OBJECTIVES:

- Discuss differences in pediatric anatomy versus adult
- Review Epidemiology of Spinal Cord Injury in Pediatrics
- Discuss Medical Management and common complications seen in Pediatric Spinal Cord Injury
- Identify key differences between inpatient acute, rehabilitation, and outpatient physical and occupational therapy.
- Identify interventions provided in inpatient acute, rehabilitation, and outpatient physical and occupational therapy post pediatric spinal cord injury.
- Discuss long-term outcomes of pediatric onset spinal cord injury
- Discuss potential issues with transition and avenues for continued education
CASE STUDY:

E.C at the time was a 19 month-old female who presented with several months of abdominal pain, weight loss, and difficulty walking ultimately leading to an MRI of the abdomen to evaluate for mesenteric adenitis. MRI of the abdomen and subsequent MRI of the spine, demonstrated a spinal cord mass extending from T8-T12.

She underwent gross total resection in March 2015 and the final pathology demonstrated pilocytic astrocytoma.

Developmental history prior to admission: E.C met her developmental milestones as appropriate. Ambulated at 13 months, kneeling, stairs with hand held assist. Had 50 words or more and made 2-3 word phrases. She had good hand dexterity was self feeding and using a fork and knife. She is right hand dominant and on admission, appropriately not yet potty trained.

PRM Consulted

WHAT IS DIFFERENT ABOUT A PEDIATRIC SPINE?

• The infant spine (0-2 years of age) has increased mobility and elasticity due to:
  • underdevelopment of the neck muscles with increased ligamentous laxity
  • incompletely ossification of vertebral bodies
  • wedge-shaped vertebrae
  • shallow, horizontally oriented spine (facet) joints.

• the relatively large size of the head with respect to the torso in young patients, increases the likelihood of cervical spine injuries, especially between the skull and first cervical vertebrae.
PEDIATRIC SPINE

• The elasticity of the pediatric spinal column probably allows some protection SCI
• This mobility and elasticity in the infant spine explains the relatively low incidence of spinal column injuries and the proportionately high incidence of SCIWORA
• The spine in children can distract up to 2 inches but the spinal cord can only distract ¼ inch before being injured in 0-2 year old

THE GROWING SPINE

• Between the ages of 2 and 10 years
• Muscles and ligaments strengthen
• Bones grow and reach a mature shape and size and become calcified
• Head is smaller in relationship to the torso.
• Age related maturation that occurs in the upper pediatric cervical spine is usually completed by approximately age 10 and the maturation of the lower cervical spine occurs by approximately age 14.
**EPIDEMIOLOGY**

- MVA, Violence, and Sports
  - Younger Children more commonly MVA
  - Adolescents - more commonly sports
- Unique to children and adolescents
  - Lap belt injuries
    - Most common in children weight 40-60lbs
  - SCIWORA
  - Birth injuries
  - Child abuse
  - Atlanto-axial instability (Down’s Syndrome, JRA)
- Hemorrhagic, Infarct, Infectious, Oncologic, Iatrogenic, Transverse Myelitis

**SCIWORA (SPINAL CORD INJURY WITHOUT RADIOLOGIC ABNORMALITY)**

- The absence of identifiable bony or ligamentous injury on complete, technically adequate plain radiographs or computed tomography.
- More common the younger the patient
  - <age 5 incidence of ~ 64%
  - 6-12yrs incidence of ~35%
  - >12 years about 20%
- ~2/3rds are now identified on MRI
  - Rupture of the anterior or posterior longitudinal ligaments, cord disruption, edema of the spinal cord
ASIA EXAM IN PEDIATRICS- WEESTEP

Scoring and classification are no different than the methods used for adults
Guidelines are based on standards used in children with subacute and chronic injuries, insufficient data in the acute setting.
Use Parents
- Interpret child’s responses
- Explain what is happening
- Modifications include modifying your instructions for children, tighten the mood as much as possible, use tickle, make things a game if possible. Make use of the caregiver as an assist.
Motor: T1 is not developed until age 4. Small finger abductor does not develop until age 4
Anorectal exam
Ask the family what terms they use for anus and feces, younger children may benefit from a doll demonstration
Use the little finger for children younger than age 3.
Under age 5, its very hard to isolate and contract the external anal sphincter, thus caution in age less than 5

