Younker Rehabilitation Interdisciplinary Conference

UNITOPIN HEALTH – DES MOINES
SÁTURDAY, MARCH 30 AND SUNDAY, MARCH 31, 2019

Purpose
Educational information will enhance the interdisciplinary clinician’s ability to provide appropriate and effective therapeutic interventions for a variety of patient diagnoses.

Overall Conference Learner Outcomes /Objectives
1. Identify current concepts in the continuum of care for the rehabilitation patient.
2. Describe the interdisciplinary team approach to therapeutic interventions.
3. Evaluate diagnosis specific therapeutic interventions to improve patient outcomes.

Topics
Spinal Cord Injury
EKSO and Robotics
Wheelchair Seating and Positioning
Continuum of Care
Limb Loss
Lymphedema
Movement Disorders and Parkinson’s
Myofascial Pain
Trauma
Brain Injury

Spinal Cord Injury
Matthew Edel, M.D.
Kimbra Korte, BS, PT

Causes of SCI
1) Vehicular Crashes 42.1% trending down
2) Falls 26.7% trending up
3) Violence 15.1%
4) Sports 7.6% trending down

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<table>
<thead>
<tr>
<th>Primary Cause of Death</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases of the respiratory system (70% pneumonia)</td>
<td>22</td>
</tr>
<tr>
<td>Other Heart disease</td>
<td>12</td>
</tr>
<tr>
<td>Infective and parasitic diseases (94% septicemia)</td>
<td>10</td>
</tr>
<tr>
<td>Hypertensive and ischemic heart disease</td>
<td>8</td>
</tr>
<tr>
<td>Neoplasms</td>
<td>7</td>
</tr>
<tr>
<td>Diseases of pulmonary circulation (96% pulmonary emboli)</td>
<td>5</td>
</tr>
<tr>
<td>Diseases of the genitourinary system</td>
<td>4</td>
</tr>
<tr>
<td>Suicides</td>
<td>4</td>
</tr>
</tbody>
</table>

### Motor Tracts

**Lateral Corticospinal**
- Located centrally and posteriorly in lateral column
- 90% of corticospinal fibers cross midline in caudal medulla
- Form Pyramidal Decussations and descend contralaterally in Lateral Corticospinal

**Anterior Corticospinal Tract**
- The remainder of corticospinal fibers (10%) cross over at the level they exit the spinal cord, and these travel in the anterior corticospinal tract.

### Sensory Tracts

**Dorsal Columns**
- Fasciculus gracilis—From lower extremities
- Fasciculus cuneatus—From upper extremities
- Touch, vibration, position sense
- Ascend spatiotemporally to the Medulla

**Lateral Spinothalamic**
- Peripherally in lateral column
- Pain and Temperature
- Ascends contralaterally to the Thalamus

### Conus Medullaris
- Terminates at L1-L2
- Due to Natural Variation
- Can be T12 – L3
- Border of UMN vs. LMN

**Thecal Sac**
- Houses Cauda Equina from L2 until S2
- Nerve roots wrapped in pia mater
- Sac comprised of Dura and Arachnoid
- Filled with CSF

### 5 Major Divisions

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Cervical</td>
<td>8</td>
</tr>
<tr>
<td>Thoracic</td>
<td>12</td>
</tr>
<tr>
<td>Lumbar</td>
<td>5</td>
</tr>
<tr>
<td>Sacral</td>
<td>5</td>
</tr>
<tr>
<td>Coccygeal</td>
<td>1</td>
</tr>
</tbody>
</table>
Brown-Sequard Syndrome

Greater ipsilateral weakness and position sense loss
Contralateral pain and temperature sensation loss

Artery of Adamkiewicz

Anterior Vascular Supply Between T12 and L2
Dominant anterior radicular artery usually on left
Important supply to caudal 2/3 of the Spinal Cord
Once reaches Spinal Cord divides into ascending and descending branches
- Descending branch travels to Conus Medullaris
- Forms Anastomotic circle with Posterior Spinal Arteries

Anterior Cord Syndrome
Cor ticospinal and Spinothalamic tracts affected
Gracilis tract is spared
Paraplegia, loss of pain and temperature
Sparing of touch and position sense
Basics
Upper Motor Neuron: A corticospinal neuron
Lower Motor Neuron: Synapses with UMN in spinal cord, exits to innervate muscle
UMN Syndrome: Loss of voluntary movement, spasticity, hyperreflexia, clonus, Babinski’s.

SCI Classification
COMPLETE
- Lack of any sensory or motor function in the lowest sacral segment
  - Sensation: Loss of sensation within anus
  - Motor: Voluntary contraction of external anal sphincter

INCOMPLETE
- At least partial sensory or motor function in the lowest sacral segment

Neurological Level of Injury
- Most caudal segment of spinal cord with normal sensation and motor function bilaterally

Sensory
- 28 dermatomes bilaterally for both light and pin prick
- Testing key point for:
  - Absent = 0
  - Impaired = 1
  - Normal Sensation = 2
- Four Scores generated (pinprick and soft BL)
- Range from 0-112
- Sensory level is the highest level with completely normal sensory function

Motor
- Testing using muscles that have 2 nerve roots each supplying them
- Each successive key muscle overlapping the muscle above by a single nerve root innervation
- So, if muscle has a 5/5 strength:
  - Innervated by two intact nerve segments
- 3/5 or 4/5 AND a key muscle above is 5/5:
  - Innervated by at least one intact nerve, the one it is named after
- 2/5 or less, neither nerve segment intact
- For muscles with no designated key muscles:
  - Considered normal if sensory is normal

<table>
<thead>
<tr>
<th>KEY MUSCLES</th>
<th>R</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5 Biceps, Brachialis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6 Extensor Carpi Radialis, Longus and Brachii</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7 Triceps</td>
<td></td>
<td></td>
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<tr>
<td>C8 Flexor Digitorum Profundus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1 Abductor Digitii Minimi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L2 Obliques</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L3 Quadriceps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L4 Tibialis Anterior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L5 Extensor Hallucis Longus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1 Gastroc, Soleous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2 Iliopsoas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3 Quadratus Gluteus</td>
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Spinal Shock: UMN vs. LMN?

<table>
<thead>
<tr>
<th>ASIA grade</th>
<th>Clinical state (below level of injury)</th>
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<tbody>
<tr>
<td>A</td>
<td>Complete: No preservation of function below level of injury, and no sacral sparing (S4-S5)</td>
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<tr>
<td>B</td>
<td>Incomplete: Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5.</td>
</tr>
<tr>
<td>C</td>
<td>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.</td>
</tr>
<tr>
<td>D</td>
<td>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 0 or worse.</td>
</tr>
<tr>
<td>E</td>
<td>Normal motor and sensory function are normal.</td>
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</table>

Lack of descending facilitation after an UMN injury

Phase I: 0 – 24hrs
- Motor neuron hyperpolarization manifests as hyporeflexia
Phase II: 1 – 3 Days
- Denervation supersensitivity & receptor upregulation
- Reflex return
Phase III: 1 – 4 Weeks
- Interneuron synapse growth
- Early hyperreflexia
Phase IV: 1 – 12 months
- Long axon synapse growth
- Late hyperreflexia

Conus Medullaris Syndrome:
- Sacral spinal cord
- Lack of preservation of function below level of injury
- Lumbar nerve roots
-ulae:
  - Bladder
  - Bowel
  - Limbs
- If localized to proximal sacral cord:
  - Can sometimes show intact bulbocavernous reflex

Cauda Equina Syndrome:
- Lucral spinal cord
- Lumbar nerve roots
-ulae:
  - Bowel
  - Bladder
  - Limbs

Spinal Mechanics and Stability:
- Generally accepted model of Spinal Stability contains three columns
  - Anterior
  - Middle
  - Posterior

Anterior:
- Anterior longitudinal ligament
- Anterior 2/3 of vertebral body
- Anterior 2/3 of the annulus fibrosis (Disc)

Middle:
- Posterior 1/3 of vertebral body
- Posterior 1/3 of annulus fibrosis
- Posterior longitudinal ligament
Posterior
- Pedicles
- Facet Joints
- Laminae
- Supraspinous Ligament
- Interspinous Ligament
- Facet Joint Capsule
- Ligamentum Flavum

Traumatic Injury
Unstable: integrity of the Middle and either the Anterior or Posterior columns are affected

Fractures or dislocations in the thoracic and lumbar spine most commonly involve the T12 and L1 vertebrae

Common Mechanisms
- Compression Flexion
- Distraction Flexion
- Translation
- Torsion Flexion

Chance Type Distraction
Flexion Distraction Injury, “Seatbelt Injury.”
If vector of force causes the axis of rotation to be anterior to the vertebral body
- Multiple types

Most common one to cause an SCI?
- Compression of all 3 columns with retropulsion of Middle column into spinal canal

Translation
Injury pattern most likely to cause an SCI
Example, person falling from height, striking an immovable object
Translation more than 25% of vertebral width?
- Ligamentous structures in all three columns most likely disrupted

