Minimal assist with stand pivot transfers | Slide board<br>Walker<br>Knee immobilizers for stability when standing |
| Mobility | Independent with manual wheelchair<br>May do limited walking with Minimal to Maximal Assist | Ultra-lightweight rigid or folding frame manual wheelchair (ex. "quickie" wheelchair)<br>Walker<br>Knee immobilizers for stability with bail lock/releases for swing phase |
| Toileting/showering | Independent | Shower seat, Over toilet aid with padded seat, adaptive equipment |
| Dressing/Grooming | Independent | Adaptive equipment |
| Eating/Feeding | Independent | N/A |

**L2-S2 Complete:** Upper extremity function present. Abdominal and back muscle functions present. Good trunk stability. Fair to good lower limb function. Functional walking possible.

| Task/Activity | Expected Functional Outcome | Equipment |
|---|---|---|
| Positioning | Independent | B LE resting splints for overnight use to prevent contractures, |
| | | |
| Bed Mobility | Independent | Ensemble bed |
| Transfers | Independent with stand pivot | Walker |
| Mobility | Minimal assist to independent with functional walking (may be limited to short distances with adaptive equipment at higher levels of injury) | Walker<br>Knee immobilizers for stability with bail lock/releases for swing phase |
| Toileting/showering | Independent | Shower seat, Over toilet aid with padded seat, adaptive equipment |
| Dressing/Grooming | Independent | Adaptive equipment |
| Eating/Feeding | Independent | N/A |

**Protocol:**

**Goals:** 1. Improve patient function

2. Prevent the effects of musculoskeletal deconditioning

3. Minimize complications of bed rest

Therapy Evaluations within 24 hours of admit and pt medically stable with plan to provide daily therapy 5 x wk except when medically contraindicated.

- **If spine unstable:** perform "bed level eval" including sensation testing, ROM testing appropriate to level of injury and avoiding motions of the extremities that will flex/ext/rotate spine, cognition, log rolling if able, family education
- Daily ROM exercises to begin on same day of evaluation with minimum repetitions 100 x daily.
- Splinting recommendations including but not limited to B UE resting hand splints and B LE rigid PRAFO's to be made at time of eval to prevent contractures and B UE wrist cock-up splints for functional tasks during day when indicated
- Make recommendations for positioning systems i.e. high turn bed, Posey Positioning System
- **If spine stable via bracing or surgery:** perform bed level eval then proceed as listed below
- Mobilization: rolling and HOB raised to max height to trial Bp stability and patient tolerance of activity (see "Considerations" section for details re: Bp stability)

Dangle EOB with abdominal binder and B LE compression wraps/stockings to maintain Bp if needed
RT present to address vent setting if needed

- Daily ROM exercises to begin on same day of evaluation with minimum repetitions 100 x daily.
- Splinting recommendations including but not limited to B UE resting hand splints and B LE rigid PRAFO's to be made at time of eval to prevent contractures and B UE wrist cock-up splints for functional tasks during day when indicated
- Make recommendations for positioning systems i.e. high turn bed, Posey Positioning System
- Develop program for daily OOB sitting tolerance (daily Cadillac chair, etc)

**Goals:** 4. Provide realistic recommendations for equipment and discharge

5. Promote patient and family education and participation

Education is an ongoing process starting at admit and continuing throughout patient's stay. Patient and family will be encouraged throughout stay to participate in the rehab process.

- Handout with written and picture/diagram instructions for daily ROM ex will be given to family and to patient with hands-on instruction from therapist at time of eval
- Positioning education and recommendations will be discussed with family at time of eval
- Family and patient education for frequent skin inspections to prevent break down will take place at time of eval
- Each therapist will review patient booklet on SCI with family and patient
- Each therapist will discuss POC and goals/expectations with family and patient
- Discharge recommendations with equipment recommendations and handouts will be discussed with family and patient at time of eval and throughout stay
- Discharge recommendations with equipment recommendations will be included on every evaluation and forwarded to case manager
- Case managers will be notified of complex discharge cases so that complex discharge team may be notified.

**Goal:** 6. Improve patients' quality of life

Daily therapy 5 x wk will be provided in order to progress patients to their highest level of function possible during the stay.

