Spinal Cord Injury (SCI)

Case Presentation
Nature of . . .
Approach/FoR . . .
Some Common Assessments
Case Presentation

“Molly”
- Background
  • 30 y/o F
  • Married, 2 kids 5 & 9 y/o
  • Injured sledding with kids, hit a wall
- Priority 1: being Mom

Thanks to Deepa Thimmaiah, MSOTR, Craig Hospital for large portion of this content.
Case Presentation

- Tx program
  - Getting up – around / transfers
  - UE strengthening (Pt into exercising, going to gym), core strengthening
  - Incorporate kids into balance activities
  - Home access
  - Kitchen (Pt worked as cook)
  - Self care (if you can’t take care of your self, you can’t take care of your kids)
  - Dressing, bed mobility, shower, bladder, bowel
  - Advanced skills – driving / car transfers

- Challenges: culture, depression, language

Thanks to Deepa Thimmaiah, MSOTR, Craig Hospital for large portion of this content.
Results of Initial Assessment: 1/8/2010

• **FIM / FAM**: Summary=Most scores <7 due to newness of injury, need for education

• **MMT results**:  
  - 4-5/5 in all muscles of UE and erector spinae, transversospinalis, to around level of T10-11. Upper 2/3 abdominals 4-5/5.

• **Sensory Results**:  
  - All sensory modalities (temp, superficial pain, fine discriminative touch, proprioception) intact through T11 spinal nerve level

• **Anticipated Neurological Level**:  
  - T11 ASIA A
Progress Note 1/11 – 1/15/2010

• Narrative Format (and not very well organized):
Initial eval results indicated a neurological level of T11, ASIA scale rating of A. Plan is to continue OT for training in self care, esp. UE and LE dressing, bathroom transfers. Begin car transfers. Molly is currently FIM level 5 in all transfers as she gets used to decreased trunk balance and moving her LEs without losing balance. #1 issue for her is to return to role as mom. Currently in standard (high back) wheelchair. Learning to do pressure releases Ind. (requires prompts for how/when) Molly sustained a SCI Jan 4th of this year. She requires daily encouragement to invest in the interventions planned. She appears to be adjusting to her injury but states daily she would rather “wait and recover on her own” and skip therapy.
Subjective: Molly requires daily encouragement to invest in the interventions; appears to be adjusting to injury but states daily she would rather “wait and recover on her own” and skip therapy.

Objective: Currently FIM level 5 all transfers – more familiar with trunk balance, moving LEs w/o losing balance. Currently in standard (high back) wheelchair. Learning to do pressure releases Ind. (requires prompts for how/when).

Assessment: SCI 1/4/2010, Neurological level of T11, ASIA A. #1 issue is return to role as mom. Improving in transfers, mobility, pressure management.

Plan: Continue OT training in self care, esp. UE and LE dressing, bathroom transfers. Begin car transfers.
Another Progress Note Format
(Craig Hospital – 2009)
Nature of SCI = Very biomechanical – but a world of other things going on:

• Need to differentiate between injury and neurological level

• Paralysis and resulting dependence in all areas of ADL

• Lack of sensation + inability to move/shift weight – therefore need for pressure management in seating/positioning and caution in transfers

• Complete interruption of roles – some forever

• New lifetime vulnerability to medical complications: UTIs, decubitis
Nature of . . .

- Returning strength – but how much?
- What neurological level of function (C6? C7?)?
- Complete? Incomplete? (ASIA scale?)
- Prognosis as far as ultimate functional ability in ADLs?? (original FIM scores and at DC?)
Greatest Attention on these ADLs:

- Transfers
- Showering
- Toileting/catheterization & management
- Dressing
- Eating (self-feeding)
- Mobility in home
- Mobility in community including transportation
Case Study: Able, 19 yo, C6 ASIA A

ASIA IMPAIRMENT SCALE

☐ A = Complete: No motor or sensory function is preserved in the sacral segments S4-S5.

☐ B = Incomplete: Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.

☐ C = Incomplete: Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3.

☐ D = Incomplete: Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more.