Torsion Flexion Injuries
SCI is most likely when both the Anterior Longitudinal Ligament and the Facets are both disrupted
- In Anterior Column
  - Compression and Rotation
- In Posterior Column
  - Distraction and Rotation

Cervical Spine
Excessive forcful extension or flexion
Axial loading
Rapid acceleration, deceleration in car
Diver Striking bottom of pool
Jefferson Fracture
Burst fracture of the Atlas (C1 Vertebra)
Caused by axial compression

Hangman’s Fracture
Traumatic Spondylolisthesis of Axis (C2 Vertebra)
Bilateral fractures through Pars Interarticularis of Axis
Result from hyperextension and axial compression
Abrupt deceleration, ex) head hitting windshield

Odontoid Fracture
Hyperextension, hyperflexion, excessive lateral bending
Type 1 - Through the Tip
Type 2 - Base of the Odontoid
Type 3 - Extends from base into the axis proper

Flexion Tear Drop
Retropulsion of large portion of vertebral body into the spinal canal
Detached from an anterior fragment, hence the “tear drop”
Associated with posterior facet and ligament disruption
Anterior Cord Syndrome if not a complete SCI

Central Cord Syndrome
If spinal cord is pinched is pinched between the vertebral body and the Ligamentum Flavum and/or hypertrophied facet joints
Only in cervical cord
Sacral sensory sparing and greater weakness in the upper limbs compared to the lower
Nontraumatic SCI

Extradural
Extradural make up 55% of all spinal tumors
Most commonly from Vertebrae
Most common primary sites of metastatic tumors to the spine are
- Lung, Breast, Prostate and Kidney
Primary, Extradural Tumors make up < 1% of all spinal tumors
- Multiple myeloma, osteogenic sarcoma, vertebral hemangioma, chordoma, chondrosarcoma

Intradural
Intradural (from parenchyma of SC)
- Ependymomas
- Astrocytomas
- Together make up 75% of all intramedullary tumors

Extradural
- Usually benign and Primary
- Meningioma
- Schwannomas, Neurofibromas

Clinical Presentation
Pain most common sign
Worse in the supine position
Involves only skeletal structures? Axial pain
Extradural metastases can present as acute spinal cord compression
- Rapid neurologic decline to para- or tetraplegia
- Tx: corticosteroids (dexamethasone), radiation, surgical intervention

Bacterial
Vertebral Osteo
At risk? IV Drug Users, Immunosuppressed, Diabetics, on HD
Most common pathogen is Staph Aureous (>50%)
Diskitis common in children due to highly vascular disk
Lumbar spine most common
Vertebral body collapse, Epidural abscess
Pain most common sign (90%)
IV Abx for at least 4 weeks, may warrant surgical tx

Pott’s Disease
Hematogenous spread
Mycobacterium tuberculosis
Typically from pulmonary focus
Treated with two to four anti-tuberculosis agents for 6 to 12 months
HIV
Vacuolar Myelopathy, primary HIV myelitis or due to opportunistic infections
Clinically evident myelopathy in 7-20% of HIV positive pt's
Vacuolar Myelopathy
- Incomplete spastic paraplegia with loss of proprioception and vibration sense
- Vacuoles found in disorganized white matter tracts in 40-55% of HIV + autopsies, most commonly mid to low thoracic cord

Transverse Myelitis
Myelopathic process of unknown cause resulting in inflammation of the spinal cord
Progress in as quick as several hours or up to 3 weeks
Usually no organism identified, but can be infectious
Thoracic region most common
MRI shows spinal cord swelling, increased signal on T2 weighted images at clinical level
Must Exclude
- SLE, MS, Neuromyelitis Optica, Paraneoplastic syndrome, nutritional deficiency, vasculopathy, infection

SPINAL CORD INJURY
Kimbra Korte, BS, PT

Secondary Medical Complications
- Joint contractures
  - ROM, positioning, casts, splints, braces
- Decubitus ulcers
  - turn q2h, w/c cushions, PRAFO, pressure relief techniques, safe and protective techniques for functional skills and ADLs

Secondary Medical Complications
- Heterotopic ossification (abnormal bone formation in soft tissue around joints)
  - Clinical findings: swelling, warmth, decreased ROM and often a low grade fever.
  - treat prophylactically
  - continue ROM in its presence
  - eventual surgery may be indicated.

Secondary Medical Complications
- UTI (urinary tract infection)
  - push fluids, esp. acidic, i.e. cranberry juice
  - use clean catheterization techniques
- Spinal shock
  - immediately following SCI there is absence of DTRs, volitional movement and sensation for a time
Secondary Medical Complications

- Spasticity
  - involuntary hypertonic state of muscle contractions
- Low blood pressure
  - normal BP for a tetraplegic is 90-110/60 mmHg

Secondary Medical Complications

- Orthostatic hypotension
  - low BP when upright
    - apply compressive stockings
    - Ace wrap legs
    - abdominal binder
    - gradual accommodation to upright positions

Secondary Medical Complications

- Pulmonary dysfunction
  - offer incentive spirometry
  - P-flex
  - breathing exercises
  - suction and chest therapy
  - quad cough

Quad Cough
An assisted cough by another person performing a modified Heimlich maneuver. A person without abdominal muscle function due to SCI has decreased vital capacity. They breath easier when lying down vs sitting up. Why? When sitting up, their diaphragm is at a mechanical disadvantage. There is no abdominal support to keep the organs from falling down and outward. When the organs drop, this pulls the diaphragm down. With inhalation, the diaphragm has less excursion downward, therefore, less air is pulled into the lungs. Lay them down if they are having difficulty breathing. Keep anterior chest wall mobile and stretched.

Secondary Medical Complications

- DVT (deep vein thrombosis/thromboembolism)
  - most common in first two weeks s/p SCI
  - major cause of death and disability in SCI population (can become a pulmonary embolism)

Secondary Medical Complications

To reduce risk of potential DVT development
- early mobilization and passive exercise should be initiated as soon as the patient is medically and surgically stable.
- compression hose or pneumatic devices applied to the legs.
- thromboprophylaxis and avoidance of constrictive clothing, leg bag straps, etc.
- vena cava filter placement is indicated in SCI pts. who have failed or contraindicated for anticoagulation therapy.
Secondary Medical Complications
With a documented DVT, mobilization and exercise should be withheld for 72 hours until appropriate medical therapy is implemented.

Clinical signs and symptoms of DVT
- Increase in the circumference of one limb
- Increase in the venous pattern of collateral veins in affected extremity
- Pain, tenderness, and/or heaviness of affected extremity
- A low-grade fever of unknown origin
- Clinical manifestation of pulmonary embolus should be monitored: chest pain, breathlessness, apprehension, fever and cough.

Secondary Medical Complications
- Autonomic dysreflexia
  - Potentially life-threatening condition that can occur in anyone with SCI at or above T6.
  - Results from various noxious stimuli, which in turn trigger sympathetic hyperactivity.
  - Occurs after the phase of spinal shock in which reflexes return.

Secondary Medical Complications
- Pathophysiology of A.D.
  - Noxious stimuli cause sympathetic hyperactivity.
  - Sympathetic inhibitory impulses that originate above T6 are blocked due to SCI.
  - Below injury, relatively unopposed sympathetic outflow (splanchnic outflow is T6-L2) with release of norepinephrine, dopamine, and dopamine-beta-hydroxylase.
  - Release of these chemicals may cause severe vasoconstriction leading to life-threatening elevation of blood pressure.

Secondary Medical Complications
- Signs and symptoms of A.D.
  - Sudden/significant ↑ BP. Normal BP with persons with T6 or above injuries is 90-110/60 mmHg. BP of 20-40 mmHg above baseline may be a sign of AD.
  - Pounding headache
  - Profuse sweating above level of lesion
  - Goose bumps

Secondary Medical Complications
- Signs and symptoms (cont.)
  - Flushing blanching of skin above level of lesion
  - Nasal congestion
  - Cardiac arrhythmias
  - Blurred or spotted vision
  - No symptoms despite ↑ BP
Secondary Medical Complications

- **Causes of A.D.**
  - bladder distention
  - bowel distention/impaction
  - UTI
  - gallstones
  - menstruation
  - pregnancy

- **Causes of A.D. (cont.)**
  - pressure ulcers
  - ingrown toenail
  - contact with hard or sharp objects
  - constrictive clothing or appliances
  - painful or irritating stimuli below the level of injury

- **Treatment of A.D.**
  - if \( \uparrow \) BP, and person is supine, immediately sit the person up.
  - loosen any clothing or constrictive devices
  - monitor BP frequently
  - survey the person for instigating causes.

  - bladder distension due to a kinked catheter hose or full bladder is the #1 cause. Get rid of the cause (cath the person, unkink cath tubing).
  - if \( \uparrow \) BP is above or at 150 mmHg systolic, consider pharmacologic management to reduce BP, then watch for hypotension.

