The additional value of gait analysis in the identification of specific physical therapy treatment goals for ambulant children with spastic Cerebral Palsy

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Course timeline

- **Background**: 10 min
- **Clinical decision within the ICF and the HOAC II**: 10 min
- **Specifics in (goal-oriented) PT for CP**: 15 min
- **Clinical example (presentation)**: 30 min
- **Clinical example (group discussion)**: 40 min
Evidence-based physical therapy

- Level II evidence for the effectiveness of strength training (strength), treadmill training (gait and endurance)

- Level IV evidence for NDT (all levels of the ICF), CE (gross motor function)

- Limited interaction effects between the different levels of the ICF

Arguments for a goal-oriented and targeted approach
## Goal-oriented physical therapy

<table>
<thead>
<tr>
<th>Design type</th>
<th>Subjects</th>
<th>Method</th>
<th>Duration of intervention (weeks)</th>
<th>Evaluation</th>
<th>Results</th>
<th>Level of evidence (conduct)</th>
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<tr>
<td><strong>1996, Bower</strong>&lt;br&gt;RCT&lt;br&gt;2*2 fact</td>
<td>N (exp): 22</td>
<td>N (contr): 22</td>
<td>Age: group 1=6.3y group 2=5.5y group 3=5.8y group 4=5.6y</td>
<td>Type: quadriplegia</td>
<td>Intervention: Group 1: usual PT based on general aims Group 2: intensive PT (1h/day) based on general aims Group 3: usual PT based on specific goals Group 4: intensive PT (1h/day) based on specific goals 2 weeks selection of goals/aims based on GMFM treatment type was mixed (eclectic)</td>
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<td><strong>2001, Bower</strong>&lt;br&gt;RCT&lt;br&gt;2*2 fact&lt;br&gt;ABA design</td>
<td>N (exp): 28</td>
<td>N (contr): 28</td>
<td>Age: X=5.9 range 3-12y</td>
<td>Type: GMFCS III-V diplegia quadriplegia</td>
<td>Intervention: Group 1: usual PT based on general aims Group 2: intensive PT based on general aims Group 3: usual PT based on specific goals Group 4: intensive PT based on specific goals</td>
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<td><strong>2005, Ekstrom</strong>&lt;br&gt;Prospective&lt;br&gt;Case-series&lt;br&gt;No control</td>
<td>N (exp): 14</td>
<td>N (contr): -</td>
<td>Age: 1y6mo-6y X=3y7mo</td>
<td>Type: GMFCS II - V</td>
<td>Intervention: functional, goal oriented training 2*/day to 25*/day (varying)</td>
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<td><strong>2009, Löwing</strong>&lt;br&gt;Prospective&lt;br&gt;Multicenter&lt;br&gt;Intervention</td>
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<td>N (contr): 22</td>
<td>Age: 4y1mo (1y5mo)</td>
<td>Type: GMFCS I-IV unilateral bilateral</td>
<td>Intervention: Exp: goal directed therapy (based on individual goals) Contr: activity directed therapy (based on general aims)</td>
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<td><strong>2010, Löwing</strong>&lt;br&gt;Prospective&lt;br&gt;ABA design</td>
<td>N (exp): 22</td>
<td>N (contr): -</td>
<td>Age: X=46 mo SD=16mo</td>
<td>Type: GMFCS I - IV</td>
<td>Intervention: phase B: goal directed functional activites (focus on learning new skills in the context of daily life) phase A: follow-up, usual intervention</td>
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<td><strong>2010, Van den Broeck</strong>&lt;br&gt;Prospective&lt;br&gt;SSRD</td>
<td>N (exp): 16</td>
<td>N (contr): -</td>
<td>Age: 3 – 12 y</td>
<td>Type: GMFCS I - II</td>
<td>Intervention: Phase A: general training program Phase B: individual training program</td>
<td>6</td>
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Advantages of a goal-oriented approach

• More specific: focus on main problems – one cannot work on all problems at the same time

• Faces heterogeneous clinical problems

• Availability of many different physical therapy techniques - promotes choosing specific techniques accordingly
Problems and difficulties

- Many different applications and definitions for treatment goals
- Lack of a clear structure to define individual goals

Which way to choose?
Back to basics!

- International Classification of Functioning, Disability and Health
- Hypothesis-Oriented Algorithm for Clinicians II (HOAC II)
Evaluation within the ICF framework

Body structure and function

**Quality**
- Postural tone
- Movement patterns

**Quantity**
- ROM
- Bony alignment
- Muscle tone
- Strength
- Endurance
- Selectivity

Activities

**Quality**
- Functional observation

**Quantity**
- Standardized motor assessment
  - Gait analysis (video/3D/EMG)

Participation

**Structured interview**
- School / work
- Family / hobbies

**Quantity**
- Specific participation questionnaires

Personal factors

- Gender
- Age
- Cognition

Environmental factors

- School environment
- Home environment
- Aids and materials

*International Classification of Functioning, Disability and Health, World Health Organisation 2010*
Hypothesis-Oriented Algorithm for Clinicians II
(HOAC II—PART 1)

Collect Initial Data
From referral information, the medical record, via observation before any formal evaluation is begun, and from the interview.

Generate Patient-Identified Problems (PIPs) List
Problems listed are almost exclusively descriptions of functional limitations and disabilities. Problems are described solely in patient-oriented terms reflecting the patient’s views of what he or she can and cannot do.

Formulate Examination Strategy
Strategy is based on an initial set of hypotheses generated from available data and the nature of the patient-identified problems.

Conduct the Examination, Analyze Data, Refine Hypotheses, and Carry Out Additional Examination Procedures Needed to Confirm or Deny Hypotheses

Add Non-Patient-Identified Problems (NPIPs) to the Problem List
NPIPs are identified by the therapist and others working with the patient (the patient, family members, etc.). This list includes the patient-identified problems, which, if not prevented from occurring, will lead to disability and diminished health status.

For Each Existing Problem

Generate a Hypothesis (or Hypotheses) as to Why the Problem Exists
Hypotheses often represent the identification of a level of impairment thought to be causing a problem. Sometimes hypotheses may be the identification of pathological processes causing impairments, functional limitations, or disabilities. All hypotheses must be verifiable through obtainable measurements.

Identify the Rationale
By use of theoretical arguments or by use of data
For Believing Anticipated Problems Are Likely to Occur Unless Intervention is Provided
The justification (rationale) for treating anticipated problems is the case argument as to why pathologies or impairments will lead to functional limitations and disabilities unless intervention is provided.

Consultation if needed

Go To “Refine Problem List”

Refine Problem List
Most problems will be maintained without modification; identify problems that should be treated by other health care workers; eliminate these problems from the list, refer patient, and document the need for referral. The problem statement should be annotated so those problems not amenable to full resolution are identified and a modified problem statement needs to be generated. Changes in the PIPs should only be done after discussion with the patient and with proper documentation.

For Each Problem: Establish One or More Goals
Goals for existing problems usually represent measurable target levels of function (disability) that a patient will achieve as a result of the intervention. There must be a temporal element for each goal (an expectation as to when the goal will be met). Goals for anticipated problems essentially consist of statements as to what problems will be avoided as a result of intervention. Goals are always patient centered and always represent outcomes that have value to the patient’s current quality of life or future quality of life.

For Each Existing Problem

For Each Anticipated Problem

Establish Testing Criteria
Testing criteria are used to examine the correctness of the hypotheses. Testing criteria usually represent specified levels (measurement) of achievements infer that the impairment level that it obtains will result in the resolution of the problem statement of the goal, but only if the hypothesis is correct.

Consultation if needed

Establish Predictive Criteria
Predictive criteria target levels of measurements or behavioral alterations that need to be obtained to predict the occurrence of anticipated problems. Because anticipated problems and outcomes are unknown, the testing of hypotheses related to anticipated problems is not possible.

Establish a Plan to Reassess Testing and Predictive Criteria
Establish a Plan to Assess the Status of Problems and Goals
The time interval between assessment of changes in the status of both types of criterion measures (testing and predictive) should be based on expected changes in those measurements; and those expectations in turn should be based on theoretical arguments and data. Goals that can be expected to be achieved sooner may be termed “short-term goals.” Short- and long-term goals, therefore, are not different in nature but only the time period expected before they are achieved.

Plan Intervention Strategy Based on Hypotheses and Anticipated Problems
Indicate why the strategy should lead to changes in the criterion measures.

Plan Tactics
Indicate how tactics are expected to alter criterion measures (state each tactic to a criterion measure). Indicate who will implement tactics (e.g., therapist, assistants, aides, family members, teachers, and the patient). Implement Tactics

Figure 1.
The initial steps of Part 1 of the Hypothesis-Oriented Algorithm for Clinicians II (HOAC II).

Figure 2.
The final steps of Part 1 of the Hypothesis-Oriented Algorithm for Clinicians II (HOAC II).
HOAC –II

- Specifically developed for clinicians
- Algorithm defining a clinical reasoning process starting from initial referral, planning examination strategy to implementing tactics
- Hypothesis-oriented
- Very long, complicated
Strengths and limitations

**HOAC**
- Structure for clinical reasoning
- Strategy-oriented
- No structure for assessment
- Complex
- Hypothesis oriented – risk of bias/errors

**ICF**
- No direct structure for clinical reasoning
- Good structure for assessment
- Not directly strategy-oriented
- Simple
- Straight-forward
Background

Clinical decision within the ICF and the HOAC II

Specifics in (goal-oriented) PT for CP

Clinical example (presentation)

Clinical example (group discussion)
Clinical examination

3DGA

GMFM (66 or 88)

CAPE

Background information and parent/child assessment

Non-patient identified problems

Problems
- ROM
- Strength
- Spasticity
- Selectivity

Problems
- Time-and distance parameters
- Kinematics
- Kinetics
- EMG

Problems
- Lying
- Rolling
- Sitting
- Crawling
- Kneeling
- Standing
- Walking
- Standing
- Running
- Jumping

Problems
- Home
- School
- Environment

Positive and negative factors
- Personal
- Environment

Patient identified problems

Generate a hypothesis as to why the problem exists

Identify the rationale

Refined problem list to main problems

One or more goals per problem

Body function and structure

Activities

Participation

Personal and environmental factors

Activities

Body function and structure

Participation

Personal and environmental factors
Definition of main problem(s)

Underlying, common factor(s) that can explain the problems at all levels of the ICF, explain the globality of the child, the causes of the child’s difficulties.
### Clinical examination

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### 3DGA and GMFM

- **Pelvic Tilt**
- **Pelvic Obliquity**
- **Pelvic Rotation**

### Participation

![Children performing motor activities](image)
Clinical examination

- Weak m. gluteus medius
- Weak m. gluteus maximus
- Increased femoral anteversion

3DGA and GMFM

- Pelvic drop
- Decreased single stance
- Reduced walking speed
- Cannot stand on one leg
- Difficulties walking over objects

Participation

- Difficulties climbing stairs
- Difficulties clearing leg to kick a ball during play
- Difficulties walking longer distances

Main problem:
Muscle control around pelvis and hips
But it’s not always as clear...

Clinical examination

3DGA and GMFM

Participation
But it’s not always as clear...

- **Clinical examination**
  - Hamstrings: MAS 1
  - Popliteal angle -50°

- **Activities**
  - 20° of knee flexion at IC
  - EMG shows increased hamstrings activity
  - Knee and hip flexion during activities (sit to stand, half-kneeling,...)

- **Participation**
  - Concentration problems at school
  - Positioning at school

**Main problem:** Hamstrings overuse???
Background
Clinical decision within the ICF and the HOAC II
Specifics in (goal-oriented) PT for CP
Clinical example (presentation)
Clinical example (group discussion)
Training principles

1. Knowledge of typical walking

2. Use of basic training principles (load, repetition, frequency)
Typical walking and goal setting

- Stability in stance
- Sufficient foot clearance during swing
- Appropriate swing phase pre-positioning of the foot
- Adequate step length
- Energy conservation

- Specific muscle training (open/closed loop, concentric, eccentric or isometric)
- Train muscles in specific ‘range of motion’
- Train muscle at specific contraction velocity
- Train for specific combination of muscle activity (coordination)

Problems in therapeutic planning

- Results of clinical exam (static)
- Dynamic ‘range of motion’ in gait
- Stability
- Underlying weakness (kinetic data)
- Primary and secondary motor patterns
- Gait velocity – control of velocity
- Fixed and dynamic problems

Individual ‘goal setting’ for physiotherapy
Steps to take

Body structure and function
- Positioning
- Stretching
- Orthosis
- Analytical muscle work
- Strengthening specific muscle groups

Activities
- Functional, active gait training
- Integration into function

Participation
- Transfer into activities of daily life
- Automatisation
Background

Clinical decision within the ICF and the HOAC II

Specifics in (goal-oriented) PT for CP

Clinical example (presentation)

Clinical example (group discussion)
Conclusion

- Using gait analysis information can be very useful in the definition of specific goals in ambulant children with CP

- It is necessary to understand the principles of muscle work during gait in order to work specifically and targeted

- Effects of individually-defined therapy programs should be evaluated on long term
Questions?
Remarks?
Ideas?

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