

ACUTE SPINAL CORD INJURY

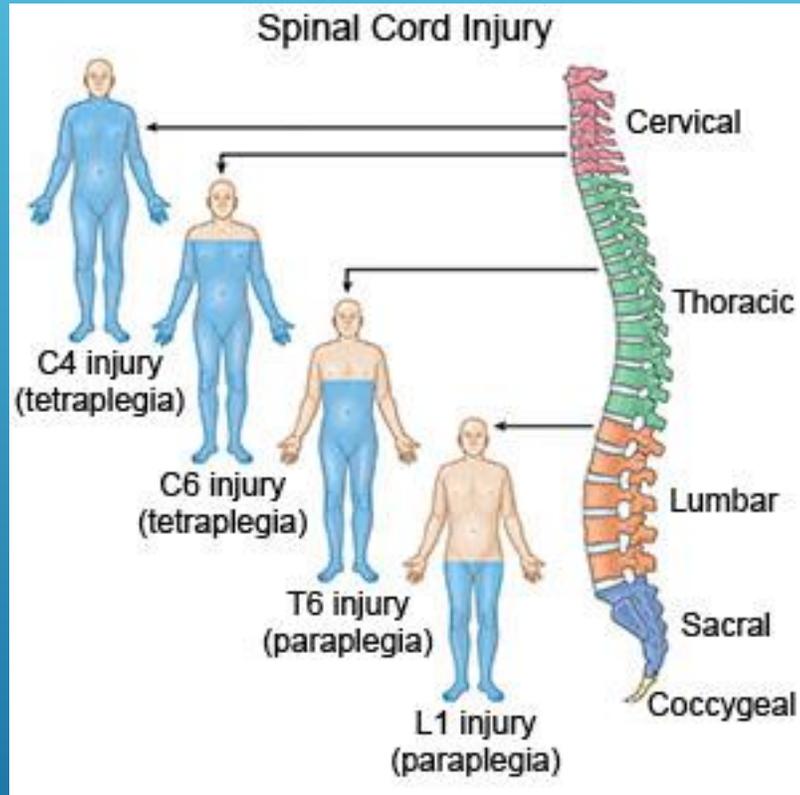
Megan B. Lovorn, M.D.



- ▶ A **spinal cord injury (SCI)** is damage to the **spinal cord** that causes temporary or permanent changes in its function. Symptoms may include loss of muscle function, sensation, or autonomic function in the parts of the body served by the **spinal cord** below the level of the **injury**. Usually affects Bowel and bladder- not always.



DEFINITION OF SPINAL CORD INJURY:



SCI:

Tetraplegia (quadriplegia) is when cervical level is affected

Paraplegia- is when Thoracic, Lumbar or sacral levels are affected.

Complete- ASIA A

Incomplete- ASIA B- ASIA E

78% of ALL
SCI's are male

Average age-
was 27 (in
1970s); now is
43 years old

SCI STATISTICS:

- ▶ The estimated number of people with SCI living in the United States is approximately 294,000 persons, with a range from 250,000 to 368,000 persons.

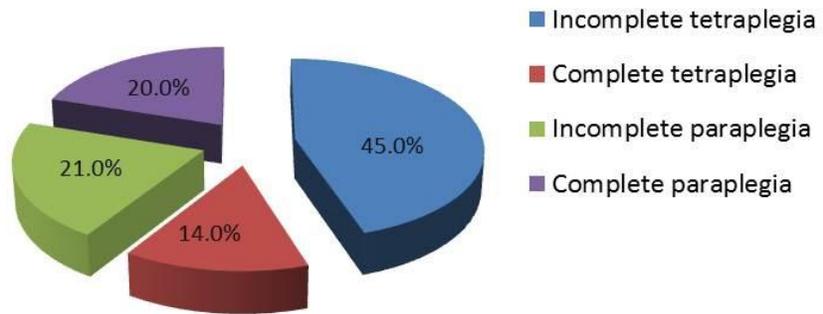
- ▶ □ Data Source: Lasfargues JE, Custis D, Morrone F, Carswell J, Nguyen T. A model for estimating spinal cord injury prevalence in the United States. *Paraplegia*. 1995;33(2):62-68.

- ▶ Given the current U.S. population size of 329 million people, a recent estimate showed that the annual incidence of spinal cord injury (SCI) is approximately 54 cases per one million people in the United States, or about 17,810 new SCI cases each year. (New SCI cases do not include those who die at the location of the incident that caused the SCI).

- ▶ □ Data Source: Jain NB, Ayers GD, Peterson EN, et al. Traumatic spinal cord injury in the United States, 1993-2012. *JAMA*. 2015;313(22):2236-2243.

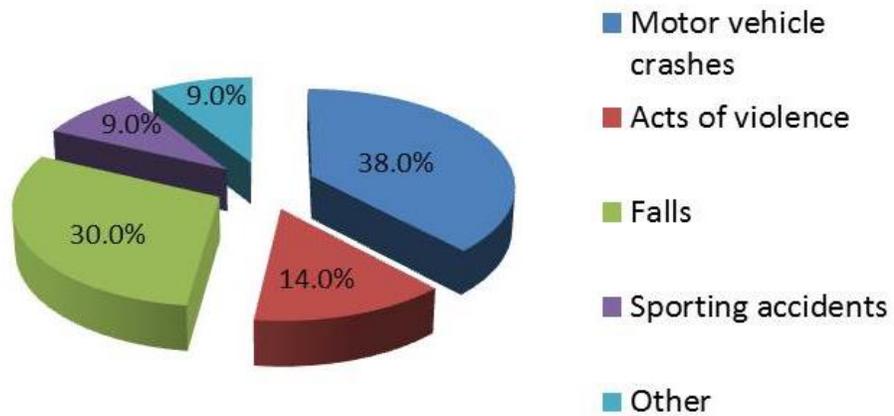
SCI STATISTICS:

The types & severity of SCI are:



SCI TYPE STATISTICS:

The causes of SCI are:



CAUSES OF SCI:

UMN:

- ▶ Due to SCI/brain injury
- ▶ After spinal shock in MOST cases of SCI
- ▶ Develop Spasticity of muscles as well as tone of bowel and bladder
- ▶ Example Types:
 - ▶ Ex: Brown Sequard Syndrome
 - ▶ Ex: Central Cord Syndrome
 - ▶ Ex: Anterior Cord Syndrome

LMN:

- ▶ During Spinal Shock
- ▶ Usually due to an injury either OUTSIDE Brain or SCI, or during spinal shock
- ▶ FLACCID PARALYSIS
- ▶ Example Types:
 - ▶ Ex: Conus Medullaris Syndrome
 - ▶ Ex: Cauda Equina Syndrome

TYPES OF SPECIFIC SCI SYNDROMES (UMN VS LMN):

Patient Name _____

Examiner Name _____ Date/Time of Exam _____



STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

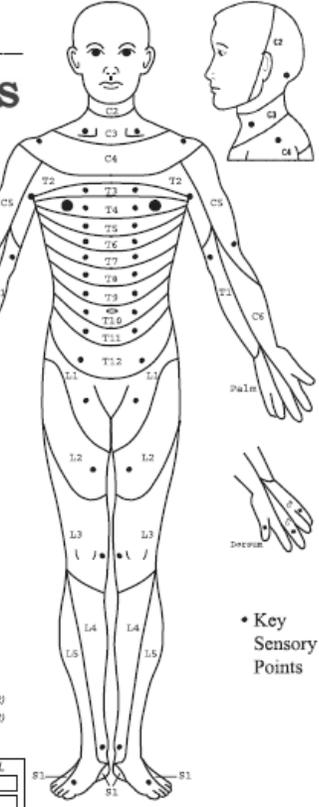
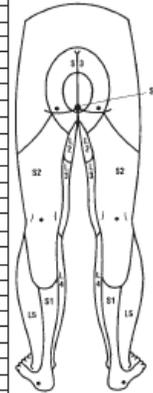