PHYSICAL THERAPY AND OCCUPATIONAL THERAPY IN PEDIATRIC ACUTE SETTING

Physical and occupational therapy should be initiated as early as medically possible in the acute setting.
1) Early mobilization can improve vital capacity, and expiratory muscle strength, and residual volume post SCI. Greenberg 2009
2) Therapy can decrease length of stay which assists to decrease health care costs by preventing secondary complications of immobility and spinal cord injury including:
   a) Joint contractures, pressure ulcers, and emboli. Fries 2005
3) Best prepare patient for transition to rehabilitation.
ACUTE PHYSICAL THERAPY

DVT prophylaxis
Skin care: pressure reliefs
Accommodation to upright position/positional changes
Strengthening
Gait training/mobility as appropriate

Bed mobility
Transfers
Prevention of joint contractures
Fabrication of splints
Family and patient education
Coordination of care between providers

ACUTE OCCUPATIONAL THERAPY

Activities of Daily Living (as age appropriate)
Positioning
Bed mobility
Passive Range of Motion
Sitting Balance
Strengthening
Family Education
Splinting
Sensory Stimulation
CASE STUDY: ACUTE PHYSICAL AND OCCUPATIONAL THERAPY

Functional Mobility:
Level of Independence:
Interventions provided:
Barriers:
Caregiver education:
Goals:

CASE STUDY

E.C was admitted to the Children’s Hospital Rehabilitation Unit (CHRU) following her resection. Since her surgery, she has had weakness and decreased sensation in her lower limbs. She has continued to have bowel movements. She has continued to spontaneously urinate since catheter removal and initial measure of post void residual was high >100mL.

Pain management included IV Toradol with plan to transition to PO NSAID.
Bowel Management with Miralax prn, report of soft bowel movements
ACUTE MEDICAL MANAGEMENT

Bowel and Bladder
DVT Prophylaxis
Hypercalcemia
Heterotopic Ossification
Skin
Latex

BOWEL/BLADDER MANAGEMENT (IN BRIEF)
BOWEL MANAGEMENT

- Antegrade continence enema (ACE)
  MACE (Malone)
  Enema directly into the cecum via a conduit commonly using the appendix accessible through an abdominal wall stoma

BLADDER MANAGEMENT

- IC program standard of bladder management
- Appendicovesicostomy/Mitrofanoff
  - Continent catheterizable conduit
- Evaluation of Pediatric Bladder Capacity: \((\text{Age} + 2 = \text{oz}) \times 2 = \text{mL}\)
- Between 2-4 years old when you would expect Potty training to occur
- Encourage independence in older patients

[Source: http://www.aboutkidshealth.ca/En/HealthAZ/TestsAndTreatments/Procedures/Pages/Mitrofanoff-Catheterization-and-Care.aspx]
THERAPY INVOLVEMENT FOR BOWEL AND BLADDER CARE

Occupational Therapy:
- Transfers
- Assistive Devices
- Positioning
- Clothing Management
- Home Adaptations/Equipment
- Coordinate with Nursing

Physical therapy:
- Can assist team in Transfer planning/problem solving.
- Assisted standing
- Outing/Community planning

DVT PPX

Incidence: 2.5% to 17.5% with a 0-2.3% for PE
Very rare in children between ages 0-5
~2% in children 6-12 years old
8% in children ages 13-15
9% ages 16-21
Added high risk situations affect numbers such as pelvic trauma and fractures

Vogel et al
AUTONOMIC DYSREFLEXIA

Similar Presentation as with Adults
Differences are in symptom reports in children less than age 5, they may have more difficulty isolating headache, may just be irritable with concurrent vital sign changes
Management: sit patient up, evaluate for triggers and manage

