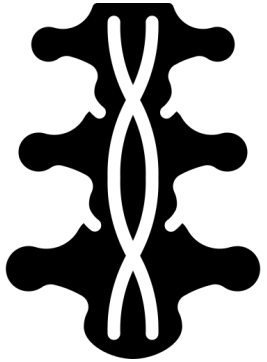
A Primer in Spinal Cord Injury for SLPs



1.

Introduction

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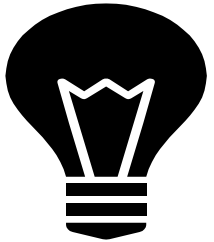
Disclosures

- Financial: None
- Non-financial: None

Learner Objectives



- Define basic concepts re: spinal cord injury (SCI)
- Describe how swallow function and cognition are likely to be impacted in SCI
- Identify common, functional goals and obstacles for individuals with SCI at acute to sub-acute levels

General Considerations

General goals for initial rehabilitation are:

- Facilitate return of swallow function and speech
- Individual to be able to recall SCI-specific mobility/ADL techniques
- Individual ultimately direct own care if needed

Heavy counseling component | Impact on family/caregivers

2.

SCI Basics

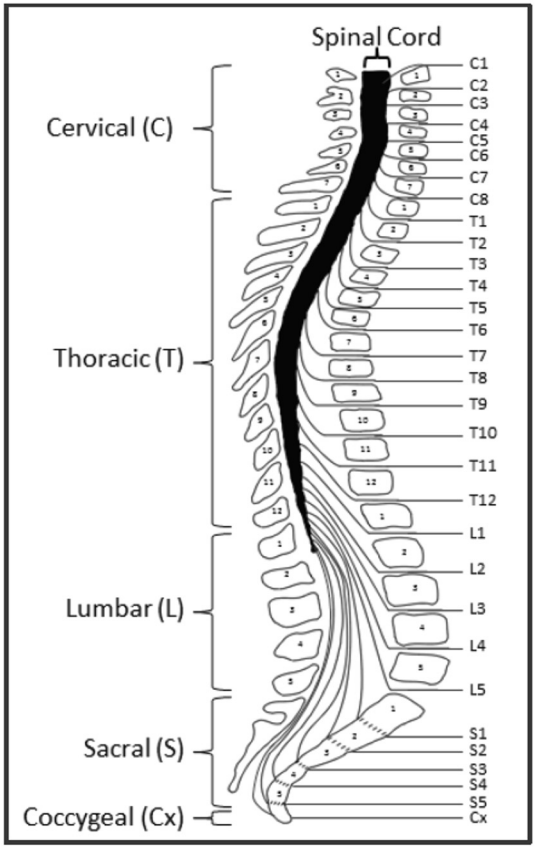
Let’s start from the beginning

The Spine

Surrounds and protects the spinal cord (among other things)

Divisions:

- Cervical: 7
- Thoracic: 12
- Lumbar: 5
- Sacral: 5 fused together (the *sacrum*)
- Coccygeal: 3-5 fused together (the *coccyx* or tailbone)

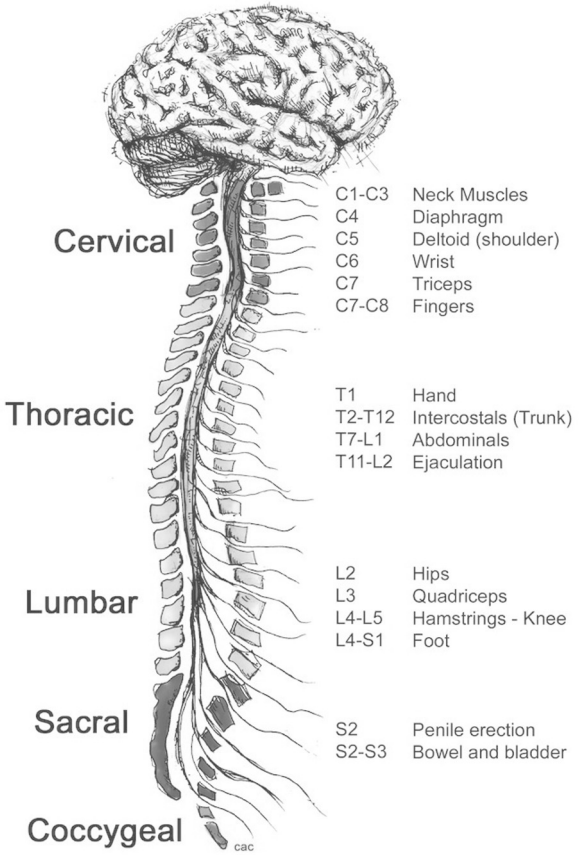


The Spinal Cord

Part of the central nervous system (CNS)

Bundle of nerves running from the base of the brain to the end of the spinal canal