☐ E = Normal: motor and sensory function are normal
Frame of Reference

• Biomechanical
• Adaptation
• OTIPM (review Nine Dimensions of Client-Centered Performance Context):
  – Environmental, role, motivational, task (including ID of strengths/problems in occupational performance including performance analysis)
  – Cultural, societal (institutional – including resources, funding), social (connections, relationships)
  – Body function, temporal
- Sense of self-efficacy and self-esteem
- Satisfaction with life roles
  - Self-maintenance
  - Self-advancement
  - Self-enhancement
- Competence in tasks of life roles
- Activities and habits
- Abilities and skills
- Developed capacities
- First-level capacities
- Organic substrate
<table>
<thead>
<tr>
<th>Occupational Functioning Model</th>
<th>WHO ICF Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-efficacy and self-esteem</td>
<td>No corresponding concept</td>
</tr>
<tr>
<td>Satisfaction with life roles</td>
<td>Participation: involvement in a life situation; the nature and extent of a person's societal functioning; the interaction between the person having a disability and/or impairment with contextual factors</td>
</tr>
<tr>
<td>• Self-maintenance</td>
<td>Activity: the execution of a task or action by an individual; the nature and extent of functioning at the level of the individual; all that a person does at any level of complexity</td>
</tr>
<tr>
<td>• Self-advancement</td>
<td>Bodily structure and psychological and physiological function</td>
</tr>
<tr>
<td>• Self-enhancement</td>
<td>Contextual factors: the complete background to a person's life and living, including both external environmental factors and internal personal factors. Environmental factors include all aspects of the physical, social, and attitudinal world</td>
</tr>
<tr>
<td>Competence in tasks of life roles</td>
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<tr>
<td>Mastery of activities and habits</td>
<td></td>
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<tr>
<td>Having abilities and skills that underlie mastery and competence</td>
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<tr>
<td>Developed capacities</td>
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<tr>
<td>First-level capacities</td>
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<tr>
<td>Organic substrate</td>
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<tr>
<td>Environment and context: the milieu in which occupation occurs, including natural and built physical environments, tools and utensils, social relationships, cultural situations, and time</td>
<td></td>
</tr>
</tbody>
</table>

*a* Natural environment (weather or terrain), human-made environment (tools, furnishings, the built environment), social attitudes, customs, rules, practices and institutions, and other individuals.

*b* Age, race, gender, educational background, experiences, personality and character style, aptitudes, fitness, lifestyle, habits, upbringing, coping styles, social background, profession, and experience.
• **FIM: FUNCTIONAL INDEPENDENCE MEASURE (also FUNCTIONAL ASSESSMENT MEASURE)**

**Scale:**

7 Complete Independence (timely, safely)
6 Modified Independence (extra time, devices)
5 Supervision (cuing, coaxing, prompting)
4 Minimal Assist (performs 75% or more of task)
3 Moderate Assist (performs 50%-74% of task)
2 Maximal Assist (performs 25% to 49% of task)
1 Total Assist (performs less than 25% of task)
• SELF CARE ITEMS

1. Feeding
2. Grooming
3. Bathing
4. Dressing Upper Body
5. Dressing Lower Body
6. Toileting
7. Swallowing*
• SPHINCTER CONTROL
8. Bladder Management
9. Bowel Management
• MOBILITY ITEMS (Type of Transfer)
10. Bed, Chair, Wheelchair ____________________ _ _ _
11. Toilet ____________________ _
12. Tub or Shower ________________________________
13. Car Transfer* _________________________________
• LOCOMOTION
14. Walking/Wheelchair (circle)
15. Stairs
16. Community Access*
• COMMUNICATION ITEMS
17. Comprehension-Audio/Visual (circle)
18. Expression-Verbal, Non-Verbal (circle)
19. Reading*
20. Writing*
21. Speech Intelligibility*

• PSYCHOSOCIAL ADJUSTMENT
22. Social Interaction
23. Emotional Status*
24. Adjustment to Limitations*
25. Employability*
• COGNITIVE FUNCTION

26. Problem Solving
27. Memory
28. Orientation*
29. Attention*
30. Safety Judgment*

*FAM items

The FAM was developed as an adjunct to the FIM to specifically address the major functional areas that are relatively less emphasized in the FIM, including cognitive, behavioral, communication and community functioning measures. The FAM consists of 12 items. These items do not stand alone, but are intended to be added to the 18 items of the FIM.
Assessments . . .

• Wheelchair/cushion (pressure management)
• Home assessment for wheelchair access and need for adaptive equipment for shower, toilet/toileting, meal prep and eating (i.e., universal cuff)
• Transfers/mobility around the house
• Self care assessments/observations (dressing, hygiene, meal prep, bathroom transfers)
• Driving including need for and use of hand controls
Assessments . . .

• MMT – to determine nerve function via muscle strength pattern – leading to establishing neurological level (functional level) = someone with a C7 neurological level is referred to as having C7 qudraplegia (or tetraplegia), and they have motor and sensory function through C7, and, if complete, no sensation in dermatomes and no function in muscles innervated from (including) C8 and below.

• Sensory – according to dermatomes – NOT peripheral nerve distribution:
Look in the thoracic region and think about what would be if no spinal nerves mixed with others in a plexus: An example of the innervation to muscles would be “biceps, C5 and C6” instead of “biceps, musculocutaneous.”