Spasticity

- **Causes frustration in clinicians and doctors**
- Can be beneficial and detrimental
- More prevalent with C and Th lesions and incomplete lesions (never with LMN)
- Characterized by hypertonicity and hyperreflexia
- Quick stretching elicits exaggerated reflexive response
- Cutaneous stimuli also can evoke abnormal reflex

- **Benefits**
  - Due to mm contractions: decreases DVT risk, and edema, increases circulation
  - Warns patient of UTI, pressure, illness, harm
  - Maintains bone health and mm size
  - Beneficial use during functional activities

- **Problems**
  - Causes contractures and abnormal posturing
  - Causes pain and sleep disturbances
  - Uncontrolled movements
  - Skin breakdown from friction
  - Interferes with functional activities, safety risk
Spasticity

Spasticity decreases with age.
Might be due to:
- ↓ NCV with normal aging
- anterior horn cell degeneration
- mm mass and fiber sz ↓
- circulation within cord ↓

Spasticity

Underlying neurological mechanism -- unknown.
Possible causes:
- loss of inhibition from higher centers
- loss of descending facilitation of afferents from Golgi tendon organs
- sprouting of new synaptic terminals within cord caudal to lesion
- hypersensitivity of neurons caudal to lesion in response to their reduced input

Spasticity Management

- Exercise/ROM,
- Positioning
- Casts/splints
- Weight-bearing, esp. if flexor spasms as standing encourages/facilitates extension patterns, prone encourages extension
- Avoid noxious stimulus

Surgical/Medical Management of Spasticity

- Meds: baclofen, Zanflex
- Intrathecal baclofen pumps
- Nerve blocks: Botox, phenol
- Selective dorsal root rhizotomy
- Dorsal root entry zone microcoagulation
- Selective sensory micro-rootlet section

Scale for Grading Spasticity

Modified Ashworth
0 - no ↑ in muscle tone
1 - slight ↑ in muscle tone, manifested by a catch and release or by minimal resistance at end of ROM
1+ - slight ↑ in mm tone, catch, followed by minimal resistance throughout ROM

Scale for Grading Spasticity

Modified Ashworth (cont.)
2 - marked ↑ in mm tone throughout ROM, easily moved
3 - considerable ↑ in mm tone, passive movement difficult
4 - rigidity in flexion or extension
Secondary Medical Complications

Temperature de-regulation: heat stroke
Tethered spinal cord: condition where scar tissue holds SC to the dura. Impedes normal motion of cord and decrease CSF flow. (surgery to release scar tissue)
Syrinx (syringomyelia) -- A cyst or cavity in the cord.
- \( ^\uparrow \)'s spasms, as does any noxious stimulus
- causes motor/sensory/ADL deterioration

Pain

- Acute pain
- Musculoskeletal/mechanical pain
- Visceral pain
- Psychological pain
- Neuopathic pain

Neuropathic Pain

- Occurs at transitional zone or below injury
- More common in incomplete injuries
- Descriptions: burning, tingling, numbness, extreme hypersensitivity
- Possible causes: nv root irritation, hypersensitive nerve tissue, poor communication between body and brain

Pain Management Strategies

- Medications
- Exercise, relaxation techniques, imagery, acupuncture, massage
- Heat, TENS, Biofeedback, soft tissue treatment options by PT’s.
- SC stimulator, Botox, Nerve blocks

Associated Complications of SCI

- Volitional motor loss
  - ROM, exercise, functional mobility
- Sensory deficits
  - educate
  - safety
  - use of other senses
- Bowel and bladder dysfunction
  - UTI/kidney infection
  - bladder/kidney stones
  - restrict calcium intake
  - \( ^\uparrow \) water intake
  - drain bladder to avoid stasis

Associated Complications of SCI

- Sexual dysfunction
- \( \downarrow \) Temperature regulation
  - education
- Pain/dysesthesias
  - drugs
  - positioning
  - ROM
  - exercise
  - prevention
  - surgery
Associated Complications of SCI

- Osteoporosis
  - mobilization
  - weight-bearing?

Ekso and Robotics

Dan Shamir, M.D.
Melissa McGinnis, PT, DPT

Learning Objectives

1. Explain the role of robotics in the continuum of care
2. Identify the evaluation process for the utilization of the EKSO
3. Identify the appropriate patients who would benefit from the EKSO.

Robotics in Rehabilitation

DAN SHAMIR MD

What is a Robot
What is a Robot

Robots mean different things to different people

A robot is an autonomous machine capable of sensing its environment, carrying out computations to make decisions, and performing actions in the real world.

It is also a machine resembling a human being and able to replicate certain human movements and functions automatically.

https://robots.ieee.org/learn/

Robots in the Rehabilitation Setting

When treating patients in the rehabilitation setting with advanced technology it is crucial the clinicians make decisions based on motor learning principles, biomechanics, neurophysiology, neuro plasticity, and knowledge of functional movement and principles such as locomotion training.

Applied in the acute setting:
- They can help with activity based neuro plasticity
- They can work as assistive devices

Robots in the Rehabilitation Setting

Status post CVA mobilization out of bed should happen in general after 24 hours but before 48 hours from the time of stroke.

The cardiovascular system often is not yet stable and becoming vertical can lead to postural hypotension and syncope with negative and adverse effects.

Tilt tables may be used to make patient more vertical

Tilt tables with integrated leg movements including functional electrical stimulation may help with the cardiovascular system and reduce the number of syncopal episodes

Tilt tables with electromechanical gait simulating stepping movements may also be of value

Robots in the Rehabilitation Setting

The biggest effect of electromechanical assisted gait training happens in the early phase after stroke onset.

In the early phase it may be particularly challenging for therapist to assist patients manually and this might be the reason why advanced technological gait trainers have the biggest advantage over manually assisted alternatives with this group of patients

Robots in the Rehabilitation Setting

Practice specificity
- The practice task needs to be similar as possible to the task that is being learned.
- That is to say that in people wanting to regain walking function, upright walking and gait training is most optimal.

For patients with severe impairments upright walking may be extremely difficult

Robotic gait trainers provide a safe and permissive environment which allows the patient to practice walking in a task specific manner without risk to themselves or the treating team.
Robots in the Rehabilitation Setting

It has been shown that brain activity during step-like movements on tilt table type stepping devices is very similar to the activity during over ground walking. Studies have shown that advanced robotic tilt tables have a positive effect on consciousness and cognition.

Robots in the Rehabilitation Setting

High therapy intensity is crucial when trying to reach optimal recovery potential. That is high number of repetitions, long therapy duration with frequent training sessions with high patient activity in each session is the optimal goal but is quite challenging to achieve in the acute setting. Robots can help therapist to intensify training at different levels. Robotic trainers can free the therapist from the manual labor and reduce the need for physical effort and increased amount of practice repetitions.

Robots in the Rehabilitation Setting

230 traditional therapy sessions for patient suffering from stroke were observed, average number of steps taken were 357, between 200 m and 300 m per training session.

561 traditional therapy sessions with individuals with SCI, an average of 51 steps were achieved and this was primarily in patients who were already able to walk.

Robots in the Rehabilitation Setting

Advanced gait trainers allow a 2-10 fold increase in the number of conducted steps in the training session.

The increased level of activity by the patient may in some part be due to an increased percentage of session actually spent with therapeutic activities reducing the time needed for the therapist to rest. With some devices 1 therapist can provide therapy to more than 1 patient at the same time in what is a group like setting using robotic devices.

Robots in the Rehabilitation Setting

Utilizing an electromechanical gait trainer (robot) patients with chronic hemiparesis who were nonambulatory conducted between 800 and thousand steps per 20-minute training session.

Individuals SCI patient initially able to walk 10 m between the parallel bars with assistance of 2 people was able to walk 606 m and 2424 m in a 30-minute training session with the assistance of the Locomat

Robots in the Rehabilitation Setting

In order to optimize neuroplasticity cortical and subcortical areas of activation need to be optimized and patient participation or effort in the gait cycle needs to be maximized. Therefore devices which can sense how much help the patient needs and optimize patient participation may lead to improved outcomes. The more repetitions and the more effort the patient puts into each repetition the better the outcome.
Robots in the Rehabilitation Setting

Advanced gait trainers provide guidance, they move the patient through a gait pattern creating a permissive environment allowing gait training in those patients who are unable to produce the movement independently. It should be noted that physical guidance can hinder the learning process in certain situations. Therefore only as much guidance as is absolutely necessary should be used with robotic training.

Robotic devices that have an integrated patient cooperative mode therefore are more optimal. Large controlled randomized trials are still missing to show the efficacy of this mode of treatment. Many of the studies done to date compared traditional therapy to assisted therapy with 100% guidance by the robot. Many of these studies found comparable results of both interventions and concluded that there was no advantage for advanced technology over other methods of gait training.