PAIN

• Similar to the adult population chronic pain is also an issue
Self abusive behavior, self mutilation in infants, children with SCI may be a manifestation of dysesthesia
HETEROTOPIC OSSIFICATION

Incidence of HO in Pediatric SCI is approximately 3% compared to 20% in adults with SCI
- Commonly involves the hip
- Average onset at 14mo post injury compared to 1-4 mo in the adult population with SCI
- Treatment: etidronate sodium may be contraindicated in pre-pubertal children because of the potential for rachitic changes
Opt for Indomethacin

HYPERCALCEMIA

In the overall SCI population- affects 10-23% of individuals most commonly involving adolescent and young adult males – w/in the first 3 months of injury.
PATHOPHYSIOLOGY

- Increased bone turnover in children/adolescents
- Large Bone Mass in Adolescent Males
- Inc. Bone Resorption

- Excess calcium is not adequately excreted
- Hypercalcuria

- Decreased Calcium Excretion

LATEX ALLERGY

- Immediate type, immunoglobulin E-mediated allergic reaction to latex
- 6-18% of children and adolescents with SCI have a latex allergy
- Presumably from frequent and extensive contact with latex containing products
- Young age of initial exposure
- Longer duration of exposure
PHYSICAL THERAPY AND OCCUPATIONAL THERAPY IN PEDIATRIC INPATIENT REHAB SETTING

Focus:
1) Promote neurological and functional recovery
2) Promote independence
3) Trial and order adaptive equipment, devices, and orthotics
4) Educate family and patient
5) Prepare for discharge- always thinking ahead.

INPATIENT REHABILITATION PHYSICAL THERAPY

Early Rehab:
- Bed Mobility
- Transfers
- Basic wheelchair skills
- Strengthening/Stretching

Late Rehab:
- Assisted standing
- Advanced functional mobility skills
- Introduction into adaptive sports/activities
- Advanced wheelchair skills
- Trial adjunct therapies
- Outing into community

Preparation for discharge home:
- School meeting
- Home accessibility/adaptations
- Wheelchair
- Assistive devices
  - Car seats
  - Orthotics
- Outpatient therapy services
  - Education
INPATIENT REHABILITATION OCCUPATIONAL THERAPY

Range of Motion
Switches/Accessibility
Strengthening UE, Trunk
Positioning
Sitting Balance: Dynamic and Static
Activities of Daily Living: Assistive Devices and DME
IADLs
Age Appropriate Play
Endurance
Neuromuscular Re-Education
Transfers- Tub and Toilet
Education: HEP, DME, Assistive devices, transfers
Bowel and Bladder Care
Wheelchair Negotiation

FUNCTION AT ADMISSION TO INPATIENT REHAB- PHYSICAL THERAPY

Bed Mobility:
Transfers:
Sitting:
Mobility:
Goals:
INTERVENTIONS DURING INPATIENT REHABILITATION-
PHYSICAL THERAPY

FUNCTION AT ADMISSION- OCCUPATIONAL THERAPY

Upper Extremity Antigravity and Against gravity Movement: Intact.
Upper Extremity Reaching Skills: Age-appropriate, Inefficient (due to decreased sitting balance)
Static and Dynamic sitting balance: Poor
Upper Extremity Grasping Skills: Age-appropriate.
Bilateral Coordination: Efficient, Pt. participating in tasks with BUE. Requires more assist when unsupported

WEE FIMS: Total Assistance for all ADLs
CASE STUDY: INPATIENT REHABILITATION OT

Rapport Building
PROM
Dynamic Sitting Balance: ring sitting, long sitting, bench sitting
Age Appropriate Functional Play and Activities of Daily Living
Strengthening: Play doh, Prone, Quadruped, Reaching against gravity, Weight bearing
Transitions between positions: Supine to sit, floor sit to bench sit
Family Education: DME recommendations, Skin Checks, ADLs
Wheelchair Mobility