Same is true of innervation to skin: “skin of thumb is innervated by C6” instead of “skin of thumb is innervated by median nerve.”
So . . . . Because of the scheme of things – that spinal nerves in areas of the extremities (C5 – T1 for UE) exit and then combine with each other in a plexus – we learned innervation by names of the combined bundles of spinal nerves:

Musculocutaneous n. (C5-7)
Radial n. (C5 – T1)
Axillary n. (C5-6)
Median n. (C5-T1)
Ulnar n. (C7 – T1)
So . . . You learned innervations based on peripheral nerve names, not the nerve roots that traveled within those peripheral nerves. And now, trying to decipher the muscle weakness patterns and sensory symptoms in SCI, this information does not serve you well!
Instead, you must go back and realize the structure of the peripheral nervous system as it would be without the nerve roots traveling in bundles with names.
Translation in terms of muscle function:

- A person who has function through (including) C5 has deltoid and various scapular muscles and biceps and can move the shoulder and GH joints and flex the elbow in various functional motions.

- Function through C6 gives innervation to wrist extensors, therefore, tenodesis grasp.

- C7 allows innervation to triceps, therefore the all important function of elbow extension in transfers.
• C8 & T1 finish out innervation to the long finger flexors and extensors as well as intrinsics – so manipulative grasp functions – therefore buttoning the shirt!
Sensory Function: Sensory exam yields nonsensical results?

• Pin prick felt in thumb but not in tip of long (middle) finger – based on peripheral nerve innervation, the median nerve innervates both the thumb and the long finger.

• HOWEVER, based on reasoning using spinal nerves – or segmental innervation, the dermatome pattern (the map of which patches of skin are innervated by each spinal nerve (C5, C6, etc) - indicates the thumb is innervated specifically by spinal nerve C6 while the index and long fingers are innervated by spinal nerve C7. So you have determined C6 is working, but C7 is not! And coming closer to determining a neurological level of C6 quadriplegia
Because the spinal nerves get mixed/blended in different combinations in the plexus and then arrive at their patches of skin based on the peripheral nerve they travel in, we have a peripheral nerve distribution chart AND a spinal nerve distribution chart – the spinal nerve chart exists because even though the spinal nerves are mixed into different peripheral nerves, all of the spinal nerves from one level (C6 for example) end up innervating one contiguous patch of skin.
Two Nerve Distributions of the Same Nerves!

Peripheral Nerve Distribution

Spinal Nerve Distribution (Dermatomes)
• This means the median nerve has in it fibers from C6 and C7 (as well as others)
• On the motor side of things, fibers from C6 innervate the wrist extensors, but travel through the radial nerve to get to ECRL, ECRB, ECU; fibers from C7 innervate the triceps, traveling through the radial nerve to get there
Sensory & Motor: Spinal segments only

Figure 3: Neurologic level C5.
Sensory: Peripheral and spinal nerve distributions

http://www.flotte2.com/PeripheralNerve_files/image020.jpg
STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

MOTOR

KEY MUSCLES (scoring on reverse side)

- w flexors
- t extensors
- w extensors
- 9r flexors (distal phalanx of middle finger)
- 9r abductors (little finger)

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

SENSORY

KEY SENSORY POINTS

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VS

tensors

vsflavors
Intervention Areas

- ADL
  - Feed
  - Groom
  - Dress
  - Bowel
  - Bladder
  - Self padding
  - Shower
- Functional Mobility
  - Wheelchair
  - Bed

- UE
  - Strength
  - ROM
  - Spasticity
  - Neural tension
  - Sensation
- Vision
- Work
- Leisure
Functional Expectations

- **C0-2**
  - Directing care
  - Driving wheelchair
  - Environmental control

- **C3-4**
  - May be off vent
  - Mouthstick

- **C5**
  - Hand driving
  - Feeding
  - Grooming
  - Look out for elbow/supinator contracture
• C6
  - Tenodesis
  - UE
    - Bathing
  - UE dressing
  - Van driving

• C7
  - Triceps
  - Bed mobility
  - Level transfers
  - LE dressing
  - Bowel/bladder

• C8
  - Grip
  - Housekeeping/meal prep
  - All basic manual chair skills
• Upper Ts
  - Balance
  - LE bathing

• Lower Ts
  - More abdominal muscles present
  - Advanced transfers

• L1-5
  - Walking with assist
Generalized Program

• Quad
  - Tolerance for upright
  - ROM/strengthening
  - Wheelchair driving
  - Feeding
  - Functional mobility/body awareness
  - Grooming
  - Technology
  - Dressing
  - Padding
  - Cooking

• Para
  - UE strengthening
  - Endurance
  - Functional mobility
  - Dressing
  - Padding
  - Shower/Bowel
  - Cooking
  - Cleaning
  - Driving
Special Considerations

