Pediatric Neurorehabilitation

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I have nothing to disclose.
Objectives

▪ Review basic concepts in the field of rehabilitation medicine and explore options for delivery of services.

▪ Gain a greater appreciation of different therapeutic options and interventions for recovery of function in patients with neurologic injuries.

▪ Review a few strategies and technologies that help facilitate recovery.

▪ Understand that neurorehabilitation is an ongoing process in response to an injury or developmental anomaly.

▪ Appreciate the role of caregivers in the recovery process.
Neurorehabilitation:

Rehabilitation is the process restoration following injury or disease, with the goal of maximizing individuals' ability to function.

Neurorehabilitation is a medical subspecialty that is aimed at the treatment of patients with disabling (and often chronic) diseases of the central or peripheral nervous system. [Selzer, 1992]

- The active process designed to reduce the effects of a primary neurological condition performance of activities in daily life.
- Therapeutic modalities implemented to overcome or improve neurologic impairment interfering with daily life.
International Classification of Functioning, Disability, and Health - CY

- Body functions
  - physiologic and psychologic
- Body structures
- Impairments
  - problems in structure or function
- Activity (task oriented)
- Participation in life situations
- Activity limitations
- Participation restrictions in life situations

- ICF describes the situation of an individual in the context of environmental and personal factors
Diagnoses:

- Traumatic and acquired brain injury
- Spinal cord injury
- Infections of the brain (encephalitis)
- Stroke
- Seizure disorder
- Pediatric cancer in late effects of cancer treatment
- Other problems that affect the brain or central motor system
How can a rehabilitation program work best?

- Acute inpatient rehabilitation
- Acute outpatient rehabilitation
- Home therapy program
- School therapy program
Rationale for Appropriateness of Setting Choice – From Acute Inpatient

- How intense should the therapy program be at this point in the recovery process?
  - How quickly are the child’s abilities changing?
- What is the child able to tolerate?
- How stable as the child medically?
- How much does the family need to learn to return home safely with the ability to meet the child’s needs?
Therapeutic Activities

Physical Therapy and Related Activities

- Neurodevelopmental Therapy (NDT), Proprioceptive Neuromuscular Facilitation, Feldenkrais, etc
- Aquatic Therapy, Hippotherapy, Pilates, Yoga
- Robotic Therapy, Virtual Reality
- Motion Analysis
- Bracing (orthoses)
The Gait Cycle
Gait: Normal Muscle Activity
Gait graphs
Therapies and Related Activities

- Neurodevelopmental therapies
- Sensory Motor Integration
- Constraint Induced Movement Therapy
- Academically oriented tasks
- Bracing (orthoses)
Occupational Therapy: Upper Extremity Management

- Stretching and strengthening
- Increase body awareness in space
- Increase motor planning
- Brachial plexus injuries can also occur, known as so called “traction” neuropathy
- Electrical stimulation
Upper Extremity Function: Treatment Options

- **Equipment**
  - Orthoses for function and ROM

- **Targeted injections (botulinum toxin)**
  - Improve selective motor control

- **Serial casting**

- **Therapy**
  - Stretch tight muscles
  - Strengthen weak muscles
  - Improve selective motor control
• Five interactive games that encourage repetitive motions
• Similar to iPad touch screen
• Eight sensors on upper limbs
  • Record joint angles of shoulders and elbows
• Accelerometer embedded in vest worn by the participant
  • Provides postural and positional data
Speech Therapy

Therapy and Related Activities

- Speech and Language Therapy
- Swallow and Feeding Team Assessment and Therapy Program
- Academic oriented services
- Augmentative communication programs
Augmentative Communication
Augmentative Communication
Outcome Measures

- Uniform data system for medical rehabilitation
- Used to assess progress in facilities across the country
- Measures gains in different domains
- To assess functional capabilities and performance, monitor progress in functional performance, and evaluate therapeutic or rehabilitative progress.