MOTOR		KEY MUSCLES (scoring on reverse side)	
C5	<input type="checkbox"/>	R	Elbow flexors
C6	<input type="checkbox"/>	L	Wrist extensors
C7	<input type="checkbox"/>		Elbow extensors
C8	<input type="checkbox"/>		Finger flexors (distal phalanx of middle finger)
T1	<input type="checkbox"/>		Finger abductors (5th finger)
UPPER LIMB TOTAL (MAXIMUM) <input type="checkbox"/> + <input type="checkbox"/> = <input type="checkbox"/> (25) (25) (50)			
Comments: <div style="border: 1px solid black; height: 100px; width: 100%;"></div>			
L2	<input type="checkbox"/>		Hip flexors
L3	<input type="checkbox"/>		Knee extensors
L4	<input type="checkbox"/>		Ankle dorsiflexors
L5	<input type="checkbox"/>		Long toe extensors
S1	<input type="checkbox"/>		Ankle plantar flexors
LOWER LIMB TOTAL (MAXIMUM) <input type="checkbox"/> + <input type="checkbox"/> = <input type="checkbox"/> (25) (25) (50)			
Voluntary anal contraction (Yes/No) <input type="checkbox"/>			
TOTALS (MAXIMUM) (58) (58) (58) (58)			
PAIN PRICK SCORE (max: 112)			
LIGHT TOUCH SCORE (max: 112)			
Any anal sensation (Yes/No) <input type="checkbox"/>			
NEUROLOGICAL LEVEL: The most caudal segment with normal function			
COMPLETE OR INCOMPLETE? <input type="checkbox"/>		ZONE OF PARTIAL PRESERVATION: Caudal extent of partially denervated segments	
ASIA IMPAIRMENT SCALE <input type="checkbox"/>		SENSORY MOTOR	
		R L	
		SENSORY MOTOR	
		R L	
		SENSORY MOTOR	

SENSORY

KEY SENSORY POINTS

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



• Key Sensory Points

SCI ASIA EXAM:

- ▶ Spinal Shock
- ▶ **Autonomic Dysreflexia**
- ▶ **Autonomic Dysfunction**
- ▶ Resting Low Blood Pressure
- ▶ Orthostatic Hypotension
- ▶ Bradycardia
- ▶ Temperature control

- ▶ Neurogenic Bowel
- ▶ Neurogenic Bladder
- ▶ Increased risk of DVT
- ▶ Increased risk of Pressure ulcers
- ▶ Spasticity
- ▶ At Level SCI Pain/Nerve Pain/MS pain
- ▶ Intimacy/Sexuality/Reproduction

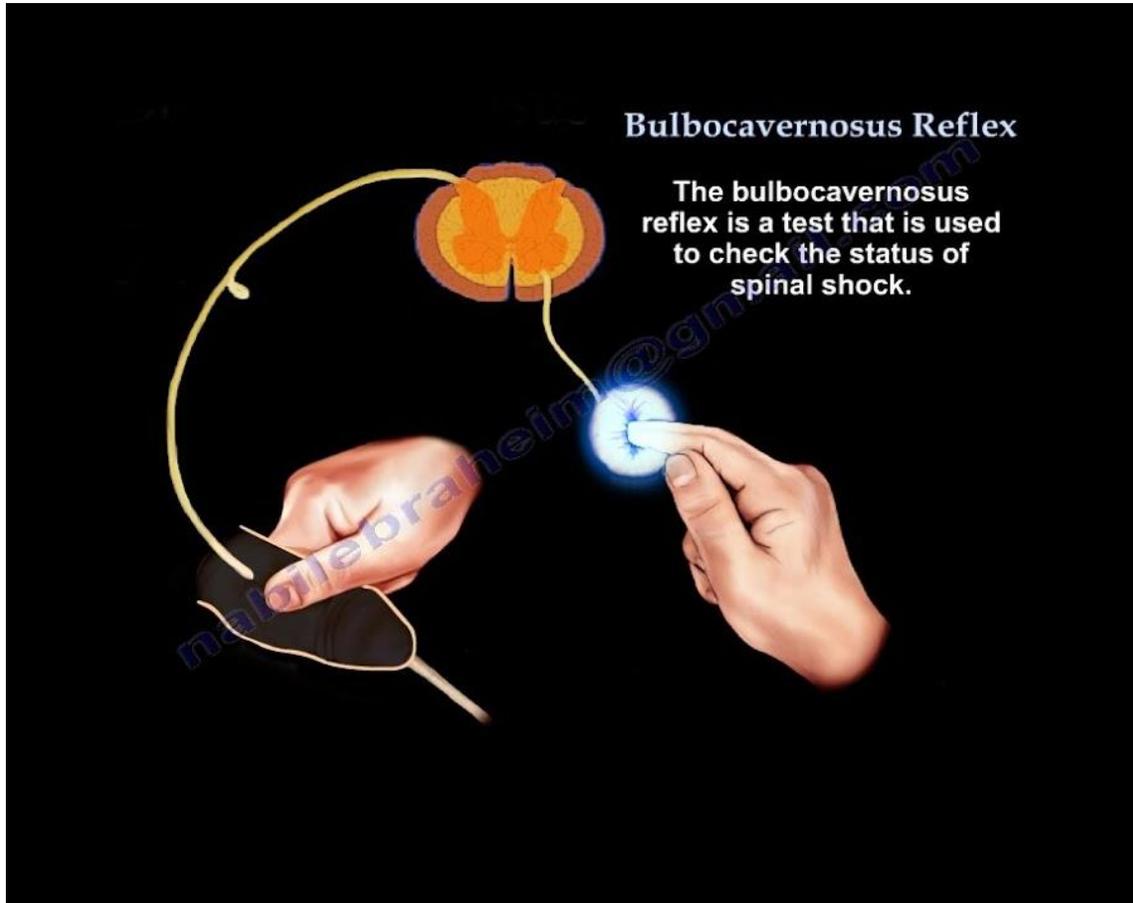
ACUTE SCI ISSUES:

SPINAL SHOCK:



- ▶ **Spinal shock** refers to a clinical syndrome characterized by the loss of reflex, motor and sensory function below the level of a **spinal cord injury** (SCI). In some instances (possibly when lesion is T6 or higher), this syndrome is associated with loss of autonomic tone leading to hypotension, hypothermia and ileus.
- ▶ Spinal shock usually lasts for days or weeks after **spinal cord injury** and the average duration is **3 to 12 weeks**. Spinal shock is terminated earlier and the pyramidal tract signs and defense reactions occur sooner in incomplete lesions than with complete transverse lesions.

SPINAL SHOCK:



SPINAL SHOCK:

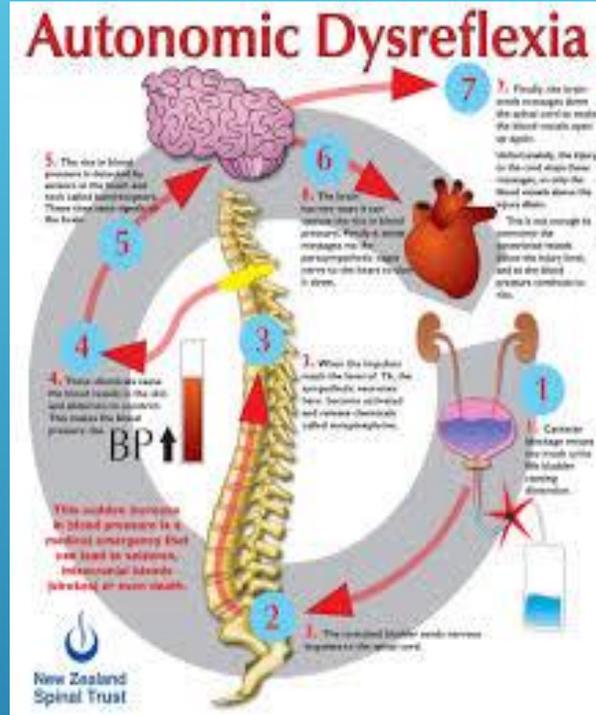
- ▶ Usually last 3-12 weeks (3-4 weeks on average)
- ▶ Less time for incomplete SCIs
- ▶ FLACCID PARALYSIS
- ▶ Decreased reflexes
- ▶ Loss of bulbocavernosus reflex
- ▶ (squeezing the glans penis or clitoris)

