What Are They Really Doing?? - Physical Activity Measurement in Cerebral Palsy©
Kristie Bjornson, PhD, PT
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Program Handouts

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What are they really doing??- Physical Activity Measurement in Cerebral Palsy

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Objectives:
- Understand measurement of physical activity in context of ICF framework
- Explore measures of physical activity in youth with CP
- Current documentation of physical activity via activity monitors in CP
- Questions/implications for:
  - Constraint Induced Movement Therapy (CIMT)
  - Body Weight-Supported Treadmill Training (BWSTT)
  - Orthotics (DAFO)

ICF model, WHO 2001

International Classification of Functioning, Disability & Health. 2001; WHO

ICF Model

Activity = 'execution of a task'
Routine walking as part of everyday life

Participation = 'involvement in a life situation' *
Participating in a walking club

* Social participation is valued differently by different individuals depending on his or her social and cultural context

Physical Activity - Ambulation

Level of Capability” vs. “Level of Performance”
Performance-based Measures of Physical and Walking Activity

Performance = what an individual actually does
- GMFCS
- Functional Mobility Scale
- ASKp vs ASKc
- LAQ-CP questionnaires
- Other questionnaires
- Activity Monitors

Other Questionnaires

(i) Functional Mobility Scale
- Rates child's usual walking ability (1-6) for different distances
- 5 / 50 / 500 metres
- ICF categories assessed
- Walking – short & long distances;
- Different locations;
- Equipment

(ii) Activity (and Participation) Questionnaires
- Traditionally, variable response
- Depends on who is reporting – child or parent (proxy) or doctor
- Can reflect subjective opinions, often proxy reports do not match self-report
- No one measure assesses all aspects of activity and participation
- Two recent excellent reviews
Activity (and Participation) Questionnaires

  - Identified 2 questionnaires with good psychometric properties that provided broadest description of how frequently children with CP perform a range of activities
    - ASK – 5-15 years, generic questionnaire addressing physical functioning
    - LAQ-CP – 3-10 years, condition specific questionnaire, addresses mobility, physical independence, schooling, social integration, clinical and economic burden

Activities Scale for Kids - ASK

- Self-report measure for children aged 5-15 years with physical disability
- 30 items (9 domains)
  - ASKCapability
    - measures what the child thinks he or she could do
    - "last week, I think I could have....."
  - ASKperformance
    - Takes into account the environment in which the child functions
    - "last week, I did ......"

ASK questionnaire

- Examples of questions relating to mobility
  - Walked without any support
  - Got around inside my house
  - Walked (or rolled) in crowded areas
  - Got around without help
  - Walked up and down a flight of stairs

ASK scores by global rating of disability

Unpublished data. Miller, Bjornson 2007
Lifestyle Assessment Questionnaire for CP - LAQ - CP

- 46 items (37 questions), parent completed questionnaire covering following domains:
  - Physical independence
  - Mobility limitation
  - Educational exclusion
  - Restriction of social interaction
  - Economic burden
  - Clinical burden

- Designed to assess impact of functional limitation
- Initially validated for children aged 4 – 6 years, extended to 5 – 16 years
- Expressed as total life style assessment score out of 100
- Higher scores reflect higher impact on child and family’s life
- Score 50 suggests assistance in ADL needed, requires educational support and limitation of family economic status
- Score 70 suggests special education setting, child’s disability severely impacts on child and the family

Kerr et al 2006 Child: Care, Health & Development 33(22)

Summary

- Clinic-based and lab-based measures tend to correlate well with each other.
- However, very little work done on defining the level of walking ability required to be a ‘community ambulator”
- Little work done on how clinic and lab-based measures correlate with level of activity in the community

Activity Monitoring

- Self report diary
- Heart rate monitoring
- Energy Expenditure
- Pedometers
- Accelerometers
- Global Positioning System

Activity Monitoring

- Uptimer (Pirpiris et al, 04)
  - Attached to lateral thigh (various attachment sites) – contains three mercury tilt switches that are responsive to limb position relative to gravity
  - Records time spent upright (not intensity)
- Advantages
  - Easy to use
- Potential disadvantages
  - Doesn’t record what the child is doing when upright: handing or walking or running

Up Time – Typically Developing Children

- Uptimer worn for 24 hrs
- Median “up-time” 5.5 hrs (range 1.5 -10.3 hrs)


What do we know about ambulatory activity in children with CP out in the community?

- Until recently, not very much!
Up Time – Children with Cerebral Palsy

- n=300 with CP, wore device 4x 24hr periods
- Children with hemiplegia have similar up-time compared to typically developing peers
- Reduced up-time in children with bilateral spasticity compared to typically developing peers


IDEEA® (Minisun.com)

- Intelligent Device for Energy Expenditure & Physical Activity
- 5 Triaxial accelerometers
- Gait parameters / 56 activities

IDEEA® (Intelligent Device for Energy Expenditure & Physical Activity)

- IDEEA data box clips to waist band
- 5 sensors with wires:
  - Front thigh (R & L)
  - Sternum
  - Under surface of foot (R & L)
  - Calibration in sitting

IDEEA® Trial

Participants:
- Age 8 - 25 years
- 30 control subjects (mean 14.5 yrs)
- 25 subjects with CP (mean 14.1 yrs)
- 16 subjects GMFCS Level I/II
- 9 subjects GMFCS Level III
- Simultaneous collection of 3-DGA & IDEEA
- Accuracy of IDEEA in detecting functional activities
- Trialled IDEEA for day in community

Summary: IDEEA® gait parameters

- IDEEA® overestimated step / stride length & underestimated cadence (both groups)
- Velocity underestimated for controls
- Velocity overestimated in children with CP
- Greater errors in step and stride length estimation were found in children with CP
- GMFCS level was not significant influence
Summary: IDEEA® activity detection