- AD - Autonomic Dysreflexia
- HO - Heterotopic Ossification
- DVT
- UTI
- Contractures/Spasticity
- Hypotension
- Bowel/Bladder
- Skin
- Sexual Health
Injury Impacts to Autonomic Nervous System

Cardiovascular control:
- Neurogenic shock
- Orthostatic hypotension
- Autonomic dysreflexia
- Cardiac dysrhythmia

Sweating abnormalities:
- Hyperhidrosis
- Hypohidrosis
- Reflex sweating below the neurological level

Bowel dysfunctions:
- Loss of bowel sensation
- Bowel incontinence
- Constipation

Bladder dysfunctions:
- Detrusor sphincter hypoactivity
- Detrusor sphincter hyperactivity
- Detrusor sphincter dyssynergia

Temperature control:
- Cold or heat intolerance
- Poikilothermia
- Hypo or hyperthermia

Sexual function:
- Erectile function
- Ejaculation
- Vaginal lubrication

http://www.torranceinc.com/clients/asia/1_anatomy/player.html
### TABLE 6. Expected Functional Outcomes

**Level T10-L1**

Functionally relevant muscles innervated: Fully intact intercostals; external obliques; rectus abdominis

Movement possible: Good trunk stability

Patterns of weakness: Paralysis of lower extremities

**FIM/Assistance Data:** Exp = Expected FIM Score / Med = NSCSC Median / IR = NSCSC Interquartile Range

**NSCSC Sample Size:** FIM=71 / Assist=57

<table>
<thead>
<tr>
<th>Expected Functional Outcomes</th>
<th>Equipment</th>
<th>FIM/Assistance Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td>Intact respiratory function</td>
<td></td>
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<tr>
<td>Bowel</td>
<td>Independent</td>
<td>6–7</td>
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<tr>
<td></td>
<td>Padded standard or raised padded toilet seat</td>
<td>6</td>
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<tr>
<td>Bladder</td>
<td>Independent</td>
<td>6</td>
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<tr>
<td></td>
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<td>6</td>
</tr>
<tr>
<td>Bed Mobility</td>
<td>Independent</td>
<td>7</td>
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<tr>
<td></td>
<td>Full to king standard bed</td>
<td>7</td>
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<tr>
<td>Bed/Wheelchair Transfers</td>
<td>Independent</td>
<td>6–7</td>
</tr>
<tr>
<td>Pressure Relief/Positioning</td>
<td>Independent</td>
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<tr>
<td></td>
<td>* Wheelchair pressure-relief cushion</td>
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<tr>
<td></td>
<td>* Postural support devices as indicated</td>
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<tr>
<td></td>
<td>* Pressure-relief mattress or overlay may be indicated</td>
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<tr>
<td>Eating</td>
<td>Independent</td>
<td>7</td>
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<tr>
<td>Dressing</td>
<td>Independent</td>
<td>7</td>
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<tr>
<td>Grooming</td>
<td>Independent</td>
<td>7</td>
</tr>
<tr>
<td>Bathing</td>
<td>Independent</td>
<td>6–7</td>
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<tr>
<td></td>
<td>* Padded transfer tub bench</td>
<td>6</td>
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<tr>
<td></td>
<td>* Handheld shower</td>
<td>7</td>
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<tr>
<td>Wheelchair Propulsion</td>
<td>Independent all indoor and outdoor surfaces</td>
<td>6</td>
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<td></td>
<td>Manual rigid or folding lightweight wheelchair</td>
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<tr>
<td>Standing/Ambulation</td>
<td>Standing: independent</td>
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<td></td>
<td>Ambulation: Functional, some assist to independent</td>
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<tr>
<td></td>
<td>* Standing frame</td>
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<td>* Forearm crutches or walker</td>
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<tr>
<td></td>
<td>* Knee, ankle, foot orthosis (KAFO)</td>
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<tr>
<td>Communication</td>
<td>Independent</td>
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<tr>
<td>Transportation</td>
<td>Independent in car, including loading and unloading wheelchair</td>
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<td>Hand controls</td>
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<tr>
<td>Homemaking</td>
<td>Independent with complex meal prep and light housekeeping; some assist</td>
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<tr>
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<td>with heavy housekeeping</td>
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<tr>
<td>Assist Required</td>
<td>Homemaking: 2 hours/day</td>
<td>2*</td>
</tr>
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*Hours per day.
Resources

• http://emedicine.medscape.com/article/322604-overview
• http://www.fscip.org/facts.htm
• http://www.sci-info-pages.com/facts.html
• http://www.pva.org/site/PageServer?pagename=pubs_generalpubs#cpg
• http://www.pva.org/site/PageServer?pagename=pubs_main#CPG
Google image search award: