Cerebral Palsy

State of the Science & Current Treatments

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Cerebral palsy

- Cerebral palsy is due to an injury to the developing brain that results in a motor disability.

- A group of multiple brain injuries or malformations with variable prognoses

- Most common pediatric physical disability (3/1000 live births)

- Often associated with cognitive, behavioral and sensory impairments
Cerebral palsy

- Classified by the type and distribution of motor impairment
- Mild or severe motor impairment
- Intellect: normal to severe disability
- Co-morbidities can include visual, hearing disabilities and seizures
- Adaptive equipment: bracing, canes, crutches, walkers, wheelchairs, communication devices

Mobility classification
Spastic Cerebral Palsy
Increased “tone”

Most common subtype
Causes: include premature birth, infection, perinatal stroke
“Velocity-dependent” resistance to motion
Dyskinetic Cerebral Palsy
variable tone/movement

Causes: jaundice, metabolic problems, trauma, hypo-ischemic encephalopathy

1. choreo-athetosis
   • Writhing component to movement

2. dystonia
   • Sustained postures
Decision Tree for CP Subtypes

Is there persisting increased muscle tone in one or more limbs?

Y

Are both sides of the body involved?

Y

Spastic Bilateral

N

Spastic unilateral

N

Is the tone varying?

Y

Dyskinetic CP

N

Non-classifiable

Increased activity - tone tends to be decreased

Ataxic CP

Reduced activity - tone tends to be increased

Dystonic CP

N

Choreo-Athetotic CP

Is there generalised hypotonia with signs of ataxia?

N

Non-classifiable

Cans C. Dev Med Child Neurol. 42:816-24, 2000
Previously? thought that CP could not be prevented, cured, treated
Current State of Science

Prevent
- Neuro-Protection

Cure
- Neuro-Regeneration

Treat
- Neuro-Plasticity
Neuro-Protection

Eliminating Prematurity is the best strategy

1. In Vitro Fertilization (IVF) transfer limits
2. Antenatal steroids – premature labor
3. Magnesium sulphate – premature labor (30% reduction of CP)
4. Caffeine for premature babies
5. Infection prevention
6. Cooling for hypoxic-ischemic encephalopathy (15% reduction in CP)
7. Melatonin for fetus with intrauterine growth restriction
8. Iodine supplements
9. Rubella (German measles) vaccinations
10. Anti-D for RH negative mothers
11. Kernicterus prevention (jaundice)
12. Car seats
13. Education - shaken baby syndrome
Neuro-Regeneration

1. Hypoxic-ischemic encephalopathy (HIE) Cooling Plus
   - Longer deeper
   - Magesium sulphate
   - Zenon
   - Topiramate
   - Erythropoietin

2. Stem Cells
   - Research shows promise
   - Not ready for clinical tx
Neuro-Plasticity

1. Early identification and intervention
   - Active engagement in movement (play)
   - Task specific
   - High dose
   - Promote “skilled” movement

2. Best evidence is constraint-induced and bimanual therapy for the upper limb in children with hemiplegic CP.

3. Promotion of physical activity throughout childhood
   - Decreased mobility level can occur w/o treatment
Medical and Surgical Treatments

Selective Dorsal Rhizotomy

Orthopaedic Surgery

Baclofen Pump

Botulinum Toxin Injections
Cerebral Palsy Treatments

A “Review of the Reviews” of the relatively few intervention studies

A systematic review of interventions for children with cerebral palsy: state of the evidence
A systematic review of interventions for children with cerebral palsy: state of the evidence


• VERY controversial article set off a flurry of editorials.

• Only 16% CP txs were classified as “green go – do it.”

• Most txs were “yellow.”
  - 58% “probably” do it
  - 20% “probably” don’t do it

• 6% were “red light – do not do it.”

• The focus for our lab is on exercise interventions
Novak et al. A systematic review of interventions for children with CP: state of the evidence


Stretching Exercises
2 Review Articles

Low level of evidence does not support PROM ex.

“Evidence alert traffic light”
Aerobic Exercise Evidence

Green Light – Do it!
Aerobic Exercise

- CP
  - No primary effect on heart or lung function
- Problem
  - limited ability to play & exercise at levels sufficient to develop and maintain cardiorespiratory fitness
- Decreased Opportunities for exercise
  - accommodations and adaptations may be needed
- Health risks due to sedentary lifestyle
  - diabetes, heart disease, stroke, cancer etc.
  - mental health
“I am exhausted just walking and you want me to exercise more?”

- Greater energy expenditure during walking but unable to play, walk or run at sufficient intensity to increase \( V_O_2 \) – low “reserve.”

- Fatigue commonly expressed by adults with CP.