- High accuracy for static activities
- Increased error in dynamic tasks for subjects with cerebral palsy
- Delay in detecting activities noted

IDEEA® - Practical Issues

- Difficulty with wires
  - Uncomfortable with splints
  - Sensors come off
  - Going to toilet
  - Seen by other people

- Not recommend for 1+ day use in paediatric population

StepWatch™

- Two dimensional accelerometer
  - Detects foot leaving the surface
  - Completely sealed
  - Worn with strap or ankle cuff
  - Continuously records steps/time interval
  - Up to two months duration

StepWatch™ Activity Monitor

- Mac/PC
- Pager size
- Dock

www.orthocareinnovations.com

StepWatch™

- Sensitivity
- Cadence
- Recording Time
- Excel

24 hour: Data Capture

- Continuous Data Collection
- Time Interval Adjustable
Outcomes

- Functional level
  - TDY/GMFCS levels for CP
- Activity Performance
  - StepWatch Activity Monitor
    - Accuracy to manual counts: 99.7%
  - Song et al. (2006) 96-97% walk-run
- Activity Scale for Kids (ASKp38)
  - Control Variable: Current Day Outlook
- Participants:
  - Youth with CP (n=81)
    - Mean age: 11.8 yrs
    - GMFCS
      - Level I: 31
      - Level II: 30
      - Level III: 20
  - TDY (n=30)
    - Mean age: 11.8 yrs
    - No difference age, race, gender, SES, parental education

Ambulatory Physical Activity Performance in Youth with Cerebral Palsy & Youth Developing Typically

Kristie Bjornson, PhD, PT
29th Annual Duncan Seminar
March, 28th 2008

Ambulatory Physical Activity Performance in Youth with Cerebral Palsy & Youth Developing Typically
Bjornson, Belza, Kartin, Logsdon, & McLaughlin, Physical Therapy 87(3), 2007

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**Case Study:**

- Spastic Diplegia
- GMFCS Level II, 8 yr/o
- Twin gestation, 32 wk premie
- Cognition- WNL
- GMFM Scores:
  - Lying/rolling 90%
  - Sitting- 86%
  - Standing-66%
  - Walk/run/Jump 45%

**Correlation of StepWatch to ASKp**

<table>
<thead>
<tr>
<th>Activity Scale for Kids (ASKp-38)</th>
<th>Average Steps/day</th>
<th>% All Time Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASKp-38 summary score</td>
<td>.57</td>
<td>.55</td>
</tr>
<tr>
<td>ASKp-38 Personal Care</td>
<td>.38</td>
<td>.35</td>
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<tr>
<td>ASKp-38 Dressing</td>
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<td>ASKp-38 Locomotion</td>
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<tr>
<td>ASKp-38 Standing</td>
<td>.44</td>
<td>.43</td>
</tr>
<tr>
<td>ASKp-38 Transfers</td>
<td>.50</td>
<td>.55</td>
</tr>
</tbody>
</table>

**Case: Spastic Diplegia**

- Self reported goals:
  - Play short stop on little league baseball team
  - Not look ‘funny’ getting on and off school bus
  - Continue walking
  - recently experienced decrease in walking distance out in community (i.e. mall/school)
Average steps/day: CP-GMFCS II

Walking intensity: CP-GMFCS II

Implications & ?’s
Activity Measurement for:
- Constraint Induced Movement Therapy ("forced use")
- Treadmill (partial weight-bearing) training
- Orthotic (DAFO) functional

Constraint Induced Movement Therapy
- Based on behavioral research on primates post rhizotomy (Taub, 1980)
- Fundamental Principles
  - Constrain non-involved limb (casting, binding, sling/removable splint)
  - Mass practice activity with involved limb

- Found significant treatment effect in a single non-randomized trial
- Positive trend favoring CIMT/forced use
- Level of evidence for effectiveness/efficacy inconclusive
- Future Research Focus:
  - Uniform outcome measures
  - Adequately powered
- ?? Upper extremity activity in daily life?

Body Weight-Supported Treadmill Training (BWSTT)
- Increased walking velocity & EE (Provost et al 2007)
- Improve stride length, decrease double limb support (Cherng et al, 2006, Begnoche 2007)
- Improve standing, walk/run/jump skills –GMFM (Cherng 2007, Begnoche 2007)
- Increased cortical activation during ankle dorsiflexion (Phillips, 2007)
- Clinical matched pairs trial-improved walking speed (Dodd, 2007)
- What about impact on daily walking activity and participation?
Effect of Dynamic Ankle Foot Orthoses (DAFOs) on Function in Children with Cerebral Palsy

Bjornson KF, Schmale G, Adamczyk-Foster A, McLaughlin, JF.
JPO 28(6), 773-776, 2006

Methods/Sample:
- Cross-over design
- DAFO- Cascade Orthotics (www. DAFO.com)
- N = 23 children
- Average age of 4.3 years (1.9-7.3),
- 52% male,
- primarily Caucasian (70%),
- GMFCS
  - I = 6,
  - II = 3
  - III =14
- OUTCOME- GMFM scores

Conclusions:
- Positive short term effect in young ambulatory youth with CP
- Independent walkers appear to benefit more
  - Standing
  - Walk/run/jump
- Average leg length was positive association Total GMFM
- Does NOT confirm long term influence on motor skill acquisition
- Effect of DAFO on physical activity in daily life?

Physical Activity:

"Some is better than none ...... and more is better than some"

USDDHS, 1996
Pate et al, 1995

In order to know if... children/youth are doing 'some or more'??
-Will need direct measures of physical activity within the context of their daily lives
Welk, 2002
QUESTIONS?