<table>
<thead>
<tr>
<th>Short Term Goals</th>
<th>Long Term Goals</th>
<th>Family/Caregiver Goals</th>
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<tbody>
<tr>
<td>Sitting with supervision</td>
<td>Doff socks with supervision</td>
<td>Independent performance of</td>
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<tr>
<td>skin checks</td>
<td></td>
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<tr>
<td>Reaching out of BOS with min A</td>
<td>Weight bear through BUE for 5 minutes</td>
<td>Understand of HEP</td>
</tr>
<tr>
<td>Doff bilateral socks and UBD with max A</td>
<td>LE management with LBD with Mod A</td>
<td>Appropriate use of DME</td>
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<tr>
<td>Transition between positions with min A</td>
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CASE STUDY- CHRU DISCHARGE

Discharged in May of 2015 (2 month stay)
Bladder Management: Family trained on completion of CIC. Discharge on regimen of CIC 5 x a day
Bowel Management: Bisacodyl suppository every night
Neuropathic pain: Gabapentin
CASE STUDY- CHRU DISCHARGE

- **Team Meetings**: Initial team/Family Meeting completed on 3/28 - Discharge Meeting completed on 5/6 with discussion regarding transition to home, preparation for home exercise program, arrival of equipment.

- **Equipment**: Nighttime hinged AFOs, b/l knee immobilizers, otter bath chair, manual w/c (ordered, loaner in interim), E-stim unit, mobile stander

- **Medical Supplies**: Catheter supplies ordered - to arrive to the home

- **Follow up appointments**: PM&R, neurosurgery and urology at Spina Bifida clinic - Scheduled for ~ 1 month after discharge

- **Therapies**: Outpatient PT 3 times weekly - Outpatient OT 2 times weekly in addition to Early Intervention therapies. - Therapies to occur at CHP Pine Center in Wexford.

OUTPATIENT

September 2015: Noted to have evolving spasticity in her lower extremities. Initial management with ongoing use of stander for multiple hours a day, (mobile stander), discussed interventions including oral medications or isolated injections

November 2015: Botox injections to bilateral quads and gastrocnemius

July 2016: using RGO daily, locomotor training 3 days a week, ending chemotherapy, decision made to initiate a bowel program once cleared from oncology with suppository, botox to left gastroc

January 2017: now s/p repeat Botox to both gastrocnemius muscles, discussion off oral spasticity management.
OUTPATIENT MONITORING

- Scoliosis and Hip Dysplasia
- Nearly all children injured pre-puberty develop scoliosis
- 2/3 of which require surgical correction
- Post puberty - 20%
- Hip Instability
- Reported in 100% of children injured younger than 5
- 60-83% injured younger than 10 years
- Related to either imbalance from spasticity (when applicable)
- Underdevelopment of the femoral head and acetabulum

SCOLIOSIS AND HIP DYSPLASIA

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Vogel, Betz, and Mulcahey
BONE MINERAL DENSITY

- In adults with pediatric-onset SCI, decreased bone mineral density (BMD) can increase the fracture risk to 19-32%
- 4 times greater than that in adult-onset SCI
- Children and adolescents with SCI have bone densities of ~60% of able-bodied age and sex matched controls
- Pathologic fractures occur in ~14% of children and adolescents with SCI

METABOLIC SYNDROME

- Constellation of risk factors for development of Type II Diabetes, CV disease and stroke, and coronary disease mortality
- Obesity being the primary inciting factor
- Features
  Abdominal adiposity, HTN, increase fasting glucose/abnormal glucose tolerance
dyslipidemia, insulin resistance
- Nelson et al looked at a total of 54 patients (20 SCI and 34 SB) age 11-20. Metabolic syndrome was identified in 32.4% of the SB group and 55% of the SCI group
SEXUALITY

- Often overlooked and at times treated like asexual beings
- Addressed in a developmentally appropriate manner
  Provide avenue to ask questions about how SCI may impact function
- In the absence of a brain injury sexual development and puberty should not be affected
  Menarche at the normal age range
  If menarche already occurred, menstruation will usually restart within 6 months