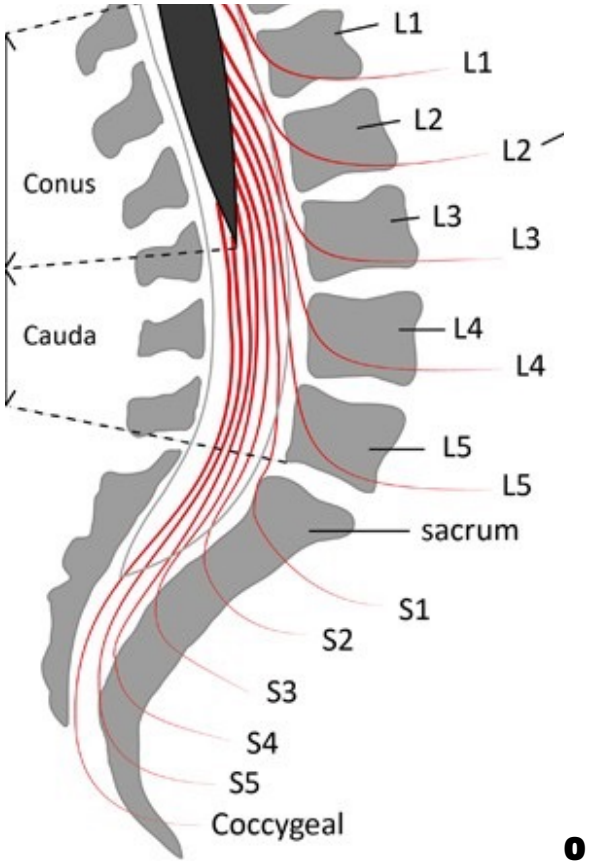
- 31 pairs of matched nerves
- Numbered to match the corresponding vertebra



The Spinal Cord continued

Conus medullaris: the end of the spinal cord proper

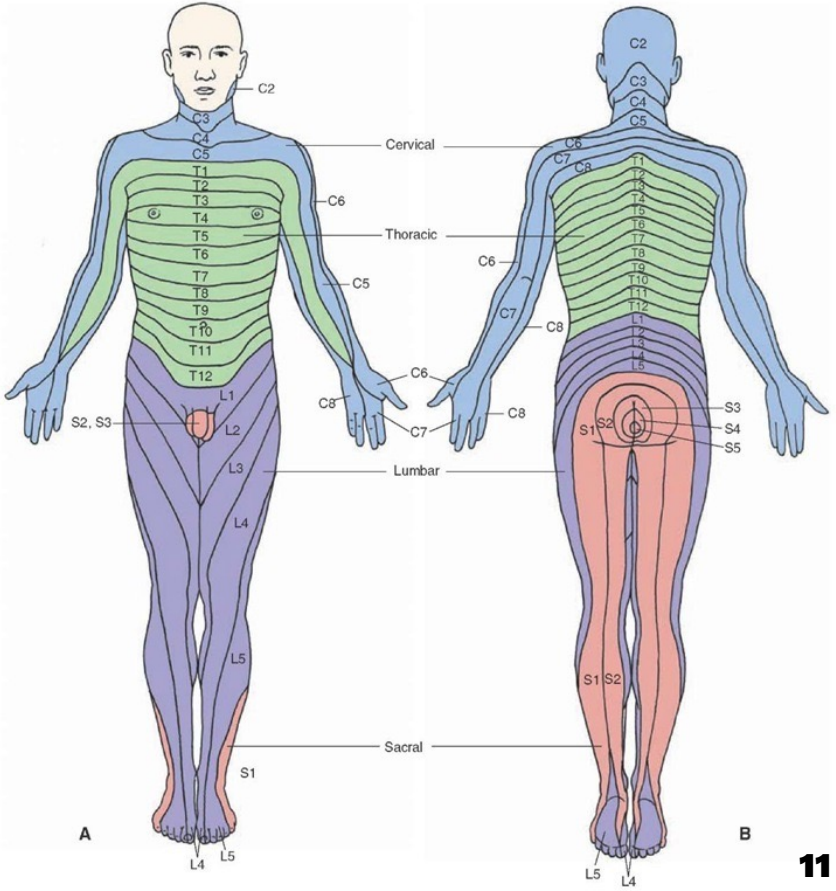
Cauda equina: describes where spinal nerve roots continue below the conus medullaris



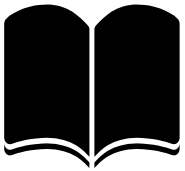
Dermatomes

Defined areas of skin to which the sensory components of spinal nerves are distributed to specific spinal cord segments

Relay sensory information back to the CNS



Definitions



Spinal Cord Injury

Damage to the spinal cord or to the spinal nerve roots within the spinal canal, resulting in temporary or permanent loss of movement and/or feeling

Tetraplegia/Quadriplegia

Paralysis caused by a cervical injury, with some degree of paralysis in both the upper body and the lower body

Paraplegia

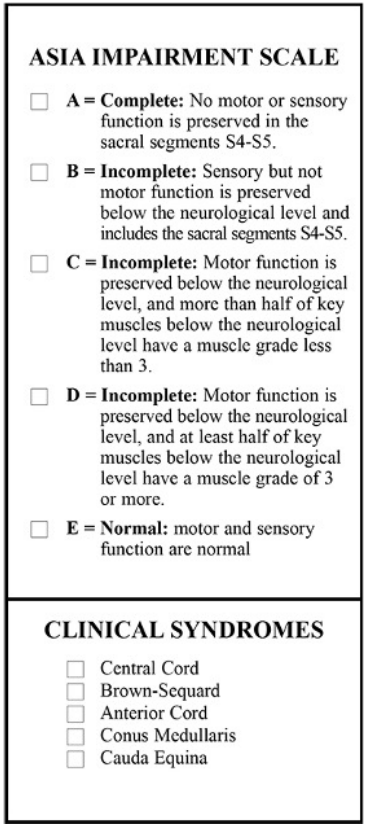
Paralysis that results from a thoracic, lumbar, or sacral injury, with some degree of paralysis in the lower body (but may include the chest)

Type of Injury

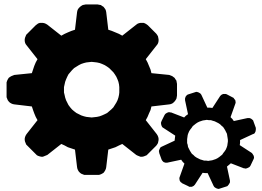
Complete SCI: defined by no feeling in the anal area and no volitional control of the anus