- Functional Independence Measure for Children (WeeFim)
- Pediatric Evaluation of Disability Inventory
The Process: Establishing Goals for Therapy

Acute Phase of Recovery
Priorities
- Medical concerns
- Gross motor skills
- Fine motor skills
- Oral motor skills
- Speech and language skills

Sub-acute and Long Term Program Goals
- Therapeutic goals continue
- Settling into a home routine
- Integration into school
- Integration into community activities
The long term goal is to enable the child to return home and resume previous activities including school and community based programs.

- Prepare a plan for return to school. It may start with home tutoring, then partial day, before return to full day with support.

- Discuss appropriate leisure activities.

- Address questions around driving safety and the need for a driving course.

- Review possible support groups for families.
Mechanisms regarding potential recovery of neurologic function are poorly understood.

Biologic modification in response to injury exist within the nervous system.

The potential mechanisms by which the nervous system can respond to injury are varied more than previously thought.

Meaningful recovery of function continues for an extended period of time.
Maximizing Function: Determining Interest and Motivation

• Increasing participation and mobility.
  – Therapy
    • Complimentary therapy
    • Aquatic therapy
    • Hippotherapy
    • Massage therapy
  – Adaptive equipment
  – Home exercise program
    • Stretching
    • strengthening
  – Community activities
    • Sports
    • Music
    • Drama
Ongoing Process

- The treatment plan changes with the changes in presentation as the child grows.
- Compliance is a factor.
- Family agreement with the plan is essential.
- Anticipatory guidance is a useful tool for understanding possibilities for treatment in the future.
Ongoing Process

- Therapy goals need to stay relevant to life events.
- Find ways to make it possible for the child to do things.
- As much as possible, support the family in their efforts. Be honest. Let them know you will be there.

[https://drive.google.com/file/d/0B-Gcm2rHCDYDb2loM25sRFViODQ/view](https://drive.google.com/file/d/0B-Gcm2rHCDYDb2loM25sRFViODQ/view)
Case Studies and Goal Setting

- **Diagnoses**
  - Spastic Diplegia: Brooke
  - Encephalopathy: Sam
  - Severe Traumatic Brain Injury: Aubrey
  - Transverse Myelitis: Isabel

- **Goal Setting**
  - Goals are based on improving function
  - Often transdisciplinary or interdisciplinary
  - Strategies carry over into all settings
  - Evolve based on developmental settings and individual needs
Spastic Diplegia: Brooke

- Born at 26 weeks gestation, twin
- Targeted tone management intermittently
- Selective dorsal rhizotomy
- Orthopedic surgery
  - 1. Bilateral proximal femoral shortening varus derotational osteotomies.
  - 2. Bilateral open hip adductor lengthenings.
  - 4. Bilateral Vulpius gastrocnemius/soleus fractional lengthening.
  - 5. Right Achilles percutaneous Z-lengthening.
  - 6. Right mid-foot release with split tibialis posterior transfer.
Brooke: Program Overview

- Goal: Increase ability to walk with an efficient gait pattern
- Inpatient therapy for a month twice
  - Tone management
    - Targeted botulinum toxin and phenol injections
  - Intensive therapy including the Lokomat
  - Ongoing therapy outpatient and at school
Before and After: Brooke
Spasticity/Dystonia Management

- Impairs function
- Causes discomfort
- Increases risk of contractures

- When treating spasticity, have a specific goal guiding placement of targeted meds, specific tasks for a therapy prescription or brace prescription, and a way to involve parents.
Normal Motor Function

- Requires coordination through the
  - Premotor cortex
  - Motor cortex
  - Thalmus/basal ganglia
  - Brain stem
  - Spinal cord
    - Pyramidal tracts/Corticospinal tracts
    - Extrapyramidal tracts
Treatment Options

- Intrathecal Baclofen (ITB™) Therapy
- Oral Medications
- Rehabilitation Therapy
- Orthopedic Surgery
- Neurosurgery
- Injection Therapy
Medications - oral

- Baclofen (Lioresal)
- Benzodiazepines (Valium and Klonopin)
- Dantrolene sodium (Dantrium)
- Imidazolines (Clondine and Tizanidine)
- Gabapentin
- Cannabinoids
Medications - Targeted