AUTONOMIC DYSREFLEXIA (AD):



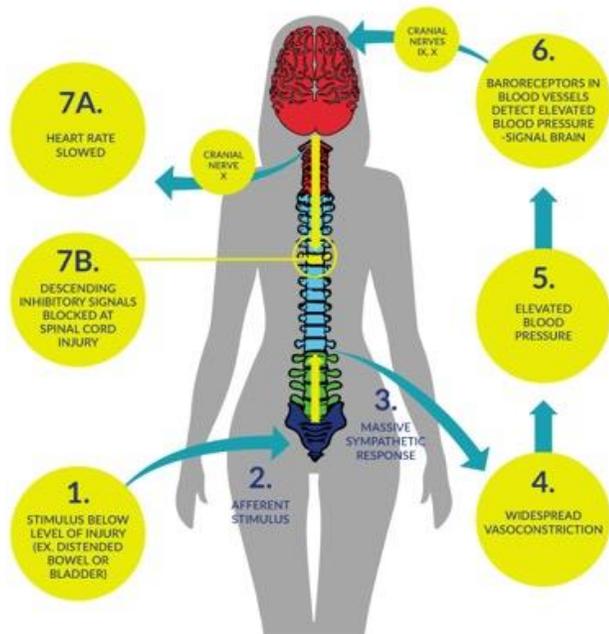
- ▶ **MEDICAL EMERGENCY!!!!!!**
- ▶ Due to SCI of T6 or ABOVE (rare cases found down to T9 in case literature)
- ▶ More likely in ASIA A (complete) than ASIA B/C/D/E (incomplete) injuries
- ▶ Abnormal overreaction to a NOXIOUS stimulation below the level of injury
- ▶ Noxious stimulation- NOT ALWAYS PAINFUL- what would cause pain in a SC intact patient!

AUTONOMIC DYSREFLEXIA (AD):



- ▶ Bowel and bladder- the most common cause of AD at 80%
- ▶ ANY NOXIOUS stimulation is rest of 20%
- ▶ Examples:
 - ▶ Hangnail
 - ▶ Sunburn
 - ▶ MI/Gallbladder attack
 - ▶ Menstruation/SEX

AUTONOMIC DYSREFLEXIA (AD) CAUSES:



- ▶ - Bradycardia- 50%
- ▶ **ELEVATED BP**
 - ▶ 20 -30 points above THEIR normal
- ▶ **Severe unrelenting HA**
- ▶ Sweating above lesion
- ▶ **NASAL CONGESTION**
- ▶ **Blurred vision**
- ▶ Goosebumps below lesion
- ▶ Sense of "impending doom"/anxiety

AUTONOMIC
DYSREFLEXIA (AD)
SYMPTOMS/SIGNS:

Autonomic Dysreflexia (AD) is a medical emergency specific to individuals with Spinal Cord Injury (SCI) at the neurological level of T6 or above. It is usually caused when a painful irritation occurs below the level of your spinal cord injury. It can present with a variety of signs / symptoms which can vary from mild to severe discomfort. As a SCI individual you need to have a good understanding of AD and be familiar with signs and symptoms and immediate management of this potentially life threatening condition. It must be addressed immediately because if it is untreated it may progress to cause a seizure, stroke or death. (Ahrens Prestice 1998).

CAUSES

Bladder

- Distension (due to catheter blockage or kinking)
- Urinary tract infection
- Bladder stones

Bowel

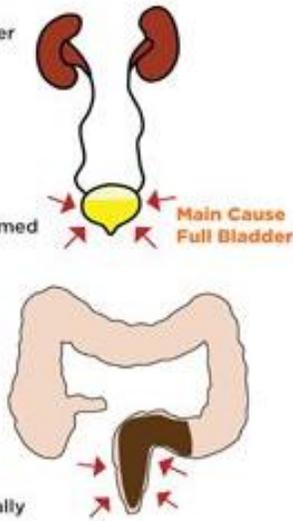
- Constipation
- Haemorrhoids
- Fissure
- Having bowel care performed

Skin

- Pressure Ulcer
- Tight Clothing
- Ingrown toenail
- Blister/burn

Others

- Scrotal compression
- Sexual stimulation
- Labour childbirth
- Menstruation and any condition that would usually cause abdominal pain

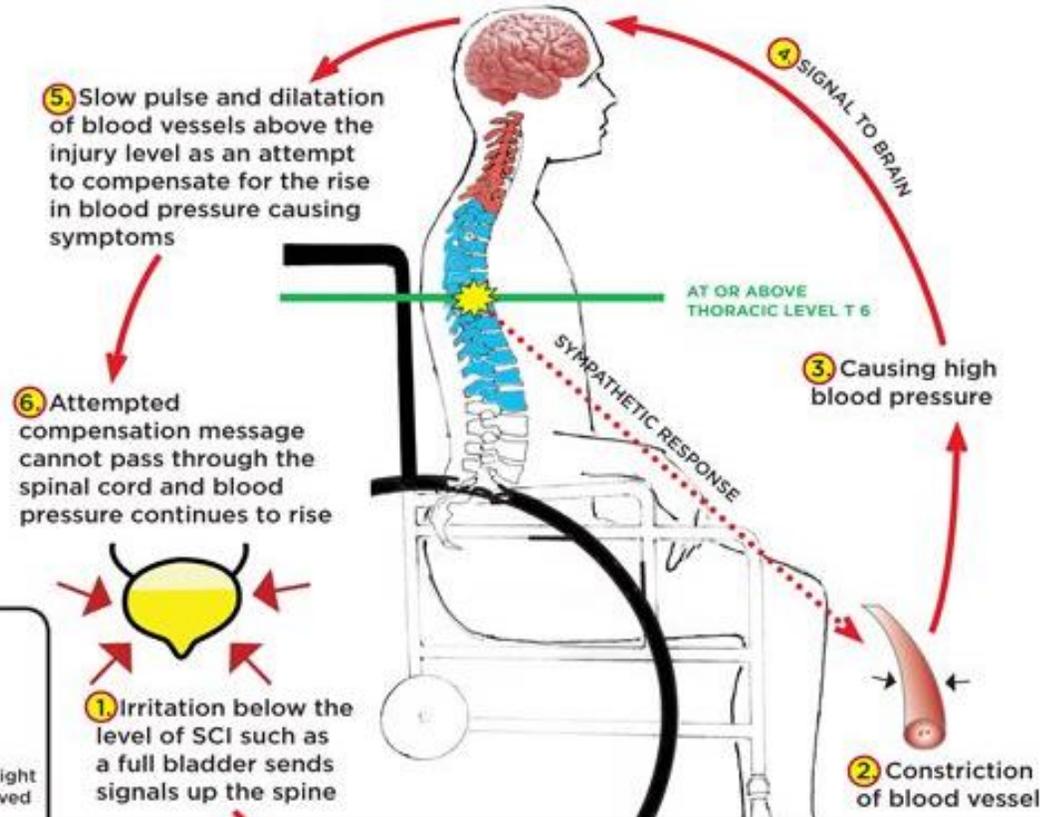


Emergency Treatment for Autonomic Dysreflexia

Signs / Symptoms of Autonomic Dysreflexia

Call for assistance - Sit upright and lower legs - Loosen any tight clothing / legs straps - Monitor BP until symptoms have resolved

HOW DO I GET AUTONOMIC DYSREFLEXIA?