Robots in Therapy

Melissa Mcginnis, DPT

Neuroplasticity
- Ability of brain to change throughout life; homunculus can change, synapses can strengthen or weaken, grey matter amount changes

Khan et al 2017 - Neurorehabilitation: applied neuroplasticity
- Stroke patients
  - Moderate quality evidence: music therapy improved gait parameters
  - Low quality evidence: repetitive task training & mobilization improved function and mobility, mirror training improved ADLs, robot-assisted training improved walking
- Research shows promising future for robotics; however, low quality evidence and inconclusive evidence exists due to low number of studies/robust studies

Pre-gait training
- Posture
- Balance/midline awareness
- Weight shift
- Stepping pattern
- Acquaintance with assistive device

Gait training in specific trajectory
- Targeted ‘relearning’ in proper trajectory without relying on compensation or therapist guiding placement
- Customized trajectory specific to patient
- Step height, length and time

Physical assistance required for gait training & therapist safety
https://www.youtube.com/watch?v=cM2CvAcBVR8
Ekso Skeleton

Physical Therapist responsibilities
• Evaluate patients for use of Ekso
  • Screen patients for indications/contraindications
  • Range of motion, transfers, tone, strength
• Assess patient’s gait pattern and subsequent deviations outside of robot
• Educate patients on using robot
• Monitor patient’s tolerance within robotic device
• Provide physical assistance to maintain safe gait environment
• Provide cues throughout session to improve patient’s gait pattern and success

Ekso Skeleton

Specific patients for Ekso Skeleton
• FDA approval for use with:
  • Patients with CVA; at least one upper extremity with 4/5 strength
  • Patients with spinal cord injuries at levels C7 to T3; ASIA D with 4/5 BUE strength
  • Patients with spinal cord injuries at levels T4 to L5; 4/5 BUE strength
• Must be screened and cleared by physician prior to PT evaluation for Ekso
• Weight of 220 lbs or less
• Patient must be able to tolerate standing program for ~ 15 minutes with stable vitals

Ekso Skeleton

Screening patients
• Must have appropriate range of motion in LE joints
  • Limited to 12 degree knee flexion contracture
  • Limited to 17 degree hip flexion contracture
  • Neutral ankle (can use knee flexion to achieve neutral)
• Anatomical make up
  • Leg segment lengths and discrepancies, hip width
• Contraindications
  • Severe medical conditions, extreme spasticity, pregnancy, colostomy, open wounds, pressure sores, cognition limiting communication or direction following, unstable fractures, severe osteoporosis

Ekso Skeleton

Progressions of intensity/ regressions
• Pre-gait to gait training
  • Midline awareness, stepping patterns, squats
  • Audio and visual feedback
  • Forward and lateral weight shift targets (audio)
• Gait training
  • Forward, right, sidestepping
• Variety of assistive devices
  • Walker, quad cane, forearm crutches
• Hand controls for patient

Ekso Skeleton

Increased number of quality steps during session
• Reciprocal pattern, neuroplasticity
• Real-time feedback for patient’s efforts
• Assistance required from robot
• Deviation from trajectory (need for more hip or knee flexion during toe off; hip or knee extension during end of swing phase)
• Number of steps taken and standing time

Objective cloud data

Ekso Skeleton

video
Objectives
1. Describe Medicare wheelchair coverage criteria to identify appropriate referrals
2. List manual and power wheelchair frame examples for Medicare wheelchair codes.
3. Identify wheelchair evaluation documentation elements.

POWER WHEELCHAIRS
Social Security Act

General provisions of the Social Security Act (the Act) govern Medicare reimbursement for all items and services, including power wheelchairs.

Section 1862(a)(1)(A) of the Act states that no payment may be made for items or services that “are not reasonable and necessary for the diagnosis or treatment of illness or injury or to improve the functioning of a malformed body member.”

Section 1833(e) of the Act requires that suppliers furnish “such information as may be necessary in order to determine the amounts due” to receive Medicare payment.
POWER WHEELCHAIRS
Social Security Act

According to the revised coverage criteria, power wheelchairs and other mobility-assistive equipment are medically necessary for beneficiaries who have mobility limitations that impair their participation in mobility-related activities of daily living, such as using the toilet, feeding, dressing, and bathing.

A power wheelchair is medically necessary when a beneficiary's mobility deficit cannot be addressed using other types of mobility-assistive equipment, such as a cane, manual wheelchair, or scooter.

Additional criteria for a power wheelchair include:
- a beneficiary or a beneficiary's caregiver must be willing and able, physically and mentally, to operate a power wheelchair; and
- a beneficiary's home must provide adequate access between rooms, maneuvering space, and surfaces for the operation of the power wheelchair that is provided.

POWER WHEELCHAIRS
Standard power wheelchairs.

Standard power wheelchairs are designed for daily use to provide basic mobility for persons weighing less than 300 pounds. Accessories, such as armrests and oxygen tank carriers, may be added to standard power wheelchairs.

POWER WHEELCHAIRS
Complex rehabilitation power wheelchairs

To receive a complex rehabilitation power wheelchair, a beneficiary must meet criteria beyond those required to receive a standard power wheelchair.

The beneficiary's mobility limitation must either
- require one or more power options or a ventilator; or
- result from a neurological condition, muscle disease, or skeletal deformity.

The beneficiary must also have received a specialty evaluation, and the beneficiary's weight should be less than or equal to the weight capacity of the power wheelchair type that is provided.

POWER WHEELCHAIRS
MOST POWER WHEELCHAIRS IN THE MEDICARE PROGRAM DID NOT MEET MEDICAL NECESSITY GUIDELINES

From 1999 to 2003, Medicare payments for power wheelchairs increased approximately 350 percent, from $259 million to $1.2 billion annually, raising concerns about inappropriate Medicare payments.

In response, in 2005 and 2006 the Centers for Medicare & Medicaid Services (CMS) revised its policies related to power wheelchair coverage and coding. After these changes, Medicare's annual payments for power wheelchairs decreased to a relative low of $658 million in 2007.

However, expenditures rose to $779 million in 2008 and $723 million in 2009.
POWER WHEELCHAIRS
Beneficiaries are eligible to receive power wheelchairs under Medicare Part B coverage of durable medical equipment (DME).

Before providing a power wheelchair, a supplier receives from a prescribing physician a prescription for the power wheelchair and documentation from the beneficiary’s medical record to support the medical necessity of a power wheelchair.

Of the $189 million that Medicare allowed for power wheelchairs provided in the first half of 2007, $95 million was for power wheelchairs that were medically unnecessary or had claims that were insufficiently documented.

Sixty-one percent of power wheelchairs provided to Medicare beneficiaries in the first half of 2007 were medically unnecessary or had claims that lacked sufficient documentation to determine medical necessity.

Fifty-two percent had claims that were insufficiently documented to determine whether the power wheelchairs were medically necessary.

Nine percent of power wheelchairs were medically unnecessary.

For two percent of claims, a less expensive type of equipment (e.g., a scooter or a manual wheelchair) should have been provided.

For the remaining seven percent of claims, the beneficiaries should have received a different type of power wheelchair than was provided.

Claims for standard and complex rehabilitation power wheelchairs had similar overall error rates (61 and 56 percent, respectively). However, standard power wheelchairs were less likely to be medically unnecessary than complex rehabilitation power wheelchairs (8 and 24 percent, respectively).

Conversely, claims for standard power wheelchairs were more likely to have insufficient documentation than claims for complex rehabilitation power wheelchairs (53 and 32 percent, respectively).

Seventy-eight percent of claims without supplier-record errors were not supported by records provided by physicians who prescribed the power wheelchairs.

That is, while suppliers’ records indicated that power wheelchairs were medically necessary, physicians’ records indicated that they were medically unnecessary, or physicians’ records provided insufficient documentation or no documentation of medical necessity. In most cases, physicians’ records had insufficient documentation to support the medical necessity of power wheelchairs.

Less often, physicians’ records contradicted suppliers’ records.

Because standard power wheelchairs accounted for most of Medicare’s power wheelchair expenditures, errors among claims for such wheelchairs resulted in higher inappropriate payments than did errors among claims for complex rehabilitation power wheelchairs ($90 million and $5 million, respectively).
POWER WHEELCHAIRS

Power wheelchairs paid for by Medicare are not always medically necessary and that claims for power wheelchairs frequently have insufficient documentation to support medical necessity.

Of the $189 million that Medicare allowed for power wheelchairs provided in the first half of 2007, $95 million was for power wheelchairs that were medically unnecessary or had claims that were insufficiently documented.

Medicare has paid significantly more in recent years for power wheelchairs than it did in 2007. These increases may indicate that CMS continues to pay for power wheelchairs that are not medically necessary and/or that have claims that do not meet documentation requirements.

Two previous OIG reports based on the same sample of power wheelchairs found problems with coding and with documentation requirements. This report shows additional problems with suppliers’ compliance with Medicare requirements. Across all three reports, 80 percent of claims for power wheelchairs supplied to beneficiaries in the first half of 2007 did not meet Medicare requirements.

Additionally, OIG has issued previous reports identifying substantial vulnerabilities in the Medicare Durable Medical Equipment, Prosthetics, Orthotics, and Supplies (DMEPOS) benefit.