- Mobility will be progressed as patient tolerates to transfers, standing, ambulation when appropriate with focus on early upright weight bearing activities and specificity of task while minimizing the use of adaptive equipment when possible
- Staff will be instructed in safe and appropriate OOB transfers with patient and OOB program updated according to patient progress
- Therapeutic exercise including ROM will be progressed to include increased intensity of repetitions and strengthening ex to support patient function and prevent deconditioning and contractures
- Ongoing recommendations for splinting/bracing will be made as mobility increases
- Recommendations for discharge and equipment will be updated as progress is made
- Ongoing education and updates will be performed with family and patient on ROM, positioning, bracing/splinting, discharge rec's and equipment rec's as progress is made.

Considerations when Providing therapy:

- Be aware when patients are on "MAP Pushes" -usually within first 7 days of injury
- Bp and HR: upon sitting with HOB elevation/Sitting upright: an elevation of greater than 20% above patient's baseline Bp and/or HR (which may bring a low Bp into what looks like a more normal range) may trigger life threatening arrhythmias. If this happens, return patient to supine and notify nurse.
- BP and HR : upon sitting HOB with HOB elevation/Sitting upright: a drop of greater than 20% below patient's baseline Bp and/or HR with abdominal binder and B LE compression stockings/ace wraps in place may indicate poor sympathetic control/input. Return patient to supine and discuss getting order with nurse re: mitodrine 20-30 mins prior to therapy to maintain Bp.
- Work with RT prior to and during mobility to monitor and/or change vent settings if patient on vent and settings are:

Pressure support >20
FiO2 > or = 70%
SIMV rate >15
PEEP >15

- Check with team if patient has transvenous/transcutaneous pacemaker prior to performing mobility. Patient may need to be cleared by cardiology first prior to mobility
- Rotoprone bed protocol contraindicated to mobility
- Femoral sheaths are contraindicated to dangling EOB, ROM ok as long as LE not flexed beyond 60 deg
- Orders: bedrest orders and strict spinal precaution orders must be discontinued prior to mobility
- Bracing: orders for bracing (Miami J, Aspen, TLSO, LSO, clam shell) and splints must be in chart with clarification of when brace must be worn and how to don/doff brace. For example: TLSO on when OOB to be applied in supine. Resting hand splint on at night with alternating limb schedule Q 2 hr. Ok to remove for ROM and skin checks.

## DVT Prophylaxis:

Recommendations:

Nonpharmacologic: SCDs should be started immediately and ROM exercises as soon as possible to decrease incidence of DVT. Non-pharmacologic methods alone are inadequate to prevent DVT in SCI patients. IVC filters are not recommended as prophylaxis due to morbidity associated with placement and removal and higher risk of complications in patients needing quad cough technique for pulmonary toilet (usually all high thoracic and cervical spine injuries).

Pharmacologic: Prophylaxis can be given prior to surgical fixation (with pre-op cessation at 24 hours pre-operatively) and re-started 24 hours after fixation. DVT prophylaxis should start less than 72 hours after spinal fixation. LMWH is preferred but UH can be used if there is renal dysfunction present. Dose adjustment to anti-Xa levels should be strongly considered.

Both nonpharmacologic and pharmacologic measures should continue at least three months after injury.

Discussion of recommendations:

The incidence of VTE (venous thromboembolic events) in untreated SCI patients is very high. Incidence ranges from 7-100% depending on the ISS, age, and method used to diagnose VTE. Morbidity and mortality related to complications of VTE in SCI patients is significant.

VTE prophylaxis should be begun as soon as possible to avoid these complications. Even with pharmacologic therapy and nonpharmacologic therapy, most studies still show some incidence of VTE among the treated patients.

Multiple studies have examined the use of unfractionated heparin (UH) versus low molecular weight heparin (LMWH) in the spinal cord injury population. The overall results suggest LMWH is more effective than UH in prevention of VTE in SCI patients. UH should be used only when the patient has renal dysfunction.

Given data regarding inadequacy of LMWH dosing in trauma and critically ill patients, consider adjusting dose to anti-Xa levels, especially in patients who are either underweight or obese or have significant volume overload/third spacing. Anti-Xa levels should be rechecked and dose re-adjusted when volume overload resolves or if there has been significant weight loss during hospitalization. There are also several studies suggesting UH, when used, should be adjusted for anti-Xa levels when appropriate anti-Xa testing is available.

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