Incomplete SCI: all other injuries, with various grading based on results of testing

Determined by ASIA testing



All together now



Level	Type	Summary
C4	A	C4 Asia A

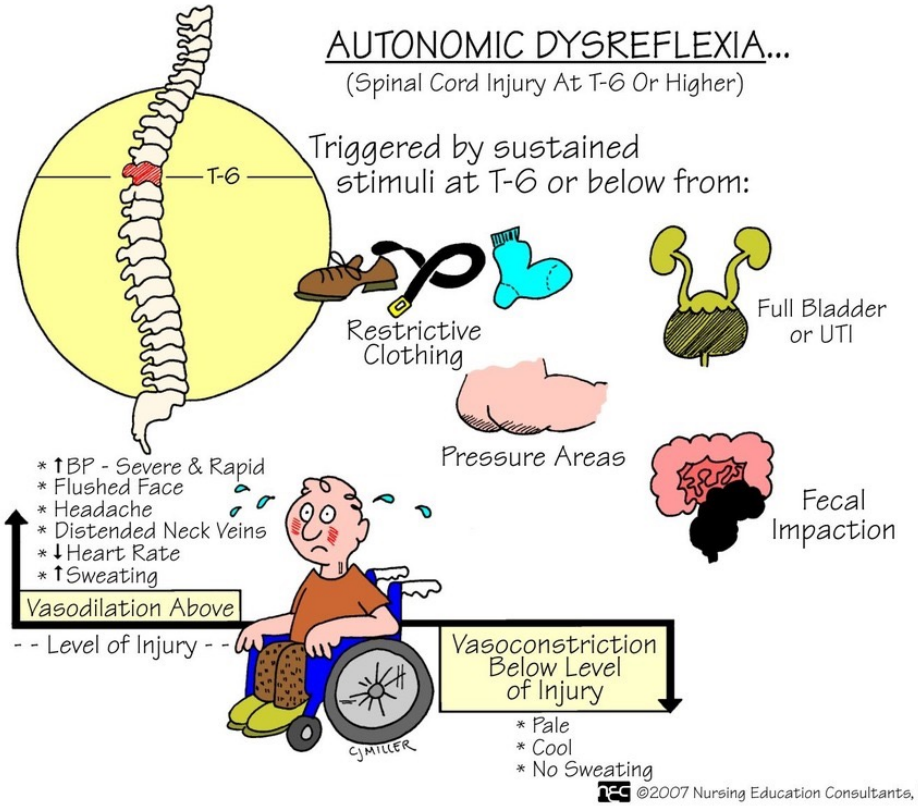
“Patient is a 78-year-old with quadriplegia due to C4 ASIA A SCI sustained in a ground-level fall with head strike.”

Complications

Autonomic dysreflexia (AD)	Bowel & Bladder	Cardiovascular	Heterotopic ossification (HO)
Pressure ulcers	Spinal shock	Spasticity	VTE

Autonomic dysreflexia is a life-threatening emergency

Find and eliminate the noxious stimulus ASAP



Bowel & Bladder

Bowel

- Incontinence
- Constipation

Bladder

- Retention
- Spasticity
- Leakage
- Incontinence
- UTI

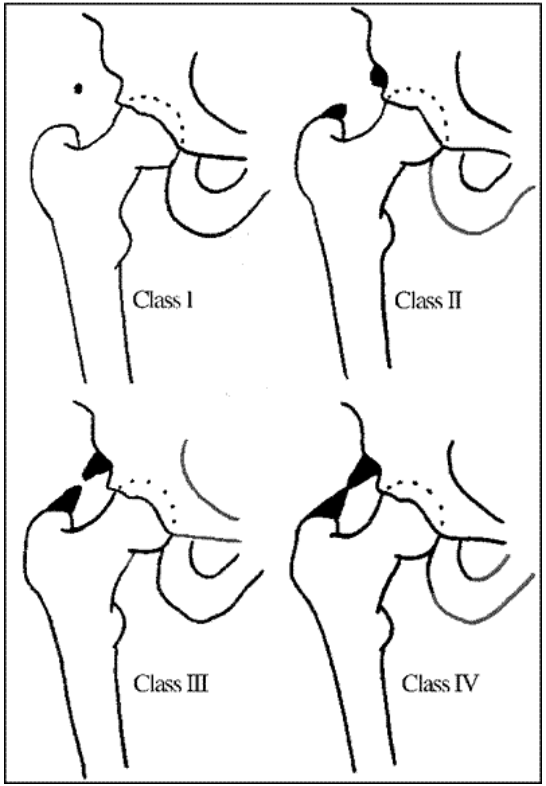
Heterotopic ossification

Abnormal growth of bone in soft tissue

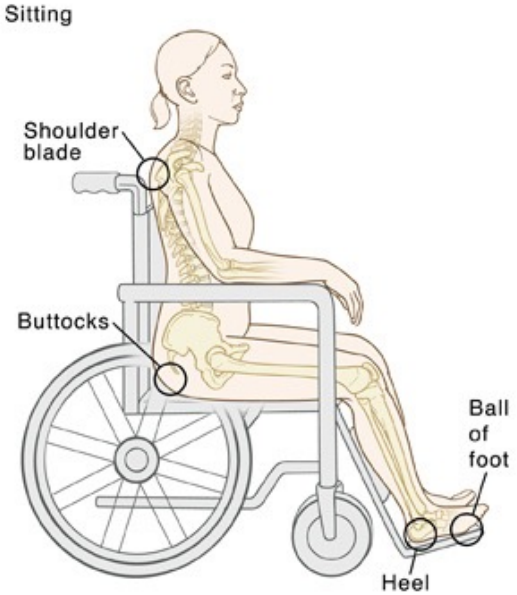
Rate of incidence from **16-53%** in SCI