Wheelchair Seating and Mobility

Colleen Steichen, MPT
Edward Diemer, OTR/L

Medicare General Wheelchair Coverage Criteria

• The beneficiary has a mobility limitation that significantly impairs his/her ability to participate in one or more MADLs such as toileting, feeding, dressing, grooming, and bathing in customary locations in the home.
• The beneficiary’s mobility limitation cannot be sufficiently resolved by the use of an appropriately fitted cane or walker.
• The beneficiary’s home provides adequate access between rooms, maneuvering space, and surfaces for use of the wheelchair that is provided.
• Use of a wheelchair will significantly improve the beneficiary’s ability to participate in MRADLs and the beneficiary will use it on a regular basis at home.
• The beneficiary has not expressed an unwillingness to use the wheelchair that is provided in the home.

Medicare Manual Wheelchair Coverage Criteria

• The beneficiary has sufficient UE function and other physical and mental capabilities needed to safely self-propel the manual wheelchair that is provided in the home and during a typical day OR the beneficiary has a caregiver who is available, willing, and able to provide assistance with the wheelchair.
Manual Wheelchairs K Codes

K1: Standard (36#, weight capacity 250#)
K2: Standard Hemi (<19” seat to floor height, 36#, weight capacity 250#)
K3: Lightweight (34-36#, weight capacity 250#)
K4: High Strength Lightweight (<34#, weight capacity 250#)
K5: Ultralightweight (<30#, weight capacity 250#)
K6: Heavy Duty (251-300# weight capacity)
K7: Extra Heavy Duty (301-450# weight capacity)

K5: Ultralightweight Wheelchair Medicare Coverage Criteria

• Beneficiary must be a full-time wheelchair user or
• Beneficiary require individualized fitting and adjustment for one or more features such as axel configuration, wheel camber, or seat and back angles, and which cannot be accommodated by a K1-K4 wheelchair and
• Beneficiary must have a specialty evaluation that was performed by a licensed/certified medical professional who has specific training and experience in rehabilitation wheelchair evaluations and that documents the medical necessity for the wheelchair and its special features.
• The wheelchair is provided by a Rehabilitative Technology Supplier that employs a RESNA-certified Assistive Technology Professional (ATP) who specializes in wheelchairs and who has direct, in-person involvement in the wheelchair selection for the patient.

Medicare Power Wheelchair Coverage Criteria

• Beneficiary does not have optimal upper extremity or lower extremity function to propel an optimally configured manual wheelchair in the home to perform MRADLs during a typical day.
• Beneficiary has the mental and physical capabilities to safely operate the power wheelchair that is provided or if the beneficiary is unable to safely operate the power wheelchair, the beneficiary has a caregiver who is able to adequately propel an optimally configured manual wheelchair, but is available, willing, and able to safely operate the power wheelchair that is provided.
• Beneficiary’s weight is less than or equal to the weight capacity of the power wheelchair that is provided and greater than or equal to 95% of the weight capacity of the next lower class power wheelchair.

Medicare Power Wheelchair Coverage Criteria (cont.)

• Beneficiary must have a specialty evaluation that was performed by a licensed/certified medical professional who has specific training and experience in rehabilitation wheelchair evaluations and that documents the medical necessity for the wheelchair and its special features.
• The wheelchair is provided by a Rehabilitative Technology Supplier that employs a RESNA-certified Assistive Technology Professional (ATP) who specializes in wheelchairs and who has direct, in-person involvement in the wheelchair selection for the patient.

Types of Power Wheelchairs: Group 2

• Typically for non-neurological diagnoses beneficiaries (cardiovascular disease, obesity)
• Single (one motor)
  • Power tilt, power recline, or power elevating leg rests
• Power seat elevate (not covered under Medicare)
• Includes standard (van style) or rehabilitation seating system for backrest and cushion

Types of Power Wheelchairs: Group 3

• Beneficiary's mobility limitation is due to a neurological condition, myopathy, or congenital skeletal deformity
• Single or multiple power options available
  • Power tilt, power recline, and/or power elevating leg rests
  • Power seat elevate (NOT covered by Medicare)
• Includes standard or rehabilitation seating system for backrest and cushion
• Alternative drive controls available (sip and puff, switches, head arrays, etc.)
Push-Rim Activated Power Assist Device

- All the criteria for the power mobility device need to be met.
- Beneficiary has been self-propelling a manual wheelchair for at least one year.

Link to video: https://www.youtube.com/watch?v=KXLSZP6mRvU

Medicare Required Documentation

Physician evaluation and referral with “face to face” documentation

Therapy evaluation with ATP present per Medicare guidelines

Letter of Medical Necessity, completed by therapist, co-signed by referring physician stating agreement with the documentation and recommendations

7 Element Order, signed by referring physician

Home evaluation, completed by ATP

Therapy Evaluation Process

• Chart review: Review note by PM&R physician regarding wheelchair mobility recommendations
• Subjective: Home set-up, caregiver support, wheelchair transport, pain, social roles (student, employee, disabled)
• Objective: current seating system, ROM, MMT, edema, tone, seated spinal and pelvic posture, skin integrity, sensation, seated edge of mat measurements, Xsensor pressure mapping as indicated, wheelchair skills, recommended equipment trial
• Assessment: Rule out lower levels of mobility devices, medical justification for recommended wheelchair frame and accessories

Example Justification

Patient is a *** year old female/male with a diagnosis of *** resulting in impaired functional mobility. The patient requires a power wheelchair for independent and safe mobility within their home. Use of a power wheelchair will allow him/her to safely participate in his/her daily activities of meal preparation, grooming, dressing, and toiletting for up to 12 hours per day.

1. The following gait aids and wheelchairs do not meet the patient’s needs:
   - Patient is unable to use a cane or walker for independent ambulation because the patient is a high fall risk secondary to B UE/LE weakness and impaired standing balance.
   - Patient is unable to propel an optimally configured manual wheelchair because the patient does not have sufficient B UE or LE strength or endurance to propel a manual wheelchair.
   - Patient is unable to use a group 2 power wheelchair because these power wheelchairs are not able to support the power seat functions and do not offer the necessary features for safe drive control and speed with the required input device for safe function in the patient’s home.

Group 3 Power Wheelchair

The group 3 power wheelchair is fully customisable power mobility device to meet the patient’s complex neurological medical needs. The parameter settings allow for user integration and customisation for speed, acceleration, and sensitivity adjustments to compensate for the patient’s physical limitations.

Data from UPH reports wheelchair team organization and process has decreased the amount of time from therapy evaluation to insurance submission by 36 days!
Continuum of Care

Dan Shamir, M.D.
Kris Miller, BSN, MBA, RN
Lonnie Norgaard, MSN, RN

References

Local Coverage Determination: Manual Wheelchair Bases

Local Coverage Determination: Power Mobility Devices

Background Information

Medicare statute was originally enacted in 1965 providing for payment for hospital inpatient services based on the reasonable costs incurred to Medicare beneficiaries.

The statute was amended in 1982 by the Tax Equity and Fiscal Responsibility Act (TEFRA), which limited payment by placing a limit on deliverable costs per discharge.

Background Information

Social Security Amendments of 1983 established a Medicare prospective payment system for the operating costs of a hospital stay based on Diagnostic Related Groups (DRGs).

The following hospitals and hospital units are excluded from inpatient hospital DRG-based PPS:
- Children’s Hospitals
- Psychiatric Hospitals
- Long-term Hospitals
- Rehabilitation Hospitals
- Distinct part Psychiatric and Rehabilitation units of general acute care hospitals that are subject to PPS;
- Cancer Hospitals

Continuum of Rehabilitation Care

DAN SHAMIR MD

Backward Information

TEFRA remained the payment system for inpatient rehabilitation hospitals and distinct part rehabilitation units from 1982 - 2001.

TEFRA payments are based upon costs during a base period, which resulted in inequities in payment between older and newer facilities.
- Newer units took sicker patients in their base period (Usually the first year of operation), which then reflected a higher TEFRA base payment rate.
- After the first year these newer units then took less sick patients but continued to receive the higher payment rate.
- Therefore newer units were getting paid more for doing the same work as the older units in general.
Background Information

The desire to control rapid growth of rehabilitation facilities and eliminate inequities in Medicare payments led to Congressional action:
- Balanced Budget Act (BBA) of 1997
- Balanced Budget Refinement Act (BBRA) of 1999
- Provisions for implementation of a Prospective Payment System
- Current implementation date of January 1, 2002

Background Information

Research began in an effort to develop a Prospective Payment System (PPS) for Inpatient Rehabilitation Facilities:
- 1984: the FIM™ instrument was developed to address the functional status measurement issue
- 1987: RAND and the Medical College of Wisconsin investigated PPS and found:
  - Diagnoses alone explained little of variance in cost
  - Functional status explained more of total costs for rehabilitation patients
- 1993: Functional Related Groups (FRGs) concept developed by N. Harada and colleagues at VA Medical Center in Los Angeles as possible basis for rehabilitation prospective payment
- 1994: FRGs concept refined and applied by M. Stineman and colleagues from the University of Pennsylvania to large rehabilitation database for use as a patient classification system
- 1994: RAND commissioned to study the stability of the FRGs and their performance related to cost rather than length of stay.

2001: Centers for Medicare & Medicaid (CMS), formerly HCFA, established a patient assessment instrument following a comparison study of two proposed instruments.
2001: Final Rule for the inpatient rehabilitation PPS was published.

2002 Final Rule

In order to be paid under the IRF PPS, the DRG exclusion criteria for rehabilitation facilities state:
- Medicare must have a provider (as a unit or hospital)
- The hospital must provide intensive multidisciplinary inpatient rehabilitation services to an inpatient population that includes patients being treated for:
  - Stroke
  - Congenital deformity
  - Spinal cord injury
  - Amputation
  - Brain injury
  - Major multiple trauma
  - Hip fracture
  - Burns
  - Neuropsychological disorders, including multiple sclerosis, motor neuron diseases, polyneuropathy, muscular dystrophy, and Parkinson’s disease
Active, polyarticular rheumatoid arthritis, psoriatic arthritis, and seronegative arthropathies resulting in significant functional impairment of ambulation and other activities of daily living that have not improved after an appropriate, aggressive, and sustained course of outpatient therapy services or services in other less intensive rehabilitation settings immediately preceding the inpatient rehabilitation admission or that result from a systemic disease activation immediately before admission, but have the potential to improve with more intensive rehabilitation.

Systemic vasculitides with joint inflammation, resulting in significant functional impairment of ambulation and other activities of daily living that have not improved after an appropriate, aggressive, and sustained course of outpatient therapy services or services in other less intensive rehabilitation settings immediately preceding the inpatient rehabilitation admission or that result from a systemic disease activation immediately before admission, but have the potential to improve with more intensive rehabilitation.

Severe or advanced osteoarthritis (osteoarthrosis or degenerative joint disease) involving two or more major weight bearing joints (elbow, shoulders, hips, or knees, but not counting a joint with a prosthesis) with joint deformity and substantial loss of range of motion, atrophy of muscles surrounding the joint, significant functional impairment of ambulation and other activities of daily living that have not improved after the patient has participated in an appropriate, aggressive, and sustained course of outpatient therapy services or services in other less intensive rehabilitation settings immediately preceding the inpatient rehabilitation admission or that result from a systemic disease activation immediately before admission, but have the potential to improve with more intensive rehabilitation. (A joint replaced by a prosthesis no longer is considered to have osteoarthritis, or other arthritis, even though this condition was the reason for the joint replacement.)

Knee or hip joint replacement, or both, during an acute hospitalization immediately preceding the inpatient rehabilitation stay and also meets one or more of the following specific criteria:

- The patient underwent bilateral knee or bilateral hip joint replacement surgery during the acute hospital admission immediately preceding the IRF admission.
- The patient is extremely obese with a Body Mass Index of at least 50 at the time of admission to the IRF.
- The patient is age 85 or older at the time of admission to the IRF.

These 13 diagnoses must make up 60% of the population and patient services will include: physician monitoring and some rehabilitation nursing, therapies, psychosocial and orthotic and prosthetic services.

In order to contain cost CMS has shifted care of patients from higher acuity higher cost facilities to lower acuity lower cost facilities, IRF level care to skilled nursing level care for certain diagnoses such as total joint replacements.
### Background Information

**1982 to 2001**
- 75% of the patient's admitted to rehab units need to come from 10 rehabilitation approved diagnosis

**2002 to present**
- 60% of the patient's admitted to rehab units need to come from 13 rehabilitation approved diagnosis

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### Background Information

- CMS has struggled to compare quality metrics across different venues, long-term acute care hospitals (LTAC), inpatient rehab facilities (IRF), skilled nursing units (SNU) and home care.

- September 2019 prospective payment system for rehab units, IRF, will no longer be based on the FIM measures but rather migrates to a Care Tool.

- In September 2019 LTAC, IRF, SNU, and home care will all be on the care tool.

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### Background Information

- With migration to the care tool it is anticipated that the future holds a site-neutral payment system where diagnosis and burden of care based on parameters from the care tool will determine the reimbursement irrespective of the site to the patient will be at.

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### Background Information

- Medicare administrative contractor (MAC)

Background Information

Between 2012 and 2013, the number of IRFs remained fairly steady at just over 1,160 providers. The number of hospital-based and nonprofit IRFs continues to decrease, while the number of freestanding IRFs and for-profit IRFs continues to increase. However, more than half of the new IRFs that opened in 2013 were hospital-based units. The average IRF occupancy rate has hovered around 63 percent for the past several years, indicating that capacity is more than adequate to handle current demand for IRF services.

Continuum of Rehabilitation Care

In 2002, the percentage of IRF cases with one of the 13 specified conditions was 42 percent. CMS suspended enforcement of the rule in 2002 because of inconsistent enforcement patterns among Medicare's administrative contractors, but it began consistently enforcing compliance in 2004 and enacted restrictions on some of the qualifying conditions.

Continuum of Rehabilitation Care

The compliance threshold was permanently capped at 60 percent in 2007 by the Medicare, Medicaid, and SCHIP Extension Act of 2007. Since then, the industry has stabilized. According to eRehabData, 60.3 percent of IRF cases counted toward the compliance threshold in 2013.

Continuum of Rehabilitation Care

The combination of renewed enforcement of the threshold and additional restrictions resulted in a substantial decline in the volume of Medicare patients treated in IRFs. As volume declined, occupancy rates, the number of rehabilitation beds, and the number of facilities also fell.

Background Information

In 2013, Medicare spent $6.8 billion on IRF care provided in about 1,160 IRFs nationwide. About 338,000 beneficiaries had more than 373,000 IRF stays. On average, Medicare accounts for about 61 percent of IRFs' discharges.

Continuum of Rehabilitation Care

The combination of renewed enforcement of the threshold and additional restrictions resulted in a substantial decline in the volume of Medicare patients treated in IRFs. As volume declined, occupancy rates, the number of rehabilitation beds, and the number of facilities also fell.

Background Information

In 2013, Medicare spent $6.8 billion on IRF care provided in about 1,160 IRFs nationwide. About 338,000 beneficiaries had more than 373,000 IRF stays. On average, Medicare accounts for about 61 percent of IRF discharges.
Continuum of Rehabilitation Care

In fiscal year 2016, CMS is removing a large number of ICD-9-CM codes from the list used to qualify for presumptive compliance with the 60 percent rule because the codes alone do not provide sufficient information that the patient would reasonably require intensive inpatient rehabilitation (Centers for Medicare & Medicaid Services 2014).

Post-acute care (PAC) providers offer important recuperation and rehabilitation services to Medicare beneficiaries after an acute care hospital stay. PAC providers include skilled nursing facilities (SNFs), home health agencies (HHAs), inpatient rehabilitation facilities (IRFs), and long-term care hospitals (LTCHs).

In 2015, FFS program spending on PAC services totaled $60 billion.
Continuum of Rehabilitation Care

In 2015, Medicare spent $7.4 billion on FFS IRF care provided in about 1,180 IRFs nationwide. About 344,000 beneficiaries had more than 381,000 IRF stays.

On average, Medicare accounts for about 60 percent of IRFs’ discharges.

Benefits access to care—IRF capacity remains adequate to meet demand. After declining for several years, the total number of IRFs increased between 2013 and 2014 and remained relatively stable in 2015. Over time, the number of hospital-based and nonprofit IRFs has declined, while the number of freestanding and for-profit IRFs has increased. In 2015, the average IRF occupancy rate was 65 percent, indicating that capacity is adequate to meet demand for IRF services. Between 2014 and 2015, the number of FFS cases rose 1.5 percent to 381,000 cases.

Continuum of Care

Kris Miller, BSN, MBA, RN
Lonnie Norgaard, MSN, RN

Post-Acute Care — Levels of Care

• Long-Term Care Hospital
• Acute Inpatient Rehabilitation
• Skilled Nursing Facility
• Home Health Care

Long Term Care Hospital — Admission Criteria

• Average Length of Stay Projected >25 days
• 3 Nights of higher acuity setting during hospitalization preceding LTCH admission OR
• Will have >96 hours of ventilation needs at LTCH
• Extended care or recovery time past traditional hospital stay is required
• Requiring Daily Physician Visit & Documentation

Long Term Care Hospital — Admission Criteria

• Medically Complex Conditions — Pulmonary, Neurological, Cardiac, ESRD, Wound Care, Infectious Diseases or complications following surgery.
• Simultaneous chronic conditions or multi-system failure w/ significant loss of independence.
Long Term Care Hospital – Plan of Care

• Daily physician involvement
• 24-hour nursing care – similar ratios to short-term hospital settings
• Therapy up to 7-days per week – dependent upon stability and complexity

Inpatient Rehabilitation Facility – Admission Criteria

Technical Admission Criteria...

• 11 Diagnoses:
  ◦ Stroke
  ◦ Spinal Cord Injury
  ◦ Brain Injury
  ◦ Amputation
  ◦ Major Multiple Trauma
  ◦ Neurological Conditions – Polyneuropathy, MS, Parkinson’s
  ◦ Hip Fracture
  ◦ Burns, rheumatoid arthritis, systemic vasculidities, congenital deformities
  ◦ Reasonable expectation of home-going
  ◦ No prior hospitalization requirement – can admit from home.

Inpatient Rehabilitation Facility – Plan of Care

• Rehabilitation Physician Involvement at least 3 days per week
• 24-hour Rehabilitation Nursing
• 3-hours of therapy 5 days per week
  ◦ At least two disciplines
• Intensive & Integrated Interdisciplinary Environment

Skilled Nursing Facility – Admission Criteria

• Prior hospitalization requirement dependent upon payer
• Patient with physical disabilities that do not require the intensity level of Inpatient Rehabilitation.
• Medical problems must be stable and require less physician supervision.
• Typically senior-care focused.

Skilled Nursing Facility – Plan of Care

• 1-2 hours of therapy per day, 5 days per week – can be only one discipline.  
  ◦ Therapy is not required for a SNF admission but is very common.
• Daily skilled nurse intervention such as IV medication, dressing changes, education, medication management education.
• Provider face-to-face visit one every 30 days.
Home Health Care – Admission Criteria

- Prior hospitalization requirement dependent upon payer
- Patient with physical disabilities that do not require the intensity level of Inpatient Rehabilitation.
- Medical problems must be stable and require less physician supervision.
- Typically senior-care focused.

Home Health Care – Plan of Care

- Nursing visits 1-7 days per week based on patient need.
  - Services may include IV therapy, wound care, catheter and ostomy care
  - Teaching patients to manage new diagnoses or changes in health status
  - Observation & Assessment of chronic conditions
- Therapy is customized based on patient need.
  - Typically each ordered discipline visits 1-3 times per week
  - Focuses on fall reduction, home safety measures and mobility in home.
- Physician oversight by patient’s PCP.
  - Face-to-face physician visit required prior to admission into home care services

Outcome Management Tools

- Long Term Care Hospital (LTCH)
  - LTCH CARE Data Set (LCDS)
  - Prior to 10/1/12 were not required to submit any patient data.
- Inpatient Rehabilitation Facility (IRF)
  - Inpatient Rehabilitation Facility – Patient Assessment Instrument (IRF-PAI)
  - Functional Independence Measure (FIMs)
- Skilled Nursing Facility (SNF)
  - Minimum Data Set (MDS)
- Home Health Care
  - Outcome and Assessment Information Set (OASIS)

The Future of FIMs and why it matters...

In October 2019, the Functional Independence Measurement (FIM) will be replaced by:
- Quality Measures for Post Acute Care (PAC).

* About 42 percent of Medicare fee-for-service (FFS) patients were discharged to a PAC setting after hospitalization in 2013. Between 2001 and 2013, Medicare spending on PAC, both facility-based and in-home, doubled from $29 billion to $59 billion per year and has grown faster than most other major Medicare spending categories.

Why the new IRF-PAI??

- The IMPACT Act of 2014 was passed into law requiring all PAC providers to submit standardized assessment data for certain quality domains (CARETOOL), which will allow for the comparison of levels of care (LTACH, IRF, SNF, and HHC) and for improved outcomes.
- This standardized data is aligned across PAC assessment instruments so that data elements use the same words, share the same meaning and share the same admission and discharge assessment periods.
- This change is further supporting payment based on Outcomes/Quality rather than Fee for Service.

FIM Overview

Functional Independence Measure (FIM) – An instrument used to measure the extent of disability based on the responses to 18 items covering:
- Motor Function:
  - Self care
  - Sphincter control
  - Mobility
  - Locomotion
- Cognitive Function:
  - Communication
  - Social cognition
The CARETOOL scoring is simplified compared with the FIM scoring.

**CARETOOL Overview**

**Quality Indicators** - Has ten sections broken into 22 specific areas for assessment. The sections have been divided up amongst the various disciplines to include RN, PT, OT and SLP.

- **Section B**: Hearing, Speech, and Vision
  - Expression of Ideas and Wants
  - Understanding Verbal and Nonverbal Content

- **Section C**: Cognitive Patterns
  - Brief Interview for Mental Status
  - Repetition of Three Words
  - Temporal Orientation
  - Recall

- **Section GG**: Functional Abilities and Goals
  - Prior Functioning: Everyday Activities
  - Prior Device Use
  - Self-Care
  - Mobility

- **Section H**: Bladder and Bowel
  - Bladder Continence
  - Bowel Continence

- **Section I**: Active Diagnosis
  - Comorbidities and Co-existing conditions

- **Section J**: Health Conditions
  - History of Falls
  - Prior Surgery

- **Section K**: Swallowing/Nutritional Status

- **Section L**: Skin Conditions
  - Unhealed Pressure Ulcers
  - Current Number of Unhealed Pressure Ulcers

- **Section M**: Medications
  - Drug Regimen Review
  - Medication Follow-up

- **Section N**: Special Treatments, Procedures, and Programs
  - Assessment period is during the first three days of admission and prior to any therapeutic intervention.
  - Discharge period is the last three calendar days prior to discharge including the day of discharge.

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**Why the CARETOOL Matters**

- Historically, PACs used different outcome measures (i.e. SNFs use MDS, IRFs use FIMs, HHC use OASIS...).
- With the CARETOOL, CMS is now able to accurately compare outcomes and quality between SNFs, IRFs, Home Health, and LTCHs (apples to apples vs apples to oranges). Prior to the CARETOOL, measuring effectiveness or comparing outcomes for patients was difficult.
- While these tools measured similar concepts, specific items differed across systems, and these differences reduce the ability to compare patient acuity, outcomes, and costs across settings. Medicare payments varied substantially for similar patients in different PAC settings with little evidence that this payment difference translates into significant benefits for beneficiaries.

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**Why the CARETOOL Matters Cont.**

- About 42 percent of Medicare fee-for-service (FFS) patients were discharged to a PAC setting after hospitalization in 2013. Between 2001 and 2013, Medicare spending on PAC, both facility-based and in-home, doubled from $29 billion to $59 billion per year and has grown faster than most other major Medicare spending categories.
- With the CARETOOL, every PAC setting is going to have to show their outcomes and quality are far superior to other settings in order to continue to receive reimbursement equal to the services and care provided.

Thank You!!
**Limb Loss**

Matthew Edel, D.O  
Travis Carlson, CPO  
Hunter Holeman, DPT

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**Demographics**

185,000 people undergo amputation of Upper or Lower Limb each year in the US  
In 2008, it is estimated that 1.9 million are living with limb loss  
◦ 500,000 with minor (fingers, hands)  
◦ 41,000 with major limb loss in the upper extremity

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**Future**

Population living with lower limb loss in the US is projected to double by 2050  
◦ Aging population  
◦ Higher rates of dysvascular disease in the obese and diabetic

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**Upper Limb**

Trauma accounts for 90% of cases  
Others include  
◦ Burns  
◦ Peripheral vascular disease  
◦ Neurologic Disorders  
◦ Infections  
◦ Malignancies  
◦ Contracture  
◦ Congenital deformities

---

**Traumatic Amputations**

Two thirds of traumatic upper extremity amputations  
◦ Adolescents  
◦ Adults <45 years old  
◦ Males account for 75%

---

**Most Common**

Transradial 31%  
Transhumeral 28%
Transradial Amputations

Based on measurements from longest residual bone (Ulna/Radius) to medial epicondyle

Long: 55 to 90%
- Allows up to 60 degrees of supination and pronation with prosthesis
- Maintains strong elbow flexion

Medium: 35 to 55%
- Pronation and supination with prosthesis lost
- Elbow flexion reduced

Short: 0 to 35%
- Difficult prosthetic suspension

Transhumeral Amputations

Long: 50-90%
- Glenohumeral motions preserved and uninhibited by prosthesis

Short: 30-50%
- Loss glenohumeral motion

Lower Limb Amputation

Approximately 159,000 lower limb amputations per year
- Vascular Conditions 82%
- Trauma 16%
- Malignancy 0.9%
- Congenital Deformity 0.8%

Leading Causes

Diabetes
- Greatest risk
- Age Adjusted Amputation Rate 18 to 28x more than non diabetics
Smoking
Hypertension
Prosthetic Fitting Success

Traumatic
- 97% ambulating with prosthesis at 3 months

Dysvascular
- Greater than 80% with functional success

Older than 65
- Transtibial 78%
- Transfemoral 57%

Older than 85
- Transtibial <2%

Amputations

Closed
- Most common for arterial disease
- Incision through healthy tissues, skin flaps for shaped primary closure

Open
- Severe trauma or overwhelming infection
- Drainage and observation

Guillotine
- Open procedure where all tissues cut at same level
- Eventually undergoes closed amputation at higher level
- Quick control of rapidly spreading infection (gas gangrene)

Immediate Postamputation

Promote wound healing
Control pain
Control edema
Prevent contracture
Initiate remobilization and preprosthetic training
Continue education

Postsurgical Healing

Tissue Perfusion
Wound Care
Adequate Nutrition

Wound Margin Necrosis

Patients with vascular compromise
Avoid trauma to prevent dehiscence
Keep clean
Edema
Stretches nerves which results in pain
Places tension on wound compromising healing
Bulbous shape slows prosthetic fitting and functional recovery

“Thousands of spirit limbs were haunting as many good soldiers, every now and then tormenting them”
- Silas Weir Mitchell, 1871

Pain

Pain

NOCICEPTIVE
- Somatic
- Neuropathic
- Local residual limb pain
- Soft tissue and Musculoskeletal components
- Phantom Limb Pain
- Phantom Limb Sensation

TREATMENT OF PAIN

NOCICEPTIVE
- Somatic
- Neuropathic
- Local residual limb pain
- Soft tissue and Musculoskeletal components
- Phantom Limb Pain
- Phantom Limb Sensation

Phantom Pain: Peripheral, Spinal, Central?