- Botulinum Toxins
  - Intramuscular injections

- Phenol Motor Branch Blocks
  - Perineural injections
Intrathecal Baclofen Pump

- Implanted pump with tunneled catheter entering the intrathecal space at L2.
- The height of the catheter can vary.
- Important that the parents and child are tied in closely to the ITB program.
Robot Assisted Gait Training: Lokomat

- Motor planning
- Increased core stability
- Increased balance
- Every 6-12 month program
- Dose related responses
Neurostimulation

• Stimulation to a specific nerve or muscle
  – Walkaide
  – Bioness
Sam is a junior History major. His poster presentation is entitled "The Fight For The 3/5 Clause". Sam wrote a 20 page paper last year about how congressional representation was determined by counting 100% of the North states' free white population and only counted slaves equal to 3/5 of a person toward congressional representation.

Sam takes 3 classes a semester at Framingham State accompanied by Personal Care Aides. He participates fully with his Tobii because of his severe speech impairment.

Sam says "I can't do things on my own and sometimes feel frustrated by feeling helpless because of my physical limitations and speech limitations"
Transverse Myelitis: Isabel

- At age 16, developed sudden onset burning pain and decreased LE sensation.
- Normal Spine MRI
- Positive mycoplasma serology
- Treated with high dose steroids and doxycycline
Isabel: Program Overview

- Intermittent therapies for specific goals
- Modifications of ankle foot orthoses
- Ongoing medical management of SCI
- Consideration for targeted tone management
- Beginning discussions on transition to adult providers

- Preparation for college
- Interest in driving
- Feels comfortable with social interactions.
Severe Traumatic Brain Injury: Aubrey

- 17 yo hit by a car
- Minimally conscious state for 3 months. Inpatient rehabilitation
  - Disorders of consciousness program
  - Acute rehab for several months
- Dicharged to home with a community rehab program

- 3 1/2 years out
- Still intermittently in a community rehab program.
- Walks with contact guard assist
- Can be independent with ADLs
- Speech is rapid
- Depression
Each person has individualized goals.

There are different options for therapy available to patients and families.

More research needs to be done to know how to optimize therapeutic interventions.

Recovery continues long after the initial injury as the child grows.
Resources

• Support Groups
  – Parent groups
  – Research groups
  – Publications – government and personal stories
  – Blogs

• Financial
  – State funded programs
  – Insurance resources
  – Home loans
  – Special loan programs through the town

  Equipment exchange programs
  – Beach buggies/chairs
  – Used equipment refurbishing
Future Directions

- Build on new technologies (ie. Mobile legs for gait training)
- Ongoing pharmacologic research
- Advanced treatments for dystonia and other movement disorders
- Continue to develop more accessible environments, modifications to vehicles, augmentative communication tools
Virtual Reality and Therapy

Developing and testing augmented-feedback strategies to improve gait training outcomes
Conclusions

- Neurorehabilitation can happen in the context of a variety of settings.
- It occurs most often in a multidisciplinary therapeutic milieu.
- It is an ongoing process that changes as the developmental and functional needs of the child change.
- The options for therapy are changing and new technologies are being developed.
References

- Chronic Headache after Pediatric Brain Injury: A systematic review (Nampiaparampil, 2011)
- What is it like to walk with the help of a robot? Children’s perspectives on robotic gait training technology (Phelan, et al, 2015)
- Adult neuroplasticity: More than 40 years of research (Fuchs & Flugge, 2014)
- Late plasticity for language in a child’s non-dominant hemisphere (Hertz-Pannier, et al, 2002)
- Clinical application of a robotic ankle training program for cerebral palsy compared to the research laboratory application: Does it translate to practice? (Sukai-Moulton, et al, 2014)
- Neurobehavioral sequelae of traumatic brain injury: evaluation and management (McAllister, 2008)
- What is the role of brain mechanisms underlying arousal in recovery of motor function after structural brain injuries? (Goldfine & Schiff, 2011)
- Traumatic Brain Injury Rehabilitation (Wa, et al, 2006)
Our Superheros!
Thank You!
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