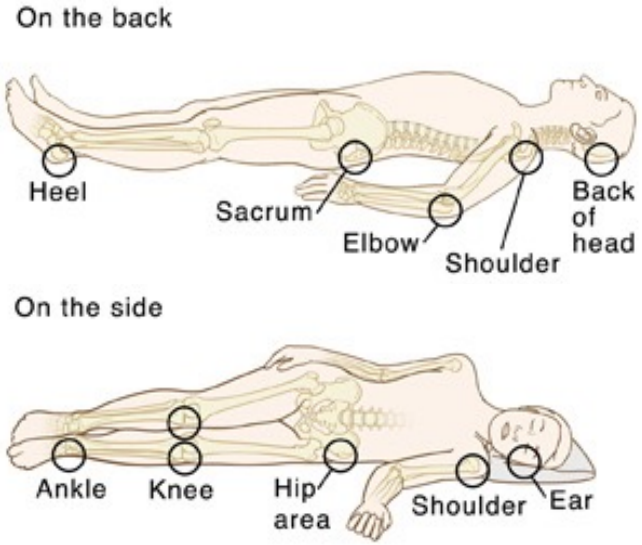
Can **trigger** autonomic dysreflexia

Symptoms can **mimic DVT**



Pressure Ulcers





Spasticity

Benefits	Problems	Triggers
• Use in functional activities • Alert the individual or caregivers to medical issues that might otherwise be asymptomatic	• Painful • Loss of range of motion, contractures • Safety risks • Prevent deep breaths • Poor sleep • Rubbing – skin breakdown • Hard to control movements	• Stretching • Moving • Skin irritation • Pressure ulcers • UTI or full bladder • Constipation • Large hemorrhoids • Fractures below SCI • Tight clothing, wraps, binders

SCI-Specific Care Needs

Prognostication

Complete Injuries

- Fairly predictable disabilities
- May recover 1-2 levels of function

Incomplete Injuries

- Disabilities are unpredictable and complex
- Likely at least some recovery

3.

Common Diagnoses & Injuries

How does this happen?

296,000

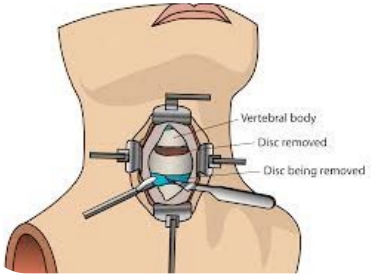
people in the U.S. living with SCI

78%
new SCI cases since 2015 are male

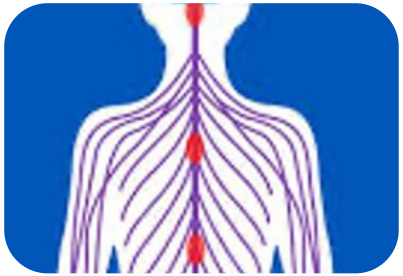
17,900
new cases annually total

Non-traumatic SCI (NTSCI)

Spinal disorders & diseases



Spinal surgery



Systemic disorders & diseases

NTSCI Diagnoses - Spinal

Ankylosing spondylitis	Arachnoiditis	AVM or Cavernous malformation	Cord syndromes	Myelopathy	Slipped disc
Spondylodiscitis	Spina bifida	Spinal cord contusion	Spinal cord infarct	Spinal muscular atrophy	Spinal stenosis
	Spinal tumor	Syringomyelia	Tethered cord syndrome	Transverse myelitis	

Not an exhaustive list

NTSCI Diagnoses - Systemic

- ALS
- Friedrich's ataxia
- Guillain-Barré syndrome
- Leukodystrophies
- Lyme disease
- Mitochondrial myopathy
- Multiple sclerosis
- Muscular dystrophy
- Neurofibromatosis
- Parkinson's disease
- Post-polio syndrome

Not an exhaustive list

Traumatic SCI (TSCI)

#1 Motor vehicle crashes

#2 Falls

#3 Acts of violence

Followed distantly by sports injuries and medical surgery complications

4.

Dysphagia

SCI-specific, of course

Risk Factors

for dysphagia in cervical SCI *

- Presence of trach (3x risk)
- Cervical surgery (1.3x risk)
- Injury severity
- Age>72 years
- Bronchoscopy required
- Comorbid brain injury
- Coughing
- Dysphonia
- Nasogastric tube
- Pneumonia

**published studies focus almost exclusively on cervical SCI*

Etiologies/Contributors

Baseline osteophytes	Comorbid brainstem trauma or stroke	Trach	Other traumatic injuries
Surgical approach & complications	Cervical hardware	Medications	Level & Type of SCI

Surgical Approach & Complications

Approach

- Anterior cervical discectomy and fusion (ACDF)
- Multi-level surgery

Complications

- Bone graft dislodgement
- Hardware rejection
- Scar tissue
- Denervation
- Infection
- Hematoma

ACDF – Acute & Chronic

Incidence: 1-80% of cases have dysphagia in first 5 days post-operatively

Most common risk factors: more levels operated, female, increased operative time, older age (>60)