Peripheral: Neuromas
- Peripheral nerve damage leads to degeneration of C fibers in spinal cord
- A fiber may branch into same area
- A fiber now transmit pain signals

Spinal: Peripheral nerve damage leads to degeneration of C fibers in spinal cord
- A fiber may branch into same area
- A fiber now transmit pain signals

Central: Majority of Amputee patients show cortical remapping on functional MRI
- High correlation between the magnitude of PLP and extent of cortical reorganization

Desensitization Techniques
- Help eliminate hypersensitivity to touch
- Compression
- Taping
- Massage
- Application of different textures

Pharmacologic
- Antiepileptics
- Antidepressants

Mirror Therapy

Dermatologic Complications

Patients with Lower Extremity Amputations experience 65% more dermatologic issues than non amputees

Skin problems experienced by approximately 75% of lower extremity prosthesis users
Ulcerations

**Common places at bony prominences**
- **Midfoot amputations:** Anterior surface
- **Ankle disarticulations:** Malleoli
- **Transmetatarsal:** Distal tibia, fibular head, tibial crest
- **Transfemoral:** Distal femur

**Etiology**

Incorrect prosthetic donning
- Wrinkles in socks and liners
- Excessive sock ply
- Insufficient sock ply (pistoning)

**Verrucose Hyperplasia**

Most common in transtibial
Wart-like lesion on distal end of residual limb
Due to “choking” effect of circumferential force in the prosthesis without distal pressure
Leads to vascular congestion

Treatment
- Adjust prosthesis
- Add padding to distal end
- Possibly new socket
- Should resolve in weeks to months

**Dermatitis/Folliculitis**

1. Hygiene of residual limb and prosthetic components
2. Soaps
3. Skin/interface system (socks, liners, socket) washed daily and thoroughly dried
4. Change skin/interface system

**Hyperhidrosis**

32-50% of patients reported
Switch to nylon sheath as an interface with liner material
Use topical or spray antiperspirants
Botulinum
Men’s Record: 100m Sprint
9.58 seconds
- Usain Bolt 2009

Men’s 100m Sprint
10.91 seconds
- Oscar Pistorious 2007

Role of Physical Therapy in Lower Extremity Limb Loss
Aid in Prosthetic Prescription & Procurement
Oversight of Skin and Prosthetic Functional Management
Rehabilitation to Return to Premorbid Level of Function

Aid in Prosthetic Prescription & Procurement:

Aid in Prosthetic Prescription & Procurement:

Table 1

<table>
<thead>
<tr>
<th>Exercise Test</th>
<th>Cardiac Output Increase</th>
<th>Capillary Blood Flow Increase</th>
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Aid in Prosthetic Prescription & Procurement:

Identify & Address Modifiable Factors to Improve Prosthetic Candidacy
Oversight of Skin and Prosthetic Functional Management:

RimabotulinumtoxinB Injections

Rehabilitation to Return to Premorbid Level of Function: Outcome Measures

Gait Outcome Measures
- Biomechanical
- Kinematic
- Kinetic
- Spatiotemporal
- Bioenergetic

ADL Outcome Measures
- Self-Report Measures
- Performance-Based Measures

Role of the Prosthetist in Lower Extremity Limb Loss

"I imagine you'll be asking for a kid rubber."
Optimum Amputee Rehabilitation

Pre-amputation care
- 3-2 weeks prior to surgery

Pre-prosthetic care
- Starts during or immediately after surgery
- POP stage
  - Optional – Doctor preference

Initial Prosthetics
- Starts 2-3 weeks post surgery

Gait and prosthetic training
- Immediately after Preparatory Fitting

Definitive stage
- 6 months after preparatory fitting

Follow-up care
- Lifetime

Post-Operative Amputee Care

Use ace bandage or compression sock for volume control and shaping of residual limb

Physical Therapy to maintain ROM and flexibility of involved joints

Below-knee amputees must keep the knee straight – no pillows under the knee

Above-knee amputees should spend time lying prone stretching the hip flexors

Post-Operative Protocol

Immediate Post-Operative Prosthesis (Non-removable)

Fit at time of surgery
- Plaster or fiberglass cast

Advantages:
- Eliminates contracture potential
- Increased weight bearing tolerance
- Reduces time to fitting of initial prosthesis

Disadvantages:
- Inability to monitor the residual limb/incision site
- Increased initial costs
- Requires coordination of surgeon and prosthetist

Post-Operative Protocol

RRD- Rigid Removable Dressing

Advantages:
- Removable
- Prefabricated or Custom
- Easy to modify
- Cost-effective
- Modular to adapt to all standard components

Disadvantages:
- Removable

Documentation Acquisition/Functional Level Assessment

K0: No ability or potential to ambulate or transfer

K1: Ability or potential to transfer or ambulate on level surfaces at fixed cadence

K2: Ability or potential for ambulation with ability to traverse low level barriers

K3: Ability or potential to ambulate with variable cadence

K4: Ability or potential to ambulate which exceeds basic ambulation skills
Initial Prosthesis
Fit as soon as suture line has healed
Accelerated delivery
Reduces edema (4-6 months)
Adjustable socket & interface
Adjustable/interchangeable components
Lacking complete cosmetic finish
Second socket required with extreme edema and rapid/excessive limb reduction

Definitive Prosthesis
Fit once the residual limb has stabilized size and shape
Endoskeletal design provides adjustable, interchangeable components
Designed to patient’s activity level with attention to vocation or recreational interests

Pinzur’s Paradigm
Risks of aggressive rehabilitation justified for elderly, dysvascular amputees because:
- Limited life span remaining
  - Lifespan after dysvascular amputation averages 5 years
- Contralateral limb is at risk
  - 50% that survive 5 years will go on to bilateral amputation
- Functional ability is marginal pre-amp
- Deactivate quickly; rehab slowly
“...I don’t want my elderly patients to sit around in a wheelchair for half the time they have left.”
**Fairley M, A new paradigm for postoperative amputation care, O&P Edge O&P Edge, April 2005

Prosthetic Design and Suspension Principles
TRANS-TIBIAL/ TRANS-FEMORAL

Patient Priorities
- Comfort
- Cosmetics
- Function
- Durability

Prosthetic Interfaces
- Reduce skin friction and shear forces
- Can be utilized for suspension
- Assist in controlling redundant tissue
Shape Capture of Residuum

- Hand Cast
  - Plaster mold is modified by hand
- CAD CAM
  - Shape captured by plaster cast or computer
  - Model is modified by practitioner on computer screen
  - Measurement based system for trans femoral sockets

Pin Suspension

- Custom or Off-the-Shelf
- Distal Pin Locks
- No Loss of Suction
- AK Harder to Push than BK
  - Softer Distal Tissue
  - Lanyard
  - Distal Shuttle Lock

Suction Suspension

- One Way Valve
- On board pump
- Air Expelled
- No Distal Pin Needed
- Longer Limb Lengths
- Simple sleeve suspension

Bio Hybrid Prosthetics

Component Selection

Determined by functional level assessment and depth/detail of Physician documentation.
Regulated by each insurance companies LCD. (Local Coverage Determination)

- The higher the function level the associated costs of the prosthetic system increases.
Knees and Foot/Ankle

Most Stable

Least Stable

More Voluntary Control

Less Voluntary Control

New Technology - Lower Extremity

“Bionics”
Evolving from mechanical to microprocessor control
Linking the amputee to the prosthesis

Component Selection

Trans Tibial Biomechanics
Sagittal Plane
Control Knee Flexion Moment
Use appropriate heel and keel to smooth gait

Trans Femoral Biomechanics
• Frontal Plane
  – Optimize M-L Stability
  – Minimize CG
  – Pelvis tilts toward unsupported side (varus moment at hip)
  – Hip abductors fire to balance moment
  – Femur displaces laterally

Poor Alignment
Follow up Care / Managements

1 per week for the first 6 weeks
1 per month or as needed
6 month follow up at PM&R