From Evidence to Practice: Optimizing Walking Outcomes in Young Children with Neuromotor Impairment

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Objectives

- Understand the current evidence on treadmill training in young children with neuromotor impairment.
- Identify indicators of readiness for the task-specific practice of walking in young children with neuromotor impairment.
- Develop an understanding of the required dosage for intensive treadmill training to promote the acquisition of walking.
- Guide practitioners in implementing an intensive treadmill training and walking program into clinical practice by demonstrating a successful model.

Importance of Walking

- Family goals/motivations
- Bone mineral density/Joint development
- Cardiopulmonary endurance
- Obesity prevention
- Social interaction

Hutton, 2002; Wilmshurst, 1998; Chien, 2006; LePage, 1998
Why Treadmill Training?

- Kinematic similarity with over-ground walking
- Increased cadence
- Automaticity of stepping
- Consistency of speed and duration
- Protected environment

Damiano et al, 2011; Lee et al, 2008

Why Intensive Training?

- Motor Learning
- Active participation
- Multiple repetitions

Kemm & Thelen, 1990; Scholz, 1990

Why at a Young Age?

- ↑ potential for cortical re-organization in children < 6 years
- ↑ neuronal cells and synaptic connections
- Experience-dependent competition for pruning
- Maturation of inhibition, extracellular matrix and myelination

Cramer et al, 2011
Cochrane Review

Treadmill interventions with partial body weight support in children under six years of age at risk of neuromotor delay

- 5 studies included
- Earlier onset of walking in children with DS
- Early use of orthotics might hinder progress in children with DS
- Further investigation needed for children with high-risk and CP

Valentin-Gudiel et al., 2011

Down Syndrome and Intensity

- RCT
- n=30
- Age at study entry 9-10 months
- Low-intensity group: 5x/week, 6 min sessions, 0.18m/s
- High intensity group: 5x/week, individualized with ↑ speeds and duration + ankle weights
- HI group showed accelerated motor milestones and ↑ alternating steps

Ulrich et al., 2008

Down Syndrome and Intensity

- HI group also showed:
  - ↑ cadence
  - ↑ gait velocity
  - ↑ step length
  - ↓ step width
  - ↑ obstacle clearance

Angulo-Barrosa, 2008; Wu, 2008
Spinal Cord Injury and Treadmill Training

- Case study
- 4.5 years
- 16 months post-injury
- w/c dependent, non-ambulatory
- ASIA C
- 16 weeks, 76 sessions
- Ambulation with Kaye walker in Kindergarten

http://ptjournal.apta.org/content/88/5/580/suppl/DC1

Myelomeningocele and Treadmill Trial

- RCT
- n=24, 12 TD, 12 MMC lumbar or sacral level
- Tested at 1, 3, 6, 9, 12 months, twelve 20 sec trials
- Treadmill practice in children with MMC elicited stepping behavior, but less than in TD
- Highly variable muscle activation, but ↓ compared to TD

Teulier et al., 2008
Sansom et al., 2013

Myelomeningocele and Sensory Input

- n=27
- 2-10 months
- L1 or below
- Six 30 sec trials with different conditions
  - Baseline
  - Visual flow (checkerboard belt)
  - Velcro
  - Friction (Dycem)
- Dycem and visual flow produced more steps than normal belt

Pantel et al., 2011
Infants with Moderate Risk for Delay

- RCT, n=28
- 6-12 months corrected age
- Treadmill group: PT plus 8 min/day, 5 days/week TT until walking onset; Average of 5.2 months of TM training
- Control group: PT only
- Quality of stepping better in TM group (↑ alternating steps, ↓ toe contact)
- High frequency of alternating steps correlated to earlier walking onset in both groups
- No difference in walking onset between groups

Angulo-Barroso et al., 2013

CP-Systematic Reviews

- Some evidence for older children
- Little information available for young children
- Most effective with GMFCS levels I-III
- ↑ walking speed
- ↑ gross motor function
- Longer and more intense protocols → better results