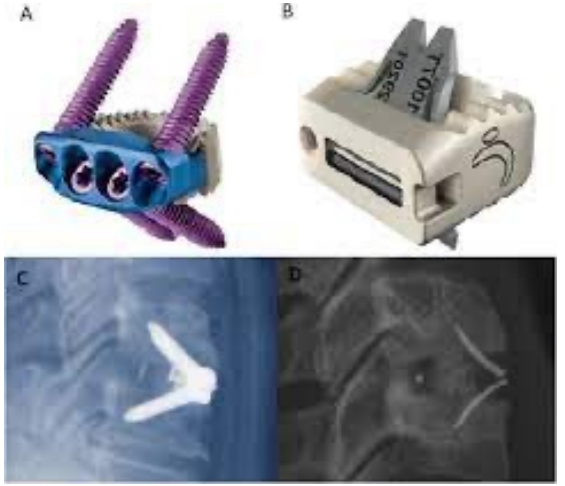
Swallow Physiology Changes

- Prevertebral swelling
- Decreased pharyngeal constriction & stripping wave
- Prolonged pharyngeal transit time
- Reduced anterior hyoid excursion
- Reduced opening of UES
- Impaired epiglottic inversion

Chronic Issues (Brady et al, 2004)

- Sent home with undiagnosed dysphagia
- Develop malnutrition or unintentional weight loss in community
- Experience psychosocial impacts of dysphagia

Cervical Hardware



Cervical Hardware Migration

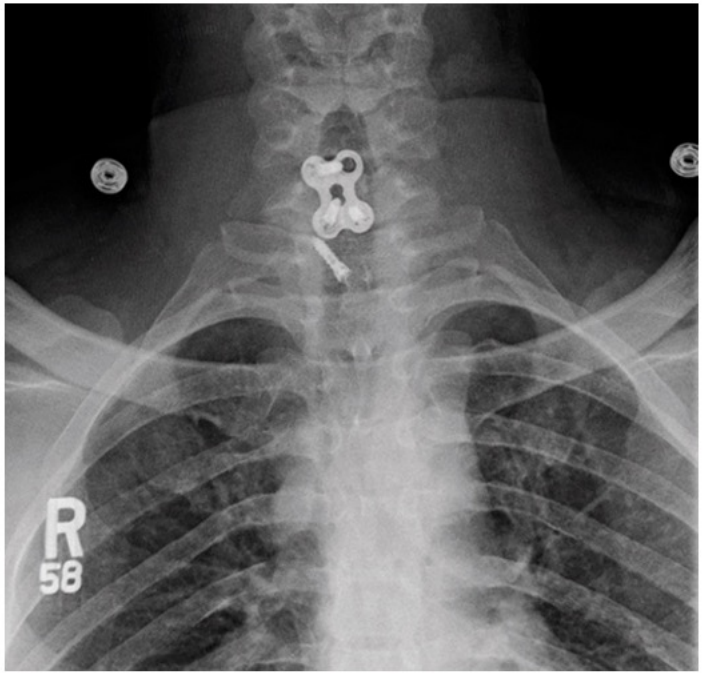


Figure 1

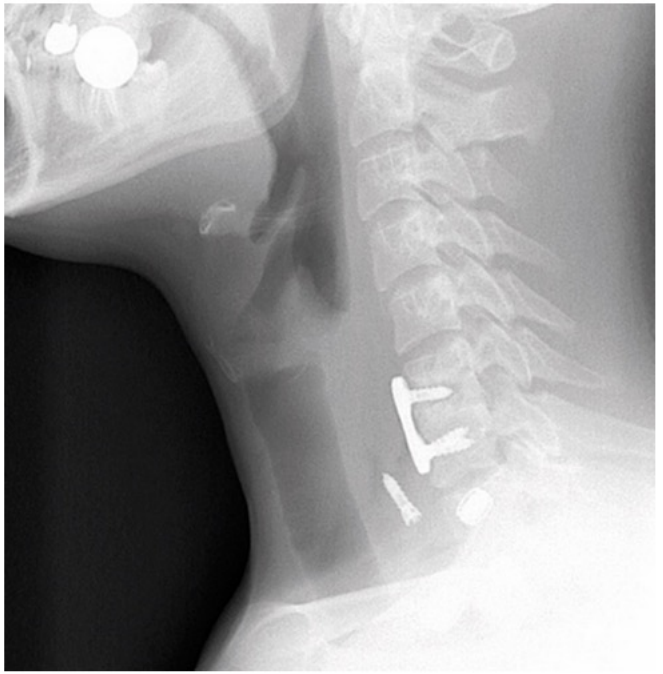


Figure 2

Medication Effects

Direct Impacts	Systemic & Motivational Impacts
• Dysarthria • Dysgeusia • Dysphagia • GI motility changes • Reflux, GERD, LPR • Respiratory depression • Xerostomia	• Anorexia • Confusion or Memory Impairment • Depression • Drowsiness, sedation • GI Upset • Nausea, vomiting • Weakness (asthenia)

Two of the most commonly prescribed medications I see – baclofen and oxycodone – have dysphagia listed as one of their “common” side effects

Level & Type of SCI

High SCI

- Cervical – decreased respiratory drive/control, laryngeal dysfunction
- T6 & above - gastric emptying, LES relaxation
- Esophageal and bowel dysmotility

High & Complete SCI

- Longer duration of respirator dependency
- Significantly altered pharyngeal and esophageal pressures

Respiratory complications are the #1 cause of death in chronic SCI

Pneumonia is the #1 respiratory complication

Normal Breathing Physiology

Primary Inspiratory Muscles	Primary Expiratory Muscles	Accessory Muscles
Diaphragm	Internal intercostals	SCM
External intercostals	Rectus abdominals	Scalenes
Scalenes	Obliques	Upper trapezius

Cervical SCI Respiratory Function

Table 1. Nerve supply of muscles of respiration

Muscle group	Nerve supply
Diaphragm	C3–C5
Sternocleidomastoid	Spinal portion of accessory nerve, anterior rami of C2, C3
Scalene	
Anticus	C5–C8
Medius	C3–C4
Posterior	C3–C4
Intercostals	Corresponding thoracic segment
Latissimus dorsi	C6–C8
Serratus posterior inferior	T10–T12
Abdominal wall muscles	T7–L1
External oblique	
Internal oblique	
Transversus abdominus	

Table 2. Changes in respiratory function after cervical spinal cord injury

Pathophysiological change	Mechanism
Reduced vital capacity	Paralysis of inspiratory muscles Distortion of upper rib cage during inspiration[39] Reduced lung compliance
Reduced chest wall compliance	Increased tone of intercostal muscles[20] Altered articulation of ribs to sternum and spine[40]
Reduced lung compliance	Low functional residual capacity[41] Recurrent respiratory infections Altered properties of surfactant[22]
Impaired cough	Paralysis of abdominal muscles[17] Reduced vital capacity
Increased secretions and bronchial tone	Decreased sympathetic tone[28]

Respiratory Dysfunction by Level

Possible impacts – depends on type

C1-C2

- Long-term ventilation, likely with trach, due to diaphragm paralysis
- No active inspiration
- Impaired neck flexion & extension

C3-C4

- No volitional movement of intercostals & abdominals
- Limited diaphragm functionality for active inspiration
- 51-83% able to wean from ventilator
- Continued weak independent respiration

C3

- Decreased sensation to neck
- Decreased ability to tilt head right/left

C4

Decreased ability to raise shoulders

Respiratory Dysfunction by Level

Possible impacts – depends on type

C5-C7

- Good diaphragm control and functionality
- Limited abdominal and intercostal functionality
- 2/3 need initial ventilation, with variable strength of respiration after weaning

T1-T5

- Impaired control of resting respiration
- Weak/ineffective cough

T6-T12

- Weak/ineffective cough

L1 and below

No respiratory impairment

SLP-Led/Implemented Interventions for Respiration

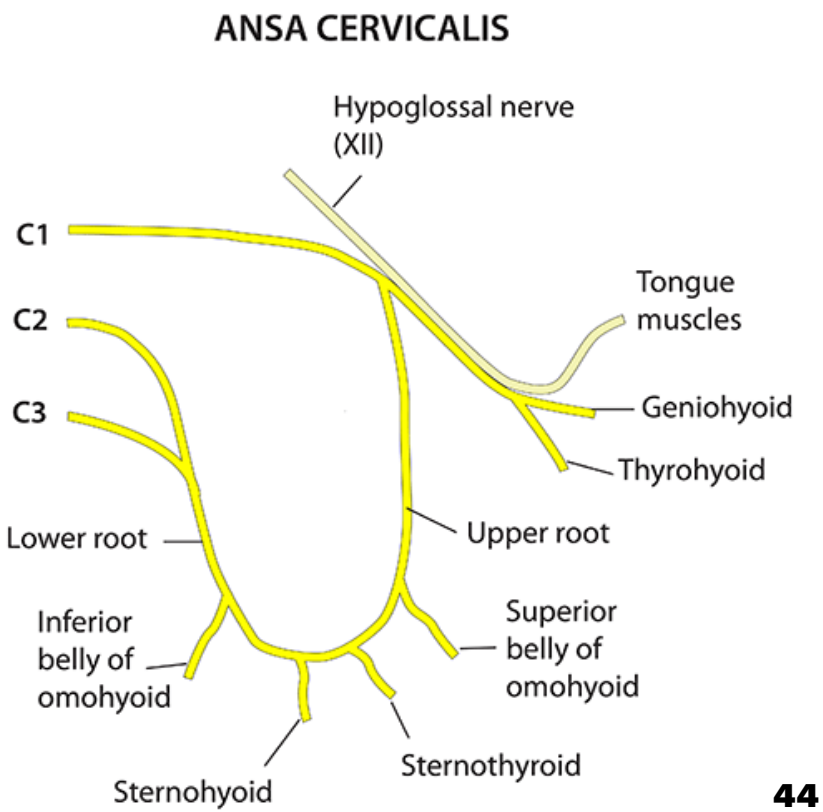
- Respiratory Muscle Strength Training
- Position Changes
- Compensatory strategies

Laryngeal Function

Respiratory, neurological, and **mechanical** disruption

Examples:

- Bulbar palsy
- Glottal/tracheal stenosis
- Ansa cervicalis involvement



Be Aware and Prepared

- Key impairment may be ineffective pharyngeal pressures
- C4 and above, ACDF = red flags in chart review
- Thorough assessment of breath support & cough
- Absent cough reflex or vagus nerve palsy decreases bedside s/s
- Instrumental assessment early (similar to trach)
- Track progress objectively & with self-report measures

Assessment & Progress Reporting Measures

Objective

- ASHA NOMS
- Cranial nerve exam
- Dysphagia Outcome and Severity Scale
- Functional Oral Intake Score
- Mann Assessment of Swallowing Ability
- Yale Swallow Protocol

Subjective (PROMs)

- EAT-10
- Deglutition Handicap Index
- Dysphagia Handicap Index
- GERD Impact Questionnaire
- MD Anderson Dysphagia Inventory
- PROMIS-GI
- Reflux Disease Questionnaire

Treatment

Compensatory strategies

Swallow exercises

Biofeedback

Respiratory control

NMES

Goal Targets

Breath Support/Control	Compensatory Strategies & Diet Mod	Pt Education
• O2 saturation • Steady respiratory rate • Exhale after swallow • Increased MPT • Improvement on RMST	• Rate of intake • Bolus size changes • Strategies effective on instrumental exam • Diet textures (not just safest but also most comfortable)	• Pt-specific s/s aspiration and risks of aspiration PNA • Respiratory health and dysphagia related to acute and chronic SCI

Example: *"Pt will* ***maintain adequate respiratory****-swallow coordination over course of meal of [texture] with modified independence as exhibited by* ***ste****ad****y respiratory rate and O2 saturation over course*** *of intake."*

5.

