Clinical exercise testing in youth with cerebral palsy

Annet Dallmeijer, PhD
Astrid Balemans, PhD
Eline Bolster, MSc PT
Prof Jules Becher, MD PhD
Dept Rehabilitation Medicine
VU University Medical Center Amsterdam
The Netherlands

Outline

• Introduction (10 min)
• Test procedures and interpretation (30 min)
• Break (10 min)
• Case presentations: focus on interpretation, interactive with audience (30 min)
• Case presentations: focus on treatment evaluation, interactive with audience (30 min)

Introduction
Clinical example

- John, 16 year old boy
- Bilateral spastic CP
- GMFCS level II

Goals:
- I would like to walk longer than 15 minutes without getting tired
- I would like to ride my bike to school every day
- I would like to fall less frequently during sports (football)

Clinical process

Patient need
- Fatigue, Walking distance ↓

Assessments
- Physical examination, CGA, other
- Exercise tests

Treatment
- Spasticity, orthotics, SEME, training

Evaluation
- Physical examination, CGA, other
- Exercise tests

Walking problems

- Energy consumption walking
- Strain walking
- Fitness
- Complaints walking

Complaints walking

Walking distance ↓

18-9-2015
Walking problems

Physical strain of walking

Clinical implementation

- Walking limitations
  - Complaints about fatigue, reduced walking distance, or reduced walking speed

- Exercise testing > What is cause of complaints?
  - Determine whether energy expenditure is increased, and/or fitness reduced

- Current practice
  - Little attention for walking economy and fitness testing
  - Lack of objective measurements (knowledge)
Test procedures

Energy systems

1. The anaerobic creatine phosphate (CF) system (< 30 sec)
2. The anaerobic glycolyse system (1-2 minutes)
   - Anaerobic capacity
3. The aerobic (oxydative) system (> 2 minutes)
   - Aerobic capacity
Exercise lab tests

- **Aerobic capacity**
  - Relies on oxidative metabolism (> 2-3 min)

- **Anaerobic capacity**
  - Short intensive exercise bouts

- **Walking economy**
  - Energy expenditure normalized for velocity

---

Aerobic fitness

Incremental maximal exercise test

- Bicycle ergometer
  - 1 min exercise bouts until exhaustion
  - Continuous measurement of VO2 and heart rate

---

Sprint performance

**Protocol**

- Wingate test (20 s); cycling as fast as possible against fixed load
- 3x 5 s sprints to get used to the procedure and establish optimal work load
- Mean power (W) over 20s: sprint power
- Sprint power is estimation for anaerobic fitness

---
Energy cost of walking

Protocol
- 6-min walk test on a (oval) walkway
- Comfortable walking speed
- Distance and time measured > walking speed
- Mobile measurements of VO₂, VCO₂, VE
  - Normalized for walking speed (J/kg/m): energy cost
- Steady state exercise
  - Aerobic metabolism is matched to energy requirements

Inclusion criteria
- Aerobic and anaerobic fitness tests (bicycle ergometer)
  - Age from 6-7 yrs
  - Intellectual ability: able to understand simple instructions
  - No contraindications for maximal exercise
- Walking economy test
  - Age from 4-5 yrs
  - Able to walk for at least 5 min at speed > 0.4 m/s

Interpretation
What is ‘abnormal’?
Aerobic fitness

- Cut off points based on health risks (metabolic syndrome) in healthy children (Dehui et al | Eur J Pediatr 2013)
- < P25: Mildly reduced aerobic fitness
  - training recommended
- < P10: Strongly reduced aerobic fitness
  - training highly recommended
- Smallest Detectable Change (SDC) VO2peak in children with CP:
  5.72 ml/kg/min (Brehm et al | PTJ 2014)

Aerobic fitness

- VO2peak total group (n=50)
  - <10th percentile
  - 10-25th percentile
  - >25th percentile

Aerobic fitness

- VO2peak GMFCS I (n=12)
  - <10th percentile
  - 10-25th percentile
  - >25th percentile

- VO2peak GMFCS II (n=15)
  - <10th percentile
  - 10-25th percentile
  - >25th percentile

- VO2peak GMFCS III / IV (n=6)
  - <10th percentile
  - 10-25th percentile
  - >25th percentile

- VO2peak other diagnoses (n=17)
  - <10th percentile
  - 10-25th percentile
  - >25th percentile
Reference values Energy Cost

<table>
<thead>
<tr>
<th>Energy Cost (J/kg/m)</th>
<th>n=31</th>
<th>n=35</th>
<th>n=20</th>
<th>n=8</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;9 year</td>
<td>6.52</td>
<td>7.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9–&lt;12 year</td>
<td>6.14</td>
<td>6.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12–&lt;15 year</td>
<td>5.44</td>
<td>6.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;15 year</td>
<td>4.65</td>
<td>5.14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Typically developing children and youth (n=179, age range 6–18)
- Source: database VUmc + Gillette (unpublished)

- +2 SD = +3 SD mildly elevated
- +3 SD strongly elevated

- Smallest Detectable Change (SDC) for EC in children with CP: 0.46 J/kg/m (Brehm et al. DMCN 2007)
Increased physical strain caused by:
- Patient type A: decreased VO2peak (aerobic fitness)
- Patient type B: increased energy consumption (decreased walking economy)
- Patient type C: both, and normal walking speed
- Patient type D: both, and low walking speed (strongly decreased walking economy)
Implications

- Both a decreased walking economy and decreased aerobic capacity can lead to high levels of physical strain of walking in children with CP.
- Exercise testing can support clinical decision making, i.e. to determine whether treatment should be aimed at improving walking economy and/or training of the (an)aerobic capacity is indicated.
- Treatment
  - Reduce energy cost: orthotic treatment, spasticity treatment, surgery
  - Improve fitness: physical training

Case presentations

Interpretation

Treatment