Grecco et al., 2011

School–Aged Children with CP

- RCT, n=36
- 3-12 years
- GMFCS I-III
- Treadmill and overground walking group
- 2x/week for 7 weeks
- All children made significant improvements in walking distance, fx mobility and balance
- Only treadmill group maintained gains at post-intervention assessments

Grasso et al., 2011
Toddlers and CP

- Quasi-RCT
- n=12
- Mean age 21 months
- Inclusion criteria
  - Cerebral palsy
  - GMFCS levels I–II
  - Ages 9 to 36 months
  - Signs of walking readiness
    - Sits for 30 sec
    - Takes 5–7 steps when supported by adult
- Exclusion criteria
  - Genetic syndrome
  - Medical contraindication for standing or walking
  - Spasticity reducing medication in the past 6 months
  - Previous or current use of treadmill in PT

Mattern-Baxter et al, 2013

Study Design

- 5.5 months
- Both groups receive regularly scheduled PT

Control group:
  - no treadmill training
Treadmill group:
  - treadmill training

Pre-intervention 6-week post-intervention 1-month post-intervention 4-month post-intervention

Protocol for Treadmill Group

- 6 weeks, home-based
- 6x/week, twice daily, for up to 20 min/each
- Minimal manual contact
- Progressively increased speed
- Mean minutes walked/day 28.2 ± 11.2
Outcome Measures

- Blinded
  - Gross Motor Function Measure-66 (GMFM-66) Dimension D and E
  - Peabody Developmental Motor Scales-2 (PDMS-2) Locomotion Subscale
- Parent-Reported
  - Pediatric Evaluation of Disability Inventory (PEDI) Mobility Scale
- Timed 10-meter walk test
- Functional Mobility Scale

Significant Between-Group Results

- PDMS-2 at post-test and 1 month follow-up
- PEDI at post-test, 1 month and 4-month follow-up
- FMS at the post-test
- Moderate effect size (Cohen’s d=0.47) for walking speed

Functional Ambulation

- Pre-intervention
- Post-intervention
- 1-month post intervention
- 4-month post intervention
Future Research

- ↑ number of subjects
- GMFCS level III
- Optimal dosage of intervention
- Treadmill training versus over-ground walking
- Effects of treadmill training in conjunction with Botox injections
- Effects on overall activity level and participation
- Feasibility of publicly available treadmills

Implementation into Practice

Treadmill Loan Program and STEPS program

Collaboration of clinical and academic setting

Observations, Family/Child Preferences

Translation of Clinical Research into Practice

Treadmill Loan Program: Initial Concept

- Current
  - Clinic-based treadmill
- Problem
  - Many client services home-based
- Opportunity:
  - Collaboration with UC Davis Biomedical Engineering Department
  - Fundraising by ES Guild ($10,000 for 6 treadmills)
Treadmill Loan Program

- Started: September 2012
- Additional equipment loan library for walking devices

Home Treadmill Protocol

- Referral Protocol
- Inclusion/exclusion criteria
- Weekly monitoring by PT
- Equipment release form
- TM management
Treadmill Loan Program-Results

STEPS
• Free university-based program
• Twice weekly sessions during spring and fall semesters
• Ongoing referrals from community PTs
• 10 DPT students, supervised by PT/faculty
• Consultation on orthotics
• Loan program for adaptive walking devices

STEPS-Results
SummerSTEPS

- First summer session offered in 2014
- Due to family feedback
- Paid by fundraising, run by ES PTs with 10 DPT students
- Overall decreased utilization in summer by families

Collaboration/Innovation

- Department of Engineering
- Senior project
- Funded by internal grant
- Scheduled prototype completion fall 2014
- Specifications per STEPS faculty
- Additional senored treadmill from fundraising efforts for additional data collection on gait parameters

Selected References

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