Cognition

Including co-occurring brain injury

Goal Targets

At acute and sub-acute/acute rehab levels, general cognitive goals are to:

- **Attend adequately to therapy sessions, conversations with other disciplines**
- **Recall and apply new information specific to SCI**
- **Plan for SCI-specific changes to daily routines**

Ultimately, when patients leave acute rehabilitation the goal is for them to be expert enough in their condition and needs that **they can direct their own care**

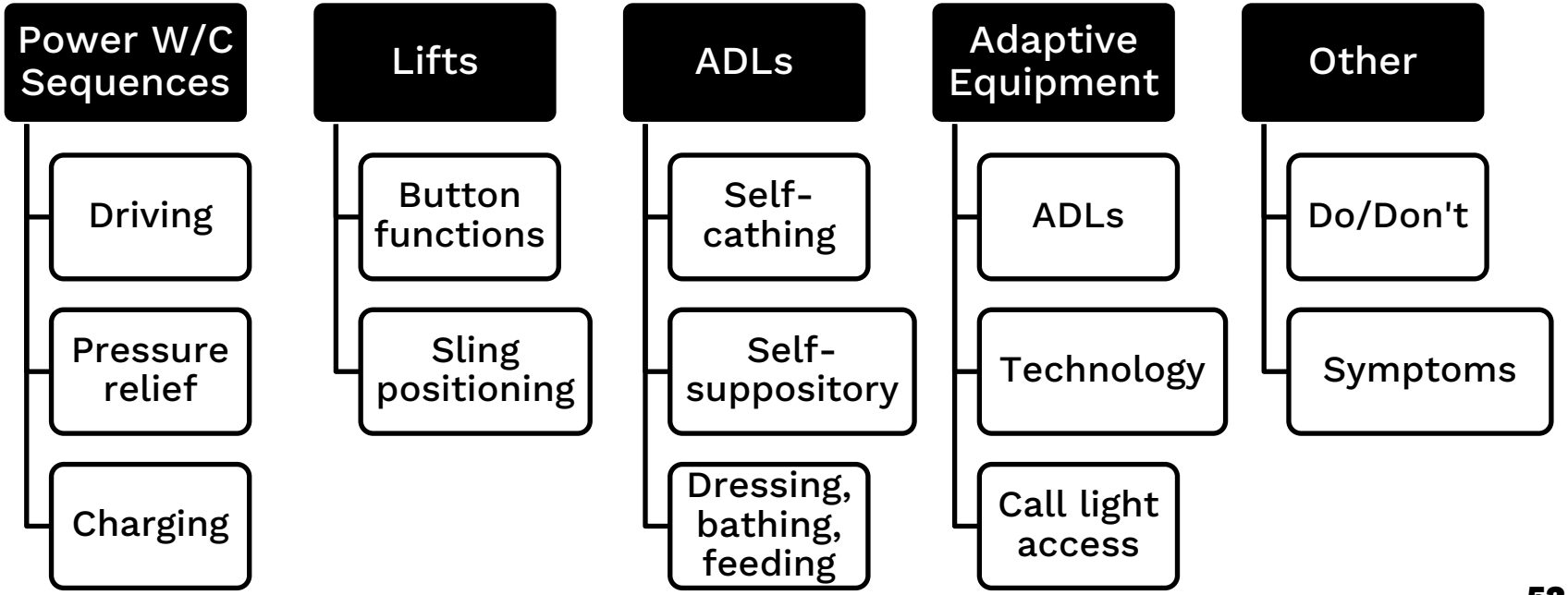
Novel Functional Information Recall Targets

At my acute rehab, initial goals are almost always:

1. Pressure relief timing and techniques to reduce risk of pressure ulcers
2. Transfer sequences to reduce reliance on lifts
3. Recall **why** bowel and bladder programs need to happen to improve adherence

Collaborate with the whole team—there is so much for people with SCI to learn, and all of it is important.

Novel Functional Information Recall Targets



SCI Daily Routines

- Morning and evening skin checks
- Pressure relief (every 30 mins out of bed, every 2 hours in bed)
- Bowel program
- Bladder program