SIGNS & SYMPTOMS

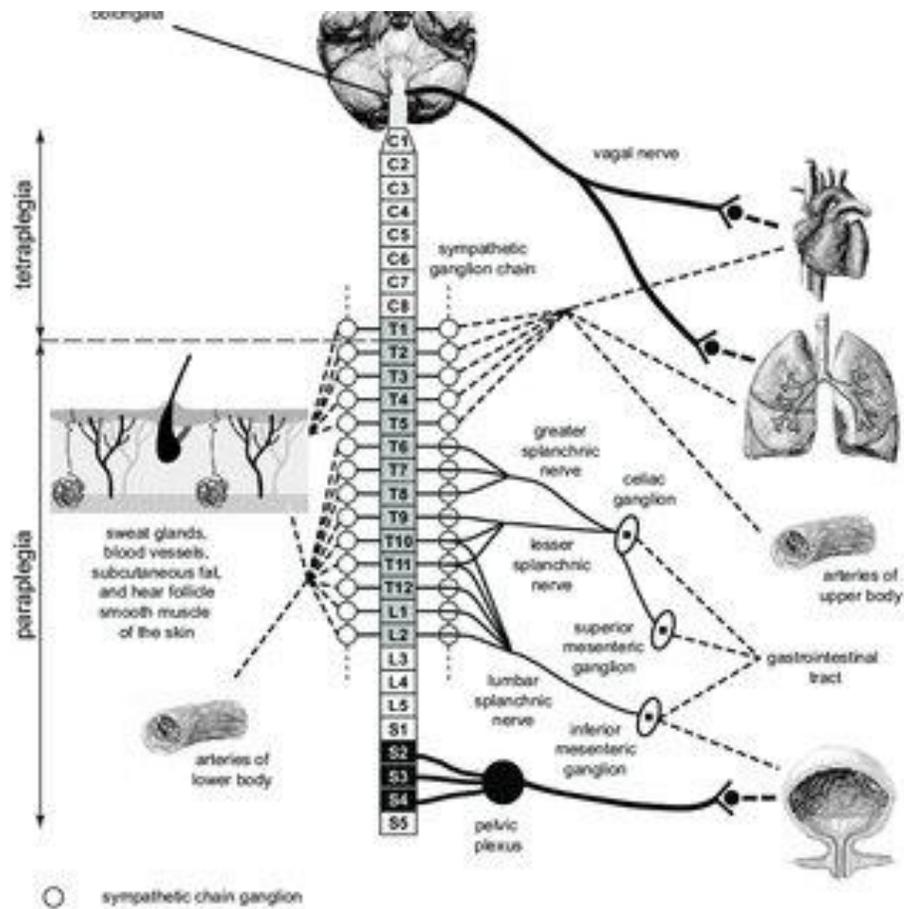


- ▶ SIT THEM UP!!!! It will lower BP
- ▶ Loosen clothing and anything tight/strip of clothes- could be cause (ex: remove TEDs, belts, bra, etc.)
- ▶ Cath them/FLUSH Foley or have them void if they can- even if did 5 minutes ago, DO IT AGAIN!
- ▶ If BP hasn't come down yet, check rectal vault and help Evacuate, with lots of Lidocaine jelly (can be another cause of AD).
- ▶ If BP hasn't come down, know it will continue to rise until CAUSE treated
- ▶ Call Medical Provider/Physicians

AUTONOMIC DYSFUNCTION (AD)TREATMENT:

- ▶ Call Medical Provider/Physicians
 - ▶ -commonly, can use Nitroglycerin or Nitro Paste to treat, since on hand (no Nifedipine/try to avoid Clonidine if can't determine cause)
 - ▶ If a suspected pain is the cause (i.e. post surgery/fracture/etc), treat with pain medicines, even if they feel no pain!
 - ▶ Don't stop work up/treatment until BP is resolved.
 - ▶ It can cause BP to go so high, patients can STROKE!!!!

AUTONOMIC DYSREFLEXIA (AD)
TREATMENT:



AUTONOMIC DYSFUNCTION:

- ▶ Autonomic dysfunction is not well studied
- ▶ Seen in patients with SCI below T6
- ▶ Can have SOME symptoms of AD, but not high blood pressure
- ▶ Symptoms can be: sweating above level of lesion, feeling “ill”, GI disturbances, etc
- ▶ Due to a noxious stimulus below lesion
 - ▶ Ex: MW- T10 patient

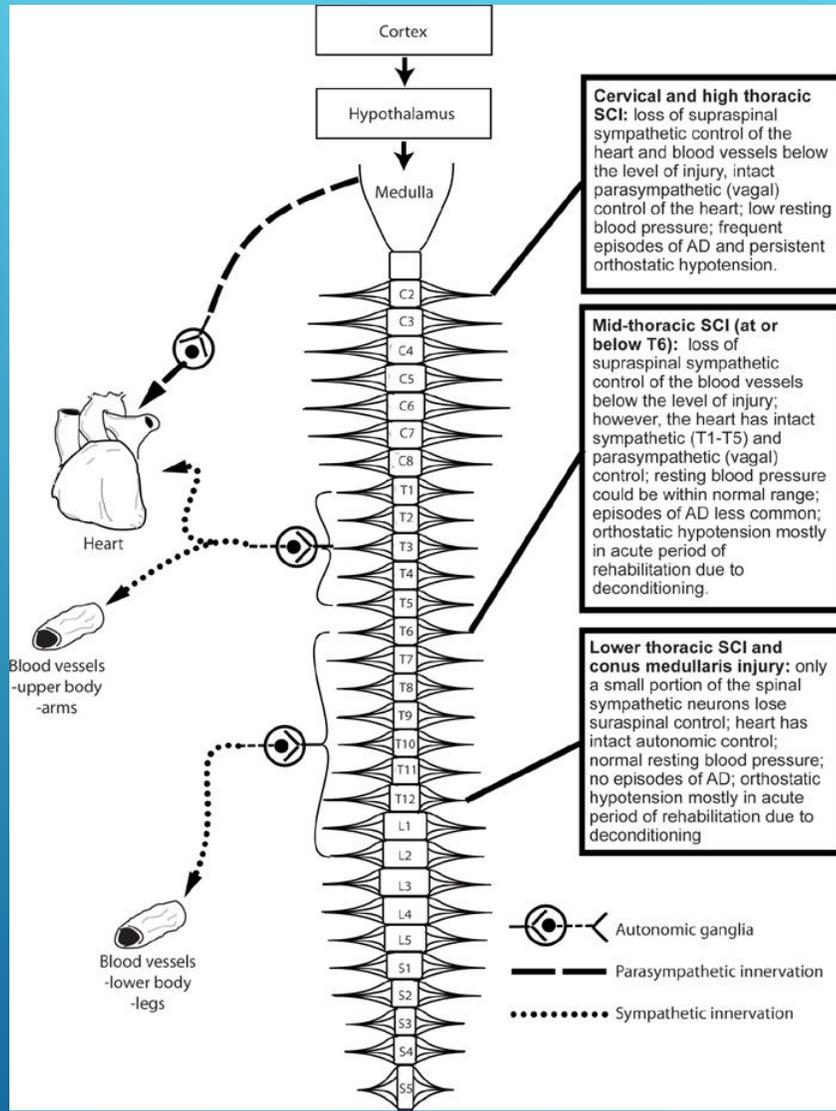
AUTONOMIC DYSFUNCTION:

RESTING LOW BLOOD PRESSURE:

In patients with lesions at T6 or above-can occur in lower SCIs, but less acute/doesn't become chronic

Due to lack of sympathetic outflow from splanchnics

Is EXTREMELY common in tetraplegics and higher paraplegics (as above)



RESTING LOW BLOOD PRESSURE:

BP laying down can run 20-60+ points below their previous BP prior to SCI

Coupled with Orthostatic hypotension, can cause dizziness/confusion/vertigo/lightheadedness/Syncope

Commonly IMPROVES symptomatically between 3-6 months after SCI

BP doesn't get better; patients usually adapt!