NEUROLOGIC RECOVERY

- The data is scant. One study cited looked at 20 patients with complete injuries
  - 7 died
  - 7 had no recovery
  - 6 improved
  - 5 enough to gain ambulation
OUTPATIENT PHYSICAL THERAPY

Focus:

Interventions:

Goals:

Progress:

OUTPATIENT OCCUPATIONAL THERAPY

In outpatient OT, therapists working on further developing and refining skills they have been working on in rehab as well as increase participation in school, work, leisure, and at home (Atkins & Basher, 2015)

- Balance
- Functional Mobility
- School Readiness
- ADLs/ IADLs
TRANSITION

Transition is more than having your first appointment in the adult clinic. It’s more importantly the journey to get you there.

TRANSITION

• Anticipatory Guidance: educating children and parents about future implications of disability
• Focus on transition into adulthood- initiated early in childhood
  Independent living
  Employment
  Financial Resources
  Socialization
  Health Care
  Sexuality
  Health care Navigation
  Community Integration
TRANSITION

• Encourage remaining active
• Participation in adaptive sports
• Proper nutrition
• Aerobic Exercise
• Encourage age appropriate participation in chores

ADAPTIVE SPORTS, EXERCISE AND COMMUNITY INTEGRATION

Sports: Large variety of options, county dependent
Camps
Go Baby Go
Networking Supports
Traveling
LONG TERM OUTCOMES

MEDICAL COMPLICATIONS

UTI (74%)
Bowel incontinence (63%)
Pressure ulcers (44%)
Rates high tetraplegia- 53%
18% AIS D
Autonomic dysreflexia (42%)
Respiratory complications (33%)
Pain at any site (69%)
Spasticity (57%)
Shoulder pain (48%)
Scoliosis (40%)
Hip contractures (23%)

Back pain (22%)
MA ET AL

Ma et al 2016 set out to use statistical analysis to test for differences in health, participation and life satisfaction in adults with pediatric versus adult sustained SCI.

Secondary Analysis of data collected in the Study of Health and Activity in People with SCI (SHAPE-SCI)

87 participants who sustained injuries prior to age 19 years, matched for lesion level, injury severity, gender, age, level of education and ethnicity

Functional Independence was assessed using the 13 item FIM.

Pain and General Health with the Short Form Health Survey

Physician Visits were evaluated using the Health Care Utilization Inventory

Depression using the PHQ-9

Leisure activity measured with the Physical Activity Recall Assessment for People with Spinal Cord Injury

Occupational and Social with the Craig Handicap assessment and reporting technique

Life satisfaction with the Life satisfaction scale
Findings
Those with pediatric sustained SCI had greater functional independence, less pain, and fewer doctor visits in the past year than those injured in childhood.
No differences in perceived health or depressive symptoms
Childhood onset reported more minutes of moderate-heavy leisure time physical activity, had higher measures of social participation and occupational participation than participants who sustained SCI in adulthood
No significant difference in life satisfaction

EMPLOYMENT

• Medical complications have impact on outcomes including employment, independent living and life satisfaction

• Employment rate of the general population age 25-34 is 93-94%
  • 42-69% in adults with pediatric onset SCI
  • Compared to individuals who sustained their injury as adults – 19-23%

• Not surprising- less severe injury associated with higher likelihood of employment, independent living and greater community participation
EMPLOYMENT

• A total of 195 interviewed
• Mean age at injury (14), age at interview 29
• Results: Of the participants, 99 (51%) were employed, 78 (40%) were unemployed, 12 (6%) were students, and 6 (3%) were homemakers.
• Factors associated with successful employment
  • education, community mobility, functional independence, and decreased medical complications

HOW IS E.C DOING NOW?
REFERENCES


• Dejong G, Palato SE, Beatty PW, Jones GC, Knoll T, Neri MT. The organization and financing of health services for persons with disabilities. Milbank Q. 2002;80(2):261-301


• Saladin JK, Krause JS. Pressure ulcer prevalence and barriers to treatment after spinal cord injury: comparisons of four groups based on race-ethnicity. NeuroRehabilitation, 2009;24(1):97-104