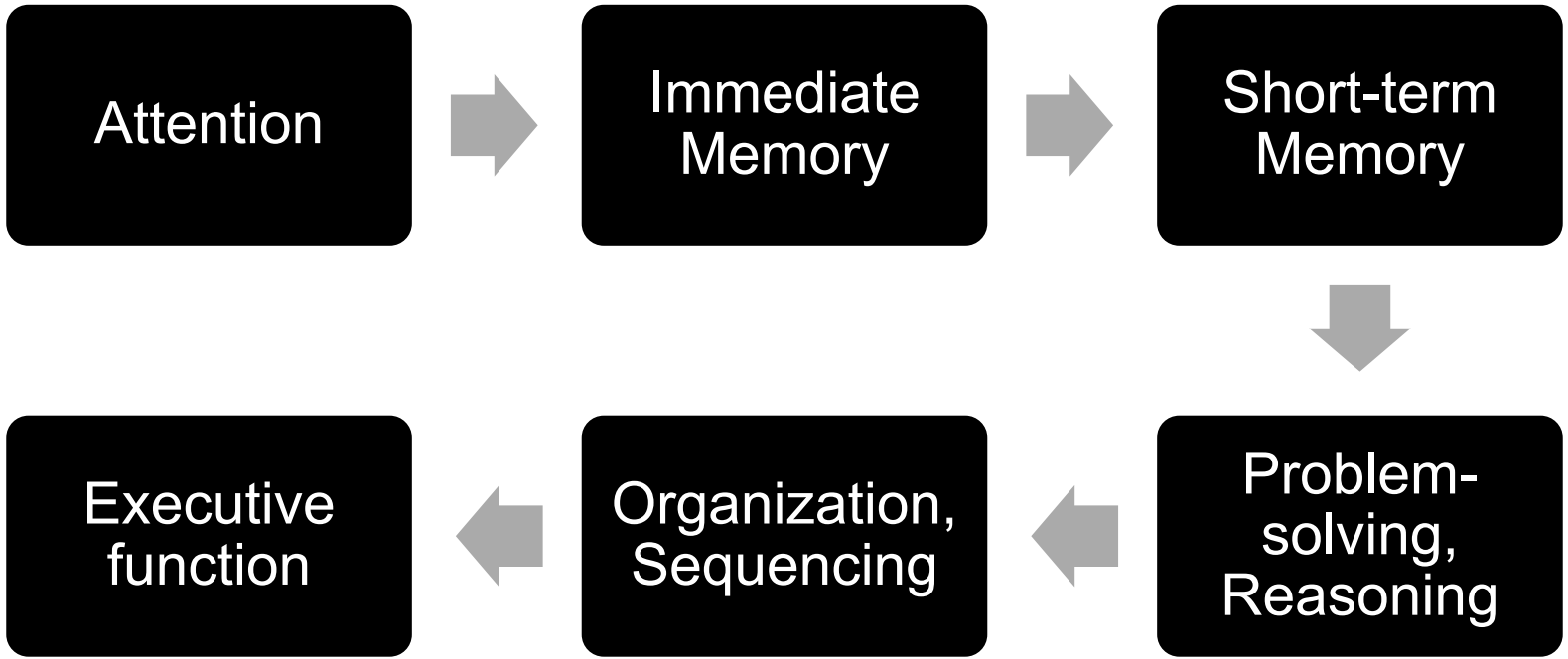
Extra time to:

- Dress/undress
- Groom
- Bathe
- Prepare meals
- Do household chores
- Complete community ADLs

Etiologies

- Acute encephalopathy
- Brain injury
- Pain
- Pain medications
- Post-Intensive Care Syndrome
- Poor sleep
- White matter degeneration?

Impairments



Co-Occurring Brain Injury Rates

- Incidence ranges from **16-59%** for TBI
- mTBI is under-identified in acute:

34-58.5% of mTBI not identified

75% missed in non-MVC admits

42.9% missed in MVC admits

Moderate and severe injuries also missed
(6% and 10% respectively)

Co-Occurring BI Impacts

Good news:

long-term outcomes for TBI with SCI similar to those with SCI alone

Bad news:

TBI with SCI prolongs acute rehabilitation stays, with increased complications and dependence on caregivers

Complications of BI with SCI

- Pulmonary infections
- Bladder infections
- Pressure ulcers
- Poor pain management

Red Flags for TBI

Consider undiagnosed TBI in SCI patients with any cognitive concerns without etiology or explained by other factors (pain, pain meds, delirium)

In chart review:

- Alcohol intoxication at time of injury
- Documented loss of consciousness
- Post-traumatic amnesia
- Traumatic mechanism of injury
- Results of medical imaging*
- Initial GCS score of <15
- Complete TSCI

IDT Interventions for BI with SCI

Call light access

Secretion management

Bundled care

Set schedule

Family training & education

6.

Summary/Q&A

You’re good, right?

Resources

Separate packet includes:

- One-page quick reference guide
- ASIA Impairment Scale scoring sheet
- Select charts/tables from presentation
- Medication side effects chart
- Functional PT/OT goals for complete SCI at all levels for ideas on cognitive targets

Highly recommend:

- Model Systems Knowledge Translation Center resources at msktc.org/sci
- Speech Uncensored Podcast episode 119: “Swallowing Challenges after Cervical SCI with Michelle Dehgan”
- TIRR-Memorial Herman SCI CEUs “Topics in SCI for SLPs”
- International Spinal Cord Society elearnSCI Modules. ElearnSCI.org

Attributions

- Slide 1 image: Flaticon.com
- Slide 7 image: https://medium.com/@anhminhdo/4-levels-of-competence-fb1bbddd945d
- Slide 11 image: (***MSKTC SCI Booklet***, 2021)
- Slide 12 image: ChristopherReeve.org
- Slide 13 image: (Brouwers et al., 2017)
- Slide 14 image: (***Dermatomes and Myotomes***, n.d.)
- Slide 17 image: (Kalsi-Ryan, 2018)
- Slide 20 image: Unknown. Nursing Education Consultants publication from 2007.
- Slide 23 image: (“Heterotopic Ossification and Spinal Cord Injuries,” 2020)
- Slide 24 image: (***Spinal Cord Injury (SCI) and Pressure Injuries***, n.d.)
- Slide 41 image: (***ACDF | Marina Spine Center | Cedars-Sinai Marina Del Rey Hospital***, n.d.)
- Slide 42 images: Manufacturer websites
- Slide 43 image: (Halani et al., 2016)
- Slide 47 image: (Randelman et al., 2021)
- Slide 55 images: Manufacturer websites
- Slide 57 image: (***Instant Anatomy - Head and Neck - Nerves - Somatic Nerves - Ansa Cervicalis***, n.d.)

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