ORTHOSTATIC HYPOTENSION (OH):

Another cause of low Blood Pressure!

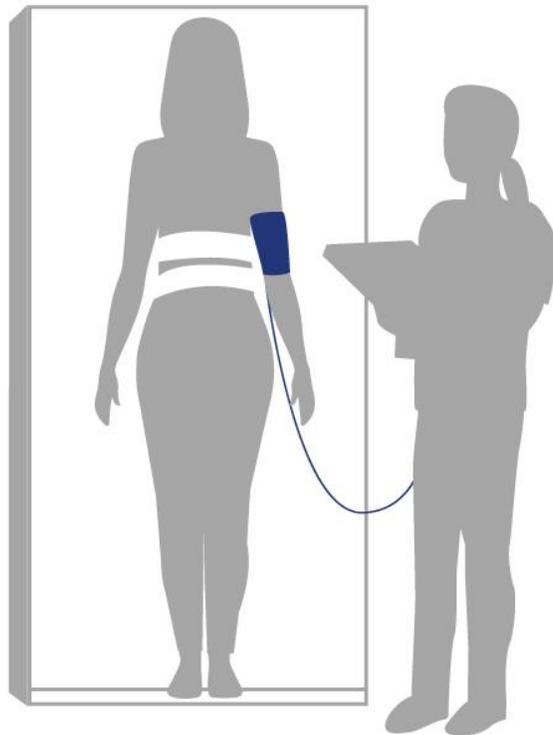
- ▶ With postural changes –sitting or standing with SCI
- ▶ Symptoms are that of LOW BP- dizziness/lightheadedness/syncope
- ▶ Due to:
 - loss of muscle tone in vessels which helps return blood to heart
 - ▶ - Neurological – lack of sympathetic increase in BP /delayed change with postural maneuvers

Patients will improve symptomatically over 3-6 months, in most cases, however BP will always drop with sitting/standing; Medicines to treat SYMPTOMS, not the BP

ORTHOSTATIC HYPOTENSION (OH):

ORTHOSTATIC HYPOTENSION

POSTURAL HYPOTENSION IS A LOW BP THAT HAPPENS WHEN TRANSITIONING TO AN UPRIGHT POSITION FROM SITTING OR LYING DOWN



ORTHOSTATIC HYPOTENSION (OH) TREATMENT:

-TEDs

-Abd Binder

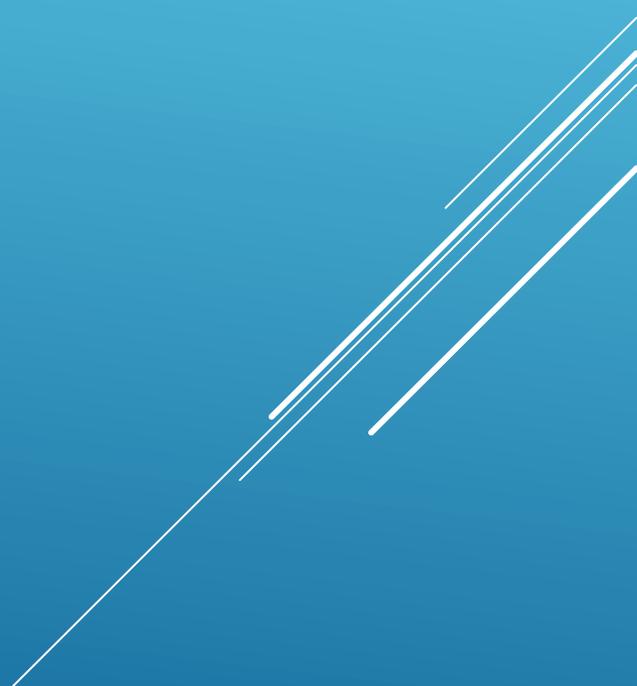
-Salt tabs/dietary Salt

-Florinef (fludrocortisone)

-Can't usually be used in CHF/ESRD

- Midodrine

BRADYCARDIA:



Usually a problem that's symptomatic in first 3 months after SCI

In patients T6 and above

Can be so severe, patients need pacemaker

Not great treatments-

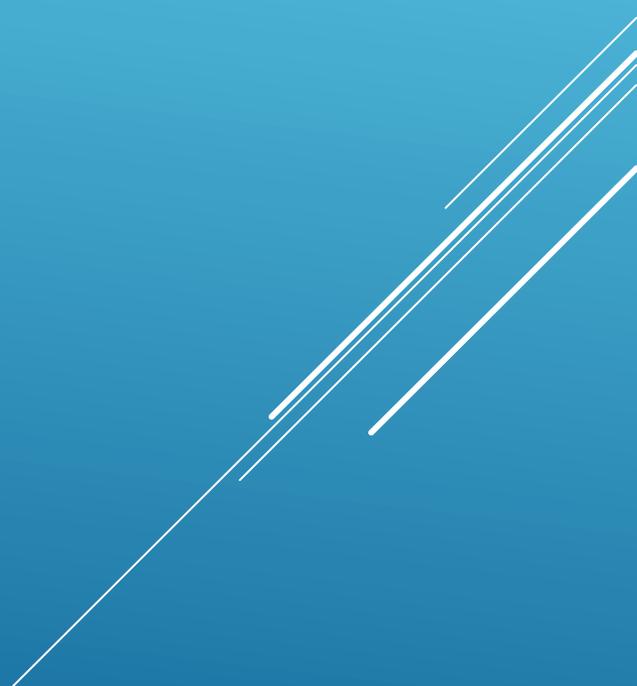
Theophylline, reduce current BP meds, temporary pacemaker, pacemaker

Only be concerned if it's symptomatic (same symptoms of OH)

BRADYCARDIA:

THERMOREGULATION:

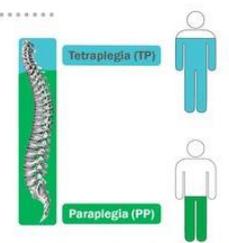
Temperature Control:



Thermoregulatory impairment in athletes with a spinal cord injury

A spinal cord injury (SCI) results in:

- Sweating response
- Sweating response
- Blood flow control



The core temperature of athletes with tetraplegia rises rapidly during exercise (in a 19-20° C environment) causing an overheating risk and potential performance decrements



Summary

- TP: heightened thermal strain during simulated and wheelchair rugby match play compared to PP and non-SCI.
- Employ appropriate cooling methods, e.g. ice vests and water sprays.
- Alternative practical methods may also be beneficial.[Ⓞ]

References

① Griggs et al. (2015). Int J Sports Physiol Perform. DOI: 10.1123/ijspp.2014-0361

② Griggs et al. (2017). Int J Sports Med. DOI: 10.1055/s-0042-121263

③ Griggs et al. (2017). J Sci Med Sport. DOI: 10.1016/j.jsams.2017.03.010

④ Griggs et al. (2015). Sports Med. DOI: 10.1007/s40279-014-0241-3

Acknowledgements

This infographic is a summary of PhD studies carried out by Dr. Katy Griggs at the Peter Harrison Centre for Disability Sport, Loughborough University. Designed by Adam Pryor, National Centre for Sport and Exercise Medicine, Loughborough University.

Wheelchair sport images are adapted from Parutakupiu's wheelchair rugby pictogram, via a Creative Commons BY-SA licence: [commons.wikimedia.org/wiki/File:Wheelchair_rugby_pictogram_\(Paralympics\).svg](https://commons.wikimedia.org/wiki/File:Wheelchair_rugby_pictogram_(Paralympics).svg)

- ▶ SCI Patients at rest can “take on temperature of room”. Get cold easier when room cool and hot easier when room is warm.
- ▶ Don't sweat the same, and blood flow is impaired, especially in tetraplegics.