*Norman et al. Pediatr Phys Ther 16:206-211, 2004*
Aerobic Exercise Interventions

Types of Exercise

– Running/walking fast
– Aerobic dance
– Treadmill: may need body weight support
– Underwater, reduced gravity treadmills
– Robotic walking with active participation
– Lower or upper extremity cycling
– Rowing
– Swimming or vigorous pool exercises
– Mat exercises
Strengthening Exercises

Yellow light – probably do it

Weak translation to activity and participation levels of ICF

Novak et al. A systematic review of interventions for children with CP: state of the evidence

Strengthening Exercises

- Contra-indicated until 1990s
- Isometric, isotonic, isokinetic exercise
- Optimally 3x/week – 48 hours for recovery
PEDALS

Pediatric Endurance Development & Limb Strengthening for Children with Cerebral Palsy

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CPRIF
Study Design

Randomized controlled trial (RCT)

Spastic diplegic CP
- 62 participants
- 7–18 years
- GMFCS I, II, and III

Cycling group, n=31
- 30 sessions over 10-12 week period

Control (no cycling) group, n=31

Pre-post assessments (12 weeks)

Evaluators blinded to subject assignment
PEDALS OUTCOMES

WHO - ICF Framework

Body function & structures

Activity

Participation

Biodex
Knee joint torque

Gross Motor Function
600 yard walk-run
Preferred walking speed

Overground cycling

Health Related Quality of Life: PedsQL, PODCI
Stationary Cycling Intervention

Phase 1 = PRE strengthening component (20 min)
Phase 2 = aerobic exercise, monitored heart rate (30 min)
Phase 1: Strengthening Component

Subject 4

Group mean ↑ = 66 lbs
(↑ from 30 - 74% BW)
Phase 2: Cardiorespiratory Training

Subject 04

Target HR Zone

Peak exercise HR

Typical HR for Session

Baseline HR

Group mean HR = 147 bpm (52% max HR)
Within the Cycling group

- Participants developed the ability to cycle independently
- ↑ in walking/running endurance
- ↑ in knee joint power/strength
  - 120 deg/s for knee extensors, 30 deg/s for knee flexors
- ↑ in gross motor function
- No change in preferred walking speed
PEDALS Summary

Between group dif. for Psychosocial health

- ↑ emotional health in cycling as compared to control group
- ↑ parent satisfaction with child’s condition in the cycling group

No sign. b/w group differences for other measures

- consistent with other RCTs
- large SDs both groups—reflects heterogeneity/co-morbidities
- control group: mean ↑ for most measures
- cycling group: motivation and capacity varied
- n=130 required for b/w group dif
Free Adapted Tricycle for all PEDALS Participants

Participation level of ICF:
86% respondents were using their bikes min. 1x / week
2 – 3 years after the program, no between group difference
Why do some children improve and others do not?
Spastic Cerebral Palsy Impairments

- Spasticity/contractures
- Selective motor control
- Strength
- Balance
Spastic CP

- damage voluntary movement pathways
- loss of **Selective Motor Control**
- mass limb flexion and extension
- mirror movements
  - preservation ipsilateral tracts
  - maladaptive plasticity

Does the extent of corticospinal tract damage predict functional outcomes?
Corticospinal tracts
Diffusion Tensor Imaging

FA=Fractional anisotrophy “directionality” of fibers
Development of a Clinical Test for Selective Control of the Lower Extremity (SCALE)

Example of scores for a child with spastic diplegic CP

Maximum score per each lower limb = 10

Fowler et al. Dev Med Child Neurol 2010
Spastic CP
Knee Motor Control = “Normal”
Spastic CP
Knee Motor Control = “Impaired”
Spastic CP
Knee Motor Control = “Unable”

Challenging to perform knee joint strengthening exercises for this child!
Gait: Normal SVMC
Step length - hip and knee coordination
Gait CP: Impaired SVMC
reduced step length
Gait CP: “Unable” SVMC markedly reduced step length
Does the clinical exam predict hip/knee coordination during walking? YES

**SCALE - MRP Correlation (right limb)**

- $r = -0.81$, $p = 0.0001$
Does the clinical evaluation correlate with Corticospinal tract MRI – DTIs parameters?

Data currently being analyzed
Can we improve selective motor control in children with spastic CP?

- July 2014: 15 sessions of intensive therapy, 3 hours/day
- UCLA undergraduate counselors
- Exercises aimed at improving **selective motor control**
- Outcomes: Brain MRI-DTIs, gait and function
Outdoor play

Isolated knee extension

Step length
Individual Laboratory Sessions

Isolated knee Strength/Power  Isolated ankle motion

Currently analyzing the results!
Exercise Recommendations

- Assess capacity
  - single joint strengthening? adaptations needed?
- “Active” motor learning, need motivation
- Specificity of training
  - Goal: ↑ walking speed → practice walking fast
  - evidence for translation across the ICF is weak
- Sufficient intensity
- Lifelong exercise programs
  - “Use it or lose it”
  - school, recreation, community programs
Transforming Healthcare for Women with Disabilities

- Funded by the Cerebral Palsy International Research Foundation
- Partnership with Tarjan Center and UCLA OB/GYN
- Focus on reproductive health
- Addressing attitudinal and physical barriers
Psychological Health

- Major problem and understudied area
- Very few lifespan CP clinics
- Depression and anxiety are common problems of adults that attend our CP clinic
- Psychologists are rarely team members
Selective Motor Control Research

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Thanks for your attention!