THERMOREGULATION:

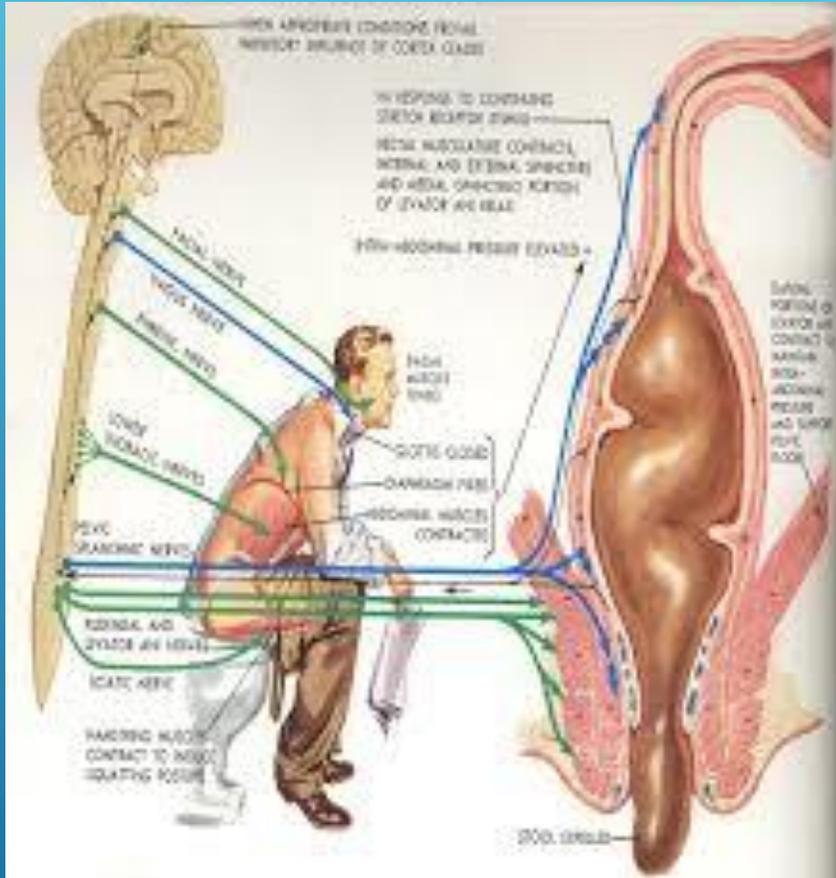
NEUROGENIC BOWEL:

How do SCI patients poop?



- ▶ Lower Motor Neuron (LMN) Bowel
- ▶ Basically, no stool propulsion during this time at ALL!!!
- ▶ Needs scheduled laxatives, and even more if on pain medicines(Colace not effective)
- ▶ Lax anus/ no tone in anal sphincters– can gape
- ▶ Will leak all types of stool
- ▶ Until spinal shock is over, is LMN bowel

INITIAL NEUROGENIC BOWEL:



NEUROGENIC BOWEL:

Lower Motor Neuron

Upper Motor Neuron

- ▶ Upper Motor Neuron (UMN) Bowel (unless has Cauda Equina or Conus Medullaris syndrome)
- ▶ Some tone to anus/anal sphincters, but can still leak loose stool
- ▶ Colon works at ~ 1/3 - 1/2 of speed of normal gut
- ▶ Still needs BOWEL PROGRAM

NEUROGENIC BOWEL (AFTER SPINAL SHOCK):

▶ Bowel Program

- ▶ -Digital Stimulation (dig stim)- stimulate up to 2nd knuckle of hand for 20-30 seconds
- ▶ Circular motion every 10-15 minutes
- ▶ NECESSARY
- ▶ Add Suppository and/or mini enema to fully empty colon/bowel
- ▶ Will take 3-6 weeks to fully train gut to go after a meal with bowel program
- ▶ need to train when going to have BM- usually in evening
- ▶ Laxatives +/- stool softeners ~8- 12 hours PRIOR to bowel program- daily is best

NEUROGENIC BOWEL:

Bowel Program!!!!

How to help patients poop!

NEUROGENIC BLADDER:

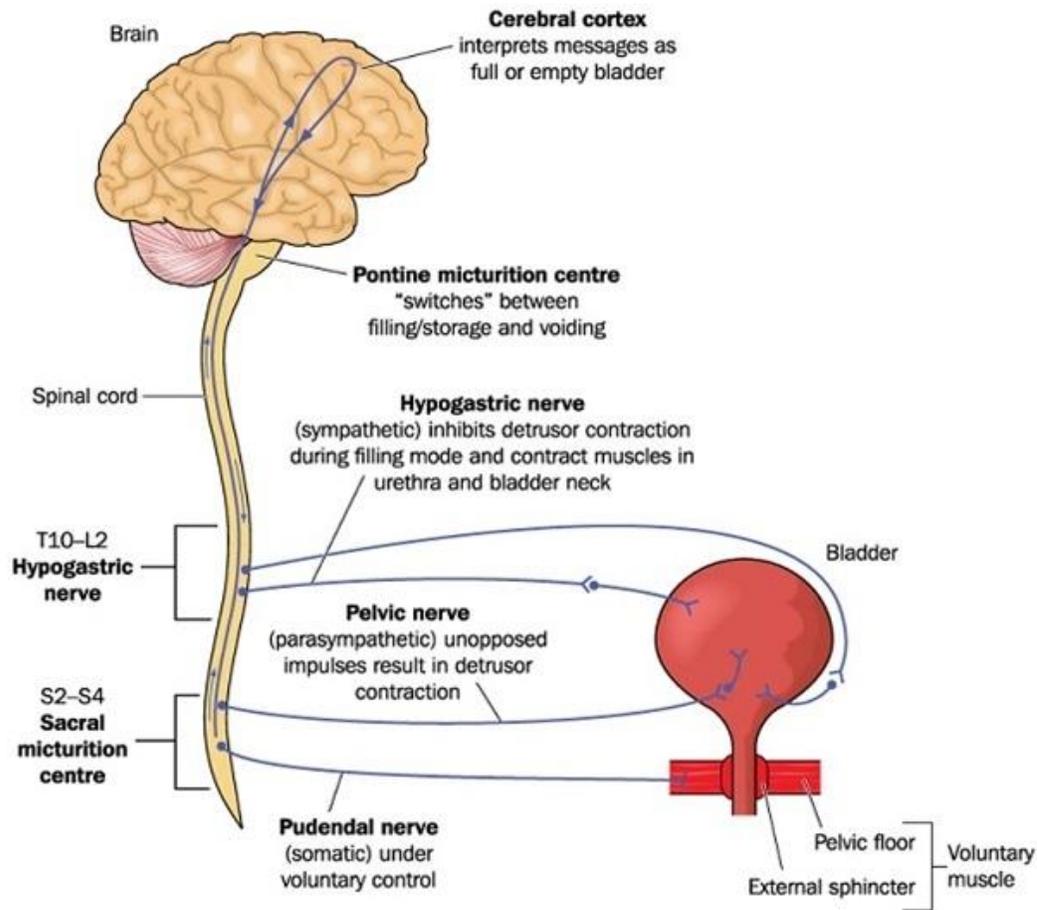
How do SCI patients empty their bladder?

*foley *suprapubic catheter *ileo conduit

*void *in/out caths *ileostomy

- ▶ Lower Motor Neuron (LMN) Bladder
- ▶ During Spinal Shock
- ▶ Passive stretch of bladder- can hold upwards of 2 LITERS in bladder before ruptures-
- ▶ RUPTURED bladder can mean death
- ▶ **Just because they void/pee, doesn't mean they are emptying**
- ▶ HAVE to bladder scan/ do PVRs after voiding to make sure emptying
- ▶ Emptying is NOT ZERO on bladder scanner; "empty" is 1cc to 200cc on bladder scanner
- ▶ Be careful of heavy patients

INITIAL NEUROGENIC BLADDER:



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NEUROGENIC BLADDER:

Upper Motor Neuron

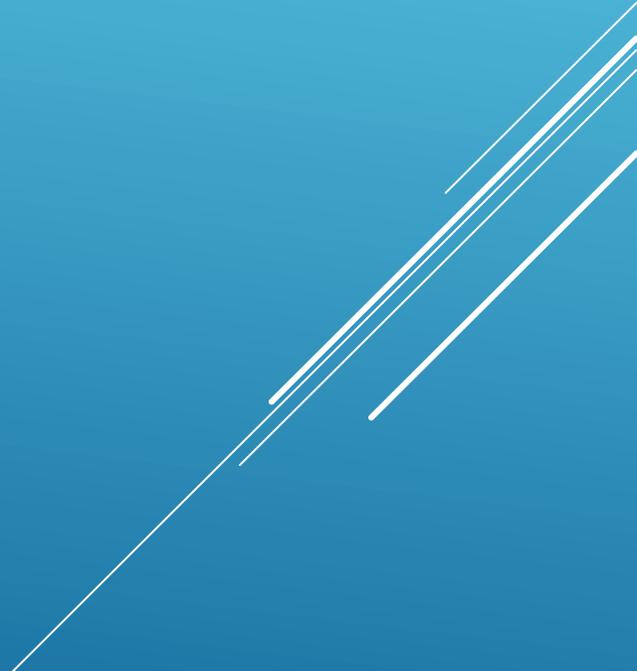
Lower Motor Neuron

- ▶ Starts developing Upper Motor Neuron (UMN) Bladder
- ▶ Which is spasticity of bladder
- ▶ That means they develop a functionally smaller bladder
- ▶ Usually void/overflow between 250-500cc- **will be WET from overflow voiding**
- ▶ We use Bladder meds- Oxybutynin, etc to functionally increase size of bladder to more normal size
- ▶ Can also do Botox of bladder, or surgical augmentation of bladder

NEUROGENIC BLADDER (AFTER SPINAL SHOCK):

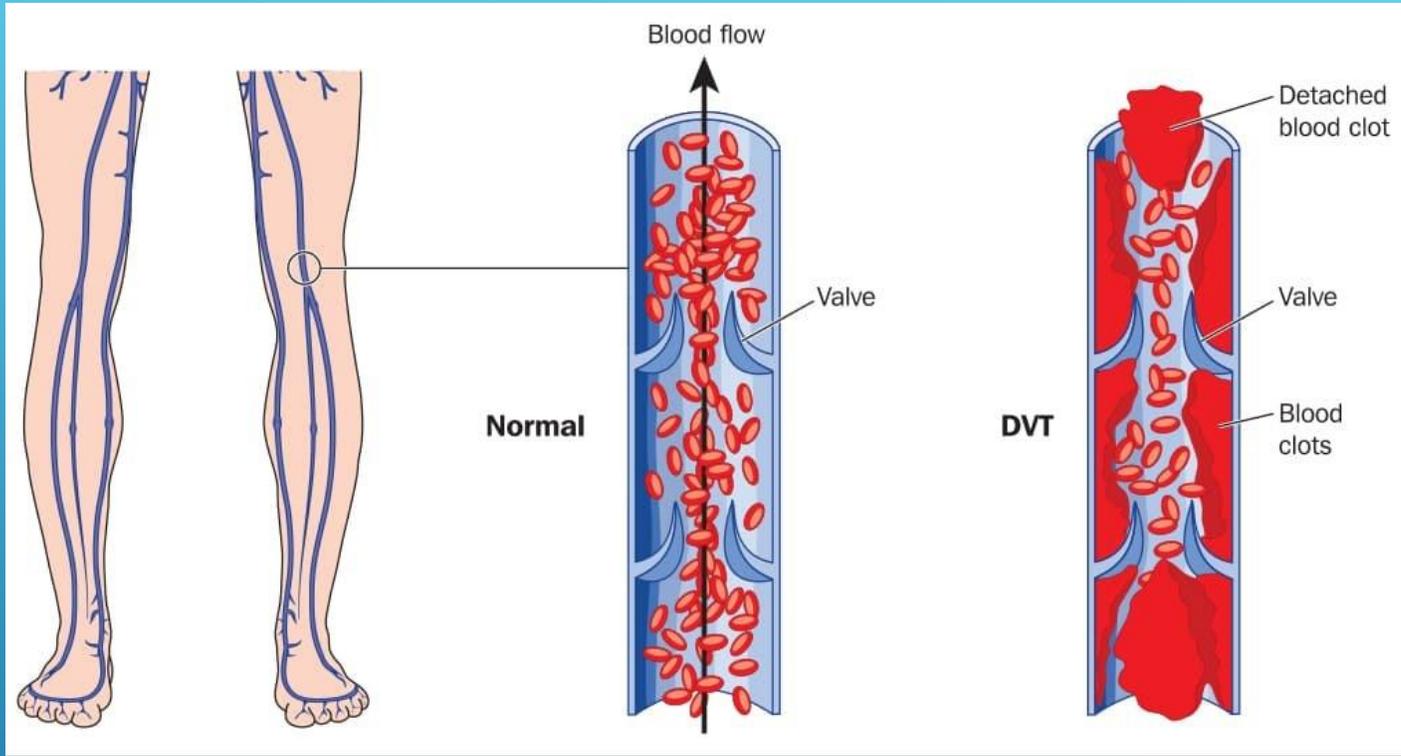
INCREASED RISK OF DVT/PE:

Highest risk of any group in first 90 days!!!

Decorative white lines consisting of several parallel diagonal strokes in the bottom right corner of the slide.

- ▶ Increased risk of DVT- (Deep Vein Thrombosis) or PE (pulmonary emboli)
- ▶ 81% of patients without prophylaxis!!!!!!
- ▶ Between day 3 and day 90
- ▶ Peak day 7 and day 14- the days we see them!
- ▶ the incidence of DVT among patients with SCI ranges from 5.3–64% when prophylaxis is implemented and from 47 to 100% when no prophylactic measures are applied
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5102284/#>
- ▶ Therefore, a VERY HIGH RISK of DVT, even with Lovenox/SQ heparin on board!

INCREASED RISK OF DVT/PE:



INCREASED RISK OF DVT/PE:

▶ DVT Symptoms/Signs:

▶ Usually UNILATERAL swelling in affected leg or arm

▶ (+) Homan's signs (pain with squeezing calf)

▶ NO SYMPTOMS

▶ **Can develop thrombophlebitis, post thrombotic syndrome, venous stasis ulcers, etc. due to chronic DVT**

▶ PE Symptoms/Signs:

▶ Shortness of breath/decreased O2 sats

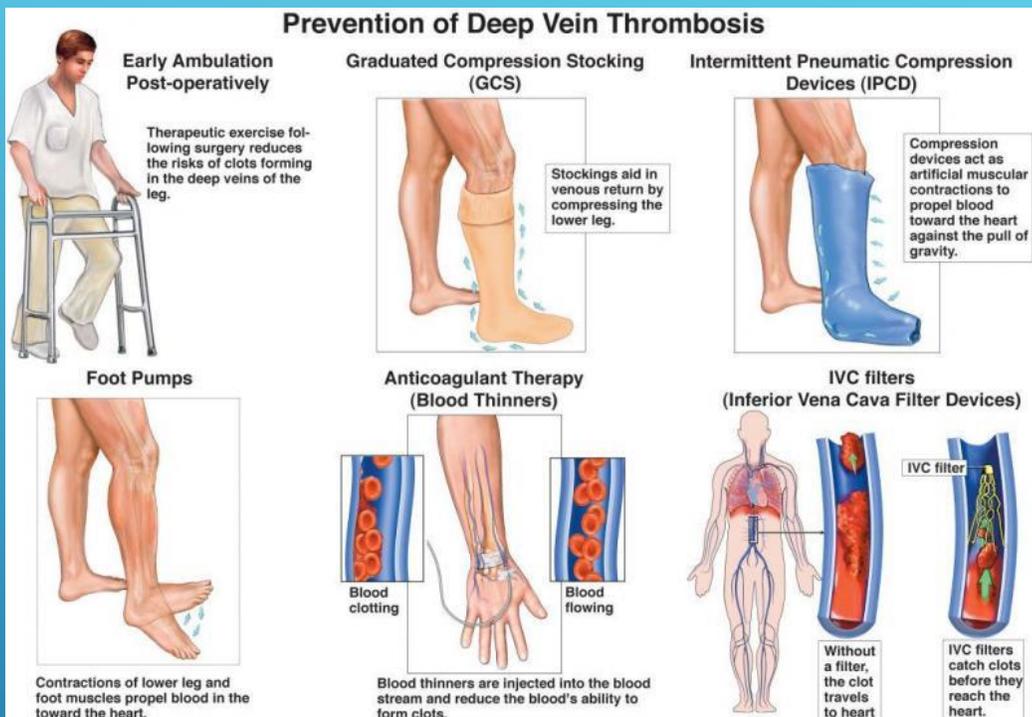
▶ Tachycardia- can be mild/absent

▶ Anxiety

▶ Have high index of suspicion

▶ Can Cause DEATH!

INCREASED RISK OF DVT/PE:



- ▶ NEED Lovenx, SQ heparin, Warfarin, or oral anticoagulants (Eliquis, etc)
- ▶ SCDs and thigh high stockings are ADDED benefit, but are not effective by themselves
- ▶ No reason to do IVC filters anymore
- ▶ Trying to prevent DVT since can develop post thrombotic syndrome
 - ▶ unilateral chronic swelling- can be severe that can lead to venous stasis insufficiency and ulcers.

INCREASED RISK OF DVT/PE:

INCREASED RISK OF PRESSURE ULCERS:

The largest cause of morbidity (not mortality) of SCI patients

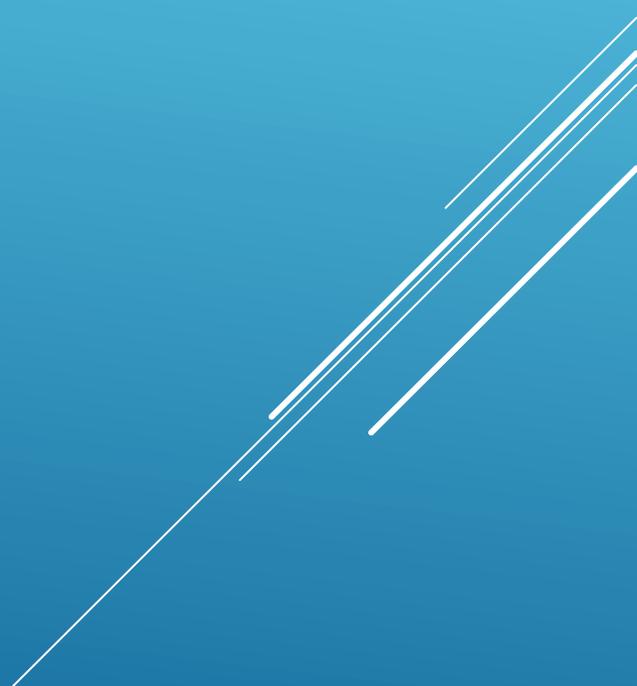
- ▶ Spinal Cord injury patients are at the highest risk for pressure ulcers of any patient population!
- ▶ Frequently, come to rehab with Pressure ulcers from ED or ICU
- ▶ Can develop a full thickness pressure ulcer (Stage IV) in 1-2 hours sitting esp if has wallet, etc in pockets
- ▶ ~20 mm Hg pressure to keep capillaries open; ~18-22 mm Hg on buttocks when laying down
- ▶ ~30 mm Hg when sitting upon buttocks
- ▶ Since they either cannot feel or cannot move, are unable to move to get off pressure points

INCREASED RISK OF PRESSURE ULCERS:

- ▶ Locations of Pressure Ulcers:
 - ▶ Sacrum
 - ▶ Ischium B/L
 - ▶ Trochanters
 - ▶ Heels- back of heels
 - ▶ Back of head
 - ▶ Back of shoulder blades/scapulae

INCREASED RISK OF PRESSURE ULCERS:

SPASTICITY:



Usually starts 2-4 weeks after SCI

“Spasticity is a motor disorder marked by a velocity-dependent increase in muscle tone or tonic stretch reflexes associated with hypertonia” in an upper motor Neuron affected patient.

Spasms or increase in muscle tone- usually worse in SCI patients and TBI patients (also affects CVA, CP, and MS patients)- usually gets worse for up to **1-2 YEARS past injury.**

Can increase risk of contractures:

SPASTICITY:

Treated with:

Baclofen

Botulinum Toxin injections

Dantrolene

Phenol injections

Valium

ITB- Intrathecal Baclofen Pumps

Zanaflex

Some cases, Clonidine/Gabapentin can help

Flexeril +/-

SPASTICITY

INTIMACY/SEXUALITY/REPRODUCTION

N:

90+% of SCI patients can have sex again, in some way shape or form



INTIMACY/SEXUALITY/R
EPRODUCTION:

IT'S POSSIBLE!

- ▶ First Line- Viagra, Cialis, Levitra
- ▶ Second Line- suppositories to stimulate erection
- ▶ Third Line- Injections into penis to stimulate erection- work 100% of time
- ▶ Implantable pumps/moveable prostheses
 - ▶ ***Basically, don't discuss sexuality except to say that's an option in most cases!!!***

INTIMACY/SEXUALITY/REPRODUCTION:

▶ Males

- ▶ Decreases ability to ejaculate
- ▶ Decreases ability to procreate
- ▶ Might need IUI
- ▶ Might need IVF

▶ Females

- ▶ Does decrease ability to have an orgasm
- ▶ Doesn't decrease ability to get pregnant/procreate
- ▶ Usually don't need additional intervention to get pregnant/have baby
- ▶ Increases risk of AD during pregnancy if level of injury T6 or above (maybe even lower)

INTIMACY/SEXUALITY/REPRODUCTION:



REPRODUCTION:

IT IS POSSIBLE!!!!

TIER 1	TIER 2	TIER 3
Nociceptive pain	<ul style="list-style-type: none"> • Musculoskeletal pain • Visceral pain • Other nociceptive pain 	<ul style="list-style-type: none"> -Shoulder osteoarthritis -Constipation -Autonomic dysreflexia headache
Neuropathic pain	<ul style="list-style-type: none"> • At level pain • Below level pain • Other neuropathic pain 	<ul style="list-style-type: none"> -Spinal cord compression -Spinal cord ischaemia -Carpal tunnel syndrome
Other pain		<ul style="list-style-type: none"> -Fibromyalgia -Irritable bowel syndrome
Unknown pain		

AT LEVEL SCI PAIN/NERVE PAIN:

At Level SCI Pain- in ~ 30-50% of patients- at their level of injury

Described as a too tight Corset, seatbelt, etc.

Treated "OK" with nerve pain agents

Gabapentin/Lyrica/Cymbalta

- ▶ Osteoporosis with increased risk of fractures
 - ▶ Seen osteoporotic fractures as early as 6 months after injury- usually after 18 months
- ▶ Spasticity
 - ▶ Increasing for 1-2 years AFTER injury
- ▶ Cardiac- increased risk of Stroke and MI
 - ▶ - in T6 or above
 - ▶ Likely due to increased AD/intimal thickening/increased CRP

- ▶ Sexual Dysfunction
- ▶ Chronic Neurogenic bowel issues
 - ▶ Need for bowel program to change up every 7-10 years- gets acclimated
 - ▶ Increased risk of death from colon CA due to lack of colonoscopies
- ▶ Chronic Neurogenic bladder issues
 - ▶ Increased risk of UTIs → sepsis risk
 - ▶ Increased risk of Kidney/Bladder stones

CHRONIC SCI ISSUES: