Upper Limb Treatment Principles in Intensive Functional Therapy in School-Aged Children and Adolescents with Cerebral Palsy 'Guidance for therapists

Curr Neurobiol 2019; 10(2): 110-122 *ISSN 0975-9042*

Upper Limb Treatment Principles in Intensive Functional Therapy in School-Aged Children and Adolescents with Cerebral Palsy: 'Guidance for therapists'

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Abstract

Aims: To develop a consensus on which upper limb treatment approach is appropriate for children with unilateral USCP and to formulate a practical guideline for clinical reasoning based on the criteria of functional therapy. Method: The FuncRehab-Cycle, coreset of tests, specific therapy components and ICF is used as a framework for clinical reasoning to enable choices for specific functional therapy approaches in upper limb treatment.

Results: Practical guideline for clinical reasoning based on criteria of functional therapy was developed to make choices between Modified CIMT, Hybrid-CIMT, BIMT or BoNT-A and BIMT or functional bimanual strength training.

Conclusions: Consensus was reached to realize a framework for clinical reasoning as a guidance for BIMT and H-CIMT, but not for M-CIMT and treatment options prior to BIMT or H-CIMT as a very helpful decision tool in rehabilitation.

Shortened title: Upper limb treatment guidance for therapists

What this paper adds: Guidance for therapist in upper limb treatment choice in children with cerebral palsy

Keywords: FuncRehab Cycle, ICF, upper limb treatment, rehabilitation

Introduction

In children with Unilateral spastic cerebral palsy [USCP] developmental disregard is a frequently occurring problem [1,2] and the affected hand [AH] will not be used to its full capacity. In bimanual activities especially, the use of the AH is needed and needs to be trained. Intensive upper limb interventions in children with USCP have been widely studied. These include constraint-induced movement therapy [CIMT], modified CIMT [M-CIMT], hybrid-CIMT [H-CIMT], bimanual intensive movement therapy [BIMT] or hand-arm bimanual therapy [HABIT] and post-botulinum toxin-A [BoNT-A] upper limb therapy modalities [3-7]. Most intensive treatment studies have been shown to have positive treatment effects at different levels of the International Classification of Functioning, Disability and Health for Children and Youth [ICF-CY] [8, 9]. In a recent meta-analysis comparing M-CIMT and BIMT modalities, no differences on ICF-CY levels were found between treatment modalities [10]. Intensity of treatment was reported as the most important factor in upper limb approaches [11,12]. Most of the effective interventions had the same theoretical background principles as motor learning, goal-directed, activity and participation-based therapy. These treatment principles are most frequently termed functional or task-oriented [13]. Learning meaningful bimanual skills, such as putting on trousers, closing a jacket zipper, using cutlery enables the transfer to their home, school and society environment, enabling an increase in the spontaneous use of their affected hand in relevant daily situations. In the

Dutch GRADE guideline [14,15] for diagnosis and treatment of children with spastic cerebral palsy [DGCP], functional therapy has been described thus: "Functional physical therapy emphasizes the learning of motor abilities that are meaningful in the child's environment and perceived as problematic by either the child or parents. Children practise these motor abilities in functional situations, with the child having an active role in finding solutions for motor problems rather than having the physical therapist's handling result in a solution. Functional goals, in terms of skills, are established with parents and children based on their priorities. Functional activities are assumed to be learned by repetitive practice of goal-related tasks in functional situations" [15]. The steering committee of the DGCP, defined six criteria of functional therapy to guide the implementation of functional therapy for children with USCP: (1) goal-directed, (2) based on the activities/participation level of the ICF-CY, (3) task-specific, (4) active involvement of the child and parents to find solutions, learn motor skills and discover new possibilities, (5) focused on functionality rather than normality and (6) context specific [15]. In the Netherlands most intensive upper limb treatment options are implemented in paediatric rehabilitation. M-CIMT, H-CIMT, BIMT, BoNT-A + intensive treatment and upper limb strength training modalities exist based on the functional criteria. Examples in the Netherlands are programmes such as the Pirate group and BoBiVA [Botulinum Toxin and Bimanual Skill Training], and several clinical H-CIMT or BIMT programmes exist. Seven rehabilitation centres [Adelante, Revalidatie Friesland, Centre for Rehabilitation UMCG, de Vogellanden, Revant, Libra Zorggroep, and Klimmendaal] started a co-operation, named The Joined Hands Group ["Handen in Elkaar groep"], to gain and exchange knowledge and increase the quality of intensive upper limb programmes for school-aged children and adolescents. Two important goals of this group were to develop a relevant coreset of tests to evaluate our programmes and to determine a decision-making model for choosing a specific programme, such as M-CIMT, H-CIMT, BIMT. Hoare B. et al. 2010 described a decision protocol for choosing either CIMT or BIMT after BoNT-A, guided by the results of the Assisting Hand Assessment [AHA] and the possibilities of holding objects or stabilising by grip [16] and in 2014 the clinical reasons to use BoNT-A were described [17].

However, the clinical reasons to choose between M-CIMT, H-CIMT, BIMT, strength training and the use of BoNT-A combined with M-CIMT, H-CIMT or BIMT in a rehabilitation setting, in the context of functional therapy, have not yet been described. In the Joined Hands Group, we decided to arrive at a consensus on which upper limb treatment approach was appropriate for school-aged children and adolescents with unilateral USCP, wishing to formulate practical guidelines for clinical reasoning based on the criteria of functional therapy.

Method

In order to systematically develop a structure for clinical reasoning, the child- centred framework of the Rehabilitation Cycle [Rehab-Cycle] for care processes was used [18], embedded in the ICF framework [19]. The Rehab-Cycle model comprises four steps: (1) Identifying problems and needs [*assessment]*; (2) relate problems to modifiable and limiting factors, define target problems and select appropriate measures [*assignment]*; (3) plan, implement and coordinate interventions [*intervention*]: (4) assess effects [*evaluation*] [19]. The Rehab-Cycle steps were combined with the criteria of functional therapy and ICF-CY, the new model being called Functional Rehab-Cycle Intensive Therapy [FuncRehab-Cycle] **(Figure 1).** The FuncRehab-Cycle is used as a framework for clinical reasoning and evaluation of programmes to enable choices for specific functional therapy approaches in upper limb treatment to be made.

FuncRehab-Cycle framework

In the stages of clinical reasoning in the context of functional therapy four steps are described, of which the first two are important for clinical decision making.

Step 1. Assessment

This contains 3 parts: 1 Identifying problems and needs, 2 task-analysis, 3 coreset of tests.

Part 1. Identifying problems and needs

Functional upper limb therapy is based on the needs in bimanual functioning of the child and his/her environment and will always start at the participation level of the child and the family-specific treatment goals are identified [15].

Part 2. Task-analysis and preliminary hypotheses

Task-analysis based on functional therapy criteria will focus on the most relevant needs of the child and parents, the defined goals and tasks and the specific context [correct environment for treatment] [20]. Included are observation of the relevant tasks and task-specific technical performance in the relevant context [ICF performance level] for the child. Both task complexity [number and order of part tasks, precision in performance, timing and time dependency] and motor learning level of the child need to be taken into account in the analysis [21,22] To formulate preliminary hypotheses about which [adaptable] factors in the hand function are most limiting of performance the needs, task-specific constraints at the level of the child and environment have to be detected.

Part 3 Determining the coreset of tests

After the task-analysis, tests have to be used to detect constraints on the child within the context of the needs at all ICF-CY levels. A coreset of tests based on functional outcome has been developed [23]. The tests have to confirm or reject the hypotheses, and have to be profiled at the levels of the ICF-CY and the functional therapy criteria. The needs of the child and parents, and the specific components of the type of interventions, such as M-CIMT, H-CIMT, BIMT, strength training, and BoNT-A treatment, are essential to define this coreset of tests.

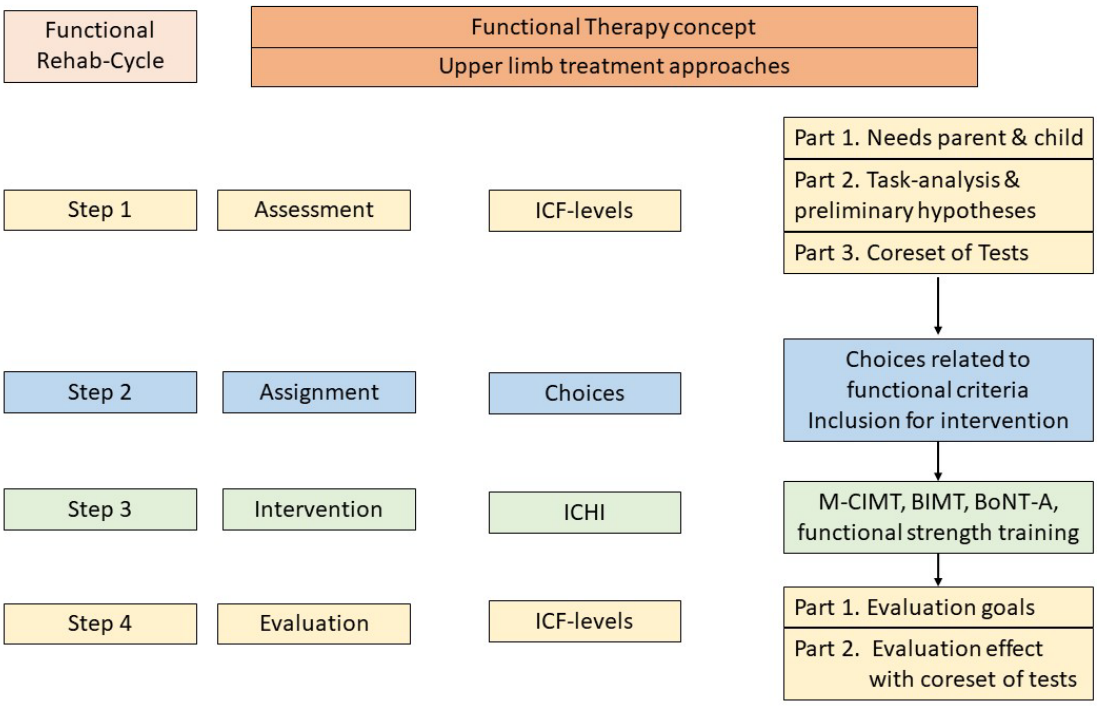

Figure 1. *Functional Rehabilitation Cycle (Rameckers E. Speth L. 2018)*

Abbreviations: ICHI= International Classification of Health Interventions.

Step 2 Assignment and decision model

In this step we use the results of the assessment to make decisions to plan interventions after identifying specific goals for treatment. Based on the goals of specific treatment programmes, the outcome of the assessments and the level of intervention at ICF-CY level a decision making model was developed, leading to specific choices for intervention.

Step 3 Specific interventions

Realising the specific intervention M-CIMT, H-CIMT, BIMT, BoNT-A + BIMT, functional strength training, that was chosen for, based on the assignment and decision model.

Step 4. Evaluation of the intervention

Specific treatment goals [Part 1] are evaluated in this step and effects of the specific interventions [Part 2] are measured **(Figure 1).**

Results

Application of the first and second steps in the context of functional therapy

Step 1. Assessment

Part 1. Identifying problems and needs

The following question is paramount in this part: "What are the children's needs in term of participation and upper limb activity?" To clarify these needs, the COPM [Canadian occupational performance measure] is a sound instrument for detecting priority of needs in upper limb activities at performance and satisfaction levels [24].

Part 2. Task-analysis

After needs are formulated and scored, several questions are relevant to the criteria for functional therapy. An important one is: "How good is the functional use of the hands performing these needs-related activities?"

Focusing on functional therapy, the tasks relevant to the needs have to be practised. These tasks can be practised either in total or as part-tasks, the use of the hands being trained within the demands of this task. Task-analysis has to be focused on the specific needs and the actual and desired performance of specific tasks. In daily activities, the use of two hands is frequently required and in children with USCP the most affected hand [AH] will be used as the assisting hand, not as the preferred hand [25]. An example is putting on trousers: the preferred hand will lead in putting them on and the AH will assist in holding them.

Based on Parts1 and 2 we conclude that functional treatment in children with USCP should incorporate bimanual training instead of unimanual training. The AH needs to be trained as an assisting hand in bimanual tasks [not as the preferred hand]. Training needs to be in the context of the activities [task specificity of grasping, holding, releasing in functional positions], but training should not relate to normal use of the hands [15]. Therefore, in upper limb rehabilitation BIMT and H-CIMT should be used based on intensive assisting hand function training.

To fulfil more detailed decision criteria, specific tests need to be chosen. The choices are dependent on the specific needs, the task-analysis and the components of M-CIMT, H-CIMT, BIMT to specifically aimed at improving bimanual functioning.

The next question that needs to be answered is: "What does the specific treatment improve in relation to the upper limb treatment analysis".

The components of, M-CIMT, H-CIMT, BIMT, functional training after BoNT-A and functional strength training are treatments focused on the improvement of: bimanual use, assisting hand function, developmental disregard [capacity or performance of assisting hand], the ability to grasp, hold, and release [ROM, muscle weakness]. **Table 1** presents an overview.

After treatment analysis focused on functional components, M-CIMT will no longer be considered for clinical decision making, and use of H-CIMT is debatable.

Part 3. Determining the coreset of tests

The next step is to identify the constraints on the treatment possibilities and relevant tasks, to select the appropriate tests to detect these specific constraints and to answer this question: "Which combination of tests is suitable for subsequently choosing and evaluating specific treatment options?"

To answer this question all available tests were categorized. Lemmens et al. 2012 [26] and Wagner et al. 2012 assigned all upper limb tests for USCP in the ICF model and we selected relevant tests measuring bimanual use in functional tasks [capacity, performance and capability] [25]. One important issue to discriminate within the tests between capacity and performance is the detection of the developmental disregard [1,27]. If the child shows to have a good capacity and a bad performance of the hand, the use of the affected hand in bimanual tasks will be hampered, but can be trained [1,27]. In **Table 2** the profile of available tests and classifications are presented and in **Table 3** the tests and classifications are related to the functional criteria and the intervention demands and relevant tests are selected.

Relevant test outcome is combined with the components of H-CIMT, BIMT, functional strength training and/or BoNT-A of the upper limb (Table 2).

In Table 3, tests/classifications are categorized and combined with the functional therapy components. Based on the functional criteria of active involvement and task-specificity, we focused on the degree of use of the hand [ABILHAND-Kids, CHEQ, combined with AROM/PROM/AOC of the wrist], use as preferred or assisting hand, degree of capacity and performance of the hands [AHA, OSAS, VOAA-DDD-R] and the amount of muscle weakness [grip/pinch/muscle and functional strength], related to the ability to hold as assisting hand. If strength differed between hands, a difference of 50% or more was used as a criterium for functional strength training.

Step 2. Assignment and decision model

The selection of the coreset of tests is based on the relevant components within the therapy programmes, the functional therapy criteria and the specific characteristics of the USCP group, including children with Manual Ability Classification System [MACS] I-V [29] and Zancolli classification I-III [15,30]. The combination of specific test outcomes will lead to decisions on the most appropriate interventions. The decision model is presented in **Figure 2**.

Based on the components of functional therapy, the children with USCP are excluded if: they are not capable of any active hand grasping and holding, have scores of Zancolli III or MACS IV-V, or have fixed contractures of wrist and finger flexors.

If the children have no active extension and abduction of the thumb, they are only able to participate in a functional therapy programme if wearing a thumb abduction splint to enable them to open their hand. In children who are not able to actively open their hand [Zancolli III] due to spasticity [significant difference between AOC [early catch] and PROM of wrist extension] [31], or have very low grip strength [32], or have contractures of the wrist flexors with extended fingers [< -20^0 dorsiflexion] [33] or finger flexors, a special treatment [splints during the

Table 1. *Important treatment components of specific functional upper limb modalities, indicating the primary focus of a specific treatment (treatment analysis).*

Functional Treatment modality	Use of hands Uni- (Uni)	Use of hands Bimanual (Bim)	Use of Affected Hand as Preferred Hand (PH)	Use of Affected Hand as Assisting Hand (AsH)	Performance assisting Hand (PAsH)		Capacity assisting hand (CapAsH)		Ability to grasp (G), Hold (H) Release (R)	Ability to Manipulate (M)		Specific training of muscle weakness Grip / pinch / functional	Overall
M-CIMT	+	-	+	-	-		-		+	+		-	
H-CIMT	+	+	+	+	- **CIMT**	+ **BIMT**	- **CIMT**	+ **BIMT**	+	- **CIMT**	+ **BIMT**	-	
BIMT	-	+	-	+	+		+		+	-		-	
Functional training post BoNT-A	-	+	-	+	+		+		+	+/-		+/-	
Functional strength training	-	+	-	+	+		+		+	-		+	

Red = treatment not to be selected, based on functional criteria and specific treatment components; Orange = may be selected after consideration; Green = select

Table 2. *ICF-CY test/classification profile upper limb tests in USCP.*

Tests	Capacity (C) performance (P)	Participation	Activities	Body Function & Structures	Personal factors	Environmental factors
COPM [24,42]	P	+	+	-	+	+
GAS [43,44]	P	+	+	-	-	+
CHEQ [45]	P	-	+	-	-	-
ADL Observation (Task-analysis)	P	-	+	-	+	+
Abilhand-kids [46]	P	-	+	-	-	-
AHA [47]	P	-	+	-	-	-
OSAS [48]	C-P	-	+	+	-	-
VOAA-DDD-R [28,49]	P	-	+	+	-	-
QUEST [50]	C	-	+	+	-	-
Jebsen Taylor [51]	C	-	+	+	-	-
MUUL [52]	C	-	-	+	-	-
Box and blocks [53]	C	-	-	+	-	-
AROM/PROM/AOC	C	-	-	+	-	-
Muscle strength [54]	C	-	-	+	-	-
Functional Strength [55,56]	C	-	+	+	-	-

Abbreviations: ADL = Activities of Daily Living; AHA = Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; JTHFT = Jebsen-Taylor Hand Function Test; MUUL = Melbourne Assessment of Unilateral Upper Limb Function; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; QUEST = Quality of Upper Extremity Skills Test; VOAA-DDD-R = Video Observations Aarts and Aarts to Determine Developmental Disregard (Revised).

Table 3. *Relevant tests at ICF-CY level and related to functional therapy demands.*

Treatment modality based on criteria for functional therapy	Use of hands Uni Bimanual (Bim)	Use of Affected Hand as Preferred Hand (PH) Assisting Hand (AsH)	Performance Assisting Hand (PAsH) Capacity of hand (CapH) Capability (CAPBil)	Ability to grasp (G) Hold (H) Manipulate (M) Release (R)	Strength needed in task-performance <50% >50%	Muscle weakness existing Difference AH-NAH < 50 % >50%	Goals
GAS	-	-	-	-	-	-	+
COPM	-	-	-	-	-	-	+
Task analysis	Uni / Bim	PH / AsH	PAsH/CapH / CAPBil	GHMR	-	+/-	+
ABILHAND-Kids	Bim	AsH	CAPBil	-	-	-	-
AHA /OSAS	Bim	AsH	PAsH/ CAPH	GHR	-	-	-
VOAA-DDD	Bim	AsH	PAsH/CapH	GHR	-	-	-
QUEST	Uni	PH/AsH	CapH	GHR	-	-	-
MUUL	Uni	PH/AsH	CapH	GHMR	-	-	-
Jebsen Taylor	Uni	PH/AsH	CapH	GHMR	-	-	-
Box and blocks	Uni	PH/AsH	CapH	GHMR	-	-	-
AROM AOC PROM	Uni	-	-	-	+	+	-
Grip Strength HHD	Uni	-	-	-	-	+/-	-
Functional strength	Uni/Bim	-	-	-	+/-	+/-	-

Red = tests not selected for decision making, based on the specific therapy components; Green = selected for decision making, based on the specific therapy demands
Abbreviations: ABILH-K = ABILHAND-Kids; AH = Affected Hand; AHA= Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; HHD = Hydraulic Hand Dynamometer; JTHFT = Jebsen-Taylor Hand Function Test; MUUL = Melbourne Assessment of Unilateral Upper Limb Function; NAH = Non-Affected Hand; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; QUEST = Quality of Upper Extremity Skills Test; VOAA-DDD-R = Video Observation Aarts and Aarts-DDD-R

day, preferably combined with BoNT-A, followed by a stretch splint during the night] is needed before starting the functional therapy programme. BoNT-A is contra-indicated if there is very low grip strength: instead a night splinting programme to stretch the finger flexors is indicated. When the weakness of the grip [> 50% difference from the non-affected hand] is most relevant, a functional strength training programme needs to be performed.

Decision model for M-CIMT versus H-CIMT

Because in M-CIMT the AH will be trained as the preferred hand and the tasks will be performed unimanually, M-CIMT will not be the first choice according to the criteria of functional therapy. In H-CIMT, bimanual training is combined with M-CIMT. Because BIMT and M-CIMT have been shown to be

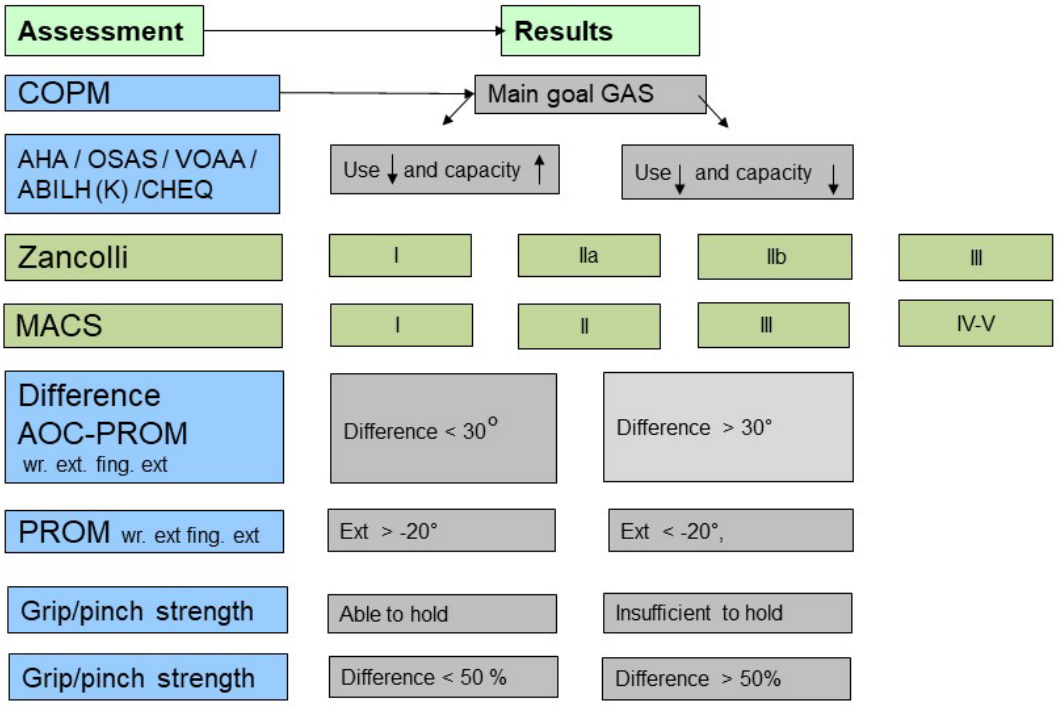

Figure 2. *Decision model for choosing type of functional therapy.*

Blue, green and grey blocks present the specific outcome categories of the tests.

Abbreviations: ABILH-K = ABILHAND-Kids ; AHA= Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire ; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; VOAA-DDD-R = Video Observation Aarts and Aarts-DDD-R; wr.ext.fing.ext = wrist extension with fingers extended.

equally effective one can argue that H-CIMT will be a treatment option in the functional intensive upper limb approach.

The decision criteria for H-CIMT are: the use of the AH is very low [low score on AHA or VOAA-DDD-R] but the capacity is high [high scores on OSAS, VOAA-DDD-R] and the ability to grasp and hold seems sufficient, indicating adequate muscle strength [< 50% difference from preferred hand]. To receive H-CIMT, children with unilateral USCP need to be classified as Zancolli I-IIA or MACS I-II, the PROM for wrist extension with extended fingers should be -20 degrees dorsiflexion or less, and the AOC-PROM difference for wrist extension should be < 30 degrees **(Figure 3).**

Decision model for H-CIMT versus BIMT

If the use of the hand in daily tasks is low but the capacity is high, the choice between H-CIMT or BIMT is arbitrary. Children with Zancolli IIB and MACS III can be included in either programmes because both offer assisting hand training. However, in the H-CIMT programme, strength needs to be sufficient in order to be able to grasp and hold in the first part of the programme where CIMT is performed and the hand is trained unimanually **(Figure 4).**

Decision model for BIMT

The choice of BIMT easily fits into the functional criteria [active training of the AH as assisting hand in specific tasks, based on needs; goal-directed in relevant contexts; and intensive therapy] and is actually indicated if both the use and capacity of the hand are low. Children with Zancolli IIB impairment can easily participate in a BIMT programme, although sufficient grip strength is a critical factor for being able to grasp and hold as the assisting hand. If the grip strength of the AH is too low to grasp and hold objects, it is debatable whether BIMT will be successful for such children and functional strength training will have to be done in advance.

In **Figure 5** the combination of test results leading to the choice of BIMT is shown.

Treatment prior to H-CIMT and BIMT

After criteria for BIMT or H-CIMT in the process, leading to clinical decisions, come specific constraints, like contractures, spasticity, and weakness of grip or pinch. Treatment to diminish the constraints of spasticity, passive and active range of motion and muscle strength has to be combined as an adjunct therapy with H-CIMT or BIMT. The combination of these treatment

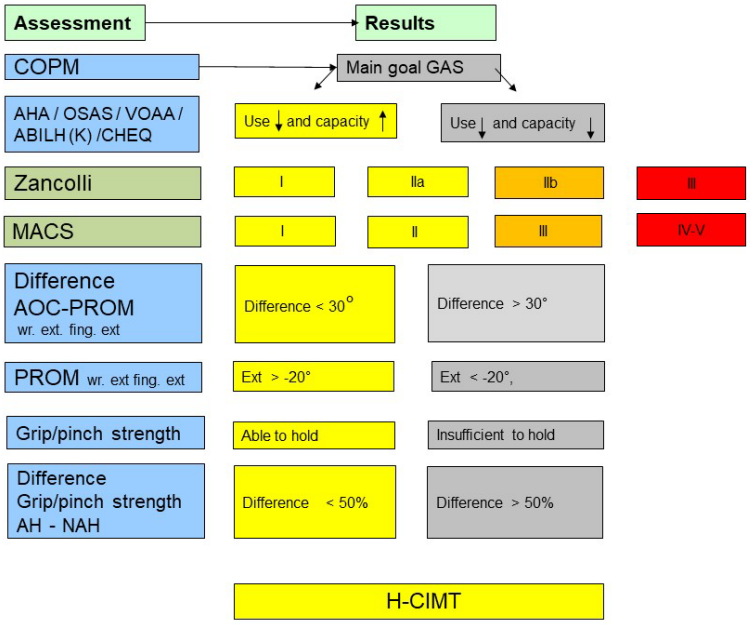

Figure 3. *The blocks in columns 2-5 show the results of the tests. Yellow and grey blocks present specific results on specific tests. Yellow blocks: in combination, they guide the treatment to the H-CIMT option; red blocks contra-indicate H-CIMT; orange blocks indicate possible inclusion, after consideration.*

Abbreviations: ABILH(K) = ABILHANDS-Kids ; AHA = Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire ; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; VOAA-DDD-R = Video Observation Aarts and Aarts-DDD-R; wr.ext.fing.ext = wrist extension with fingers extended.

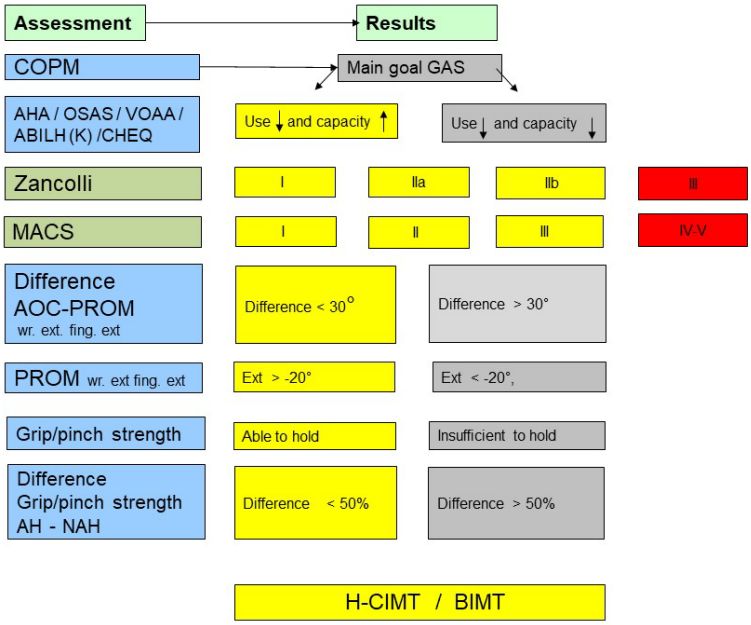

Figure 4. *The blocks in columns 2-5 show the results of the tests. Yellow and grey blocks present specific results on specific tests. Yellow blocks: in combination, they guide the treatment to the H-CIMT / BIMT option; red blocks contra-indicate H-CIMT / BIMT; orange blocks indicate possible inclusion, after consideration.*

Abbreviations: ABILH(K) = ABILHANDS-Kids ; AHA = Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire ; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; VOAA-DDD-R = Video Observation Aarts and Aarts-DDD-R; wr.ext.fing.ext = wrist extension with fingers extended.

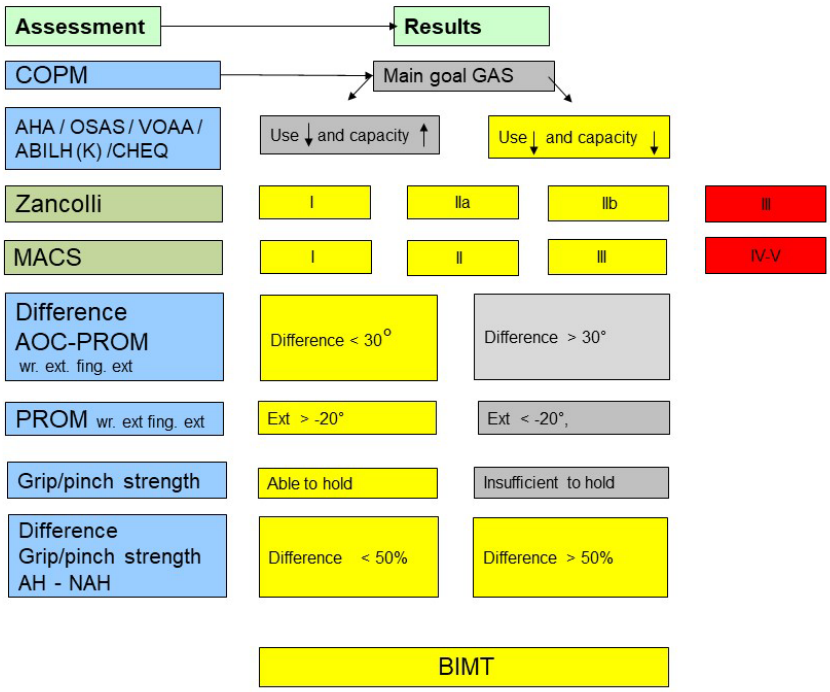

Figure 5. *The blocks in columns 2-5 show the results of the tests. Yellow and grey blocks present specific results on specific tests. Yellow blocks: in combination, they guide the treatment to the BIMT option; red blocks contra-indicate BIMT; orange blocks indicate possible inclusion, after consideration.*

Abbreviations: ABILH(K) = ABILHANDS-Kids ; AHA = Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire ; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; VOAA-DDD-R = Video Observation Aarts and Aarts-DDD-R; wr.ext.fing.ext = wrist extension with fingers extended.

options will enhance the effect of BIMT and H-CIMT. Treatments such as BoNT-A injections in spastic muscles, splints/orthoses, or surgery are options if AROM/PROM and spasticity are relevant constraints in a child with USCP. Furthermore, functional bimanual strength training can be used to increase the effect of H-CIMT and/or BIMT in children with significantly reduced strength in the affected hand. [See appendix 1 for clinical decision figures for BoNT-A, splints/ surgery or strength interventions].

The use of BoNT-A as adjunct treatment to BIMT has been studied intensively [7,34-36], showing positive effects on decreasing spasticity, though contradictory effects are found on activity level, resulting in different advice in guidelines [15,34]. Our advice is not to consider BoNT-A + BIMT as a treatment option in children who are able to actively open their hand, as stated in our DGCP guideline [15].

However, BoNT-A in the finger flexors can be considered in cases of high spasticity [AOC - PROM difference >30 degrees]. Because BoNT-A only reduces tone, a dynamic stretch splint during the night is needed to improve both the length of the finger flexors after BoNT-A and the AROM for opening the hand to grasp. In clinical discussions, the team should be aware of the reduction of the grip and pinch strength, due to BoNT-A, making it impossible to hold objects as the assisting hand [5,15]. BIMT or functional strength training is needed directly after the BoNT-A. If children have no active extension and abduction of the thumb, they are only able to participate in a functional therapy programme when wearing a thumb abduction splint during the day to enable them to open their hands more easily.

If muscle weakness is hampering the needs and goals of the child with USCP one can consider functional bimanual strength training, separate or combined with BIMT. Evidence of efficacy for strength training of the upper limb in USCP is moderate [13,37]. However, the relevance for strength training is high, based on the existing muscle weakness in wrist and fingers [32,38-40]. If grip and pinch strength of the AH is tested and the AH-NAH difference is high [> 50%], making it impossible to grasp, hold and stabilize objects, functional bimanual strength training of the upper limb should be considered. Children with Zancolli grading III have to be excluded from functional strength training, because of their lack of ability to use the hand to hold and stabilize objects. [See appendix I]

Discussion

A framework for clinical decision-making for specific functional upper limb treatment modalities is proposed. The need for a framework to guide rehabilitation teams is great because the evidence alone of the effects of specific treatments will not guide teams in decision-making for a specific patient [13,41].

The FuncRehab Cycle framework integrates rehabilitation processes, ICF framework and functional criteria for upper limb treatment and incorporates selective use of tests [coreset] based on the specific components of relevant treatment modalities. The purpose of using this framework was to create a decision tool for choosing the best treatment modality for a specific individual patient and which could be used iteratively before and after specific interventions, in line with a life-long rehabilitation perspective [15].

The choices for specific treatment modalities are based on the high level of evidence of goal-, task- and context oriented upper limb therapies [13] and the conclusion in the DGCP guideline [15] that functional therapy should be performed as the leading approach in children with CP. Criteria for functional therapy are developed and these criteria were used to choose treatment approaches such as M-CIMT, H-CIMT, BIMT, BoNT-A + BIMT and functional strength training. Hoare et al 2012 reported reasons to use BoNT-A as an adjunct treatment for upper limb interventions [42]. As stated earlier, the DGCP guidelines decided against the use of BoNT-A to enhance the functional use of the hand in daily activities, but suggested its consideration when there was high spasticity, together with dynamic stretch splints when the PROM is becoming too limited, especially of wrist, thumb [webspace] and fingers [15]. The decision to use functional criteria and ICF framework as background is based on evidence of treatment options and is helpful for rehabilitation teams in clinical decisions using the combined outcome of the coreset of tests in a multidisciplinary setting. The choices for specific treatment options are always based on complex interactions between many factors relating to all ICF levels. This framework for clinical decision-making is only one tool that can be used when focusing on functional therapies and the motor components of these treatment options. It is up to the rehabilitation team to consider both personal and environmental factors in making choices. In particular, when deciding between group or individual-based therapy, the abilities to follow instructions and to perform intensive rehabilitation during a specific period need to be taken into account [home situation, school situation etc.]

We have focused on the most frequently-used evidence-based treatment options in the Netherlands for the USCP, MACS I-II-III group. The use of orthoses, stretching, and surgery was only mentioned in the context of improving conditional factors to enhance the ability of children with more severe impairments to participate in these functional therapy programmes, but not into this guidance for clinical reasoning as separate intervention.

The FuncRehab Cycle as a framework can be helpful in choosing between treatment options with a consensus- and evidence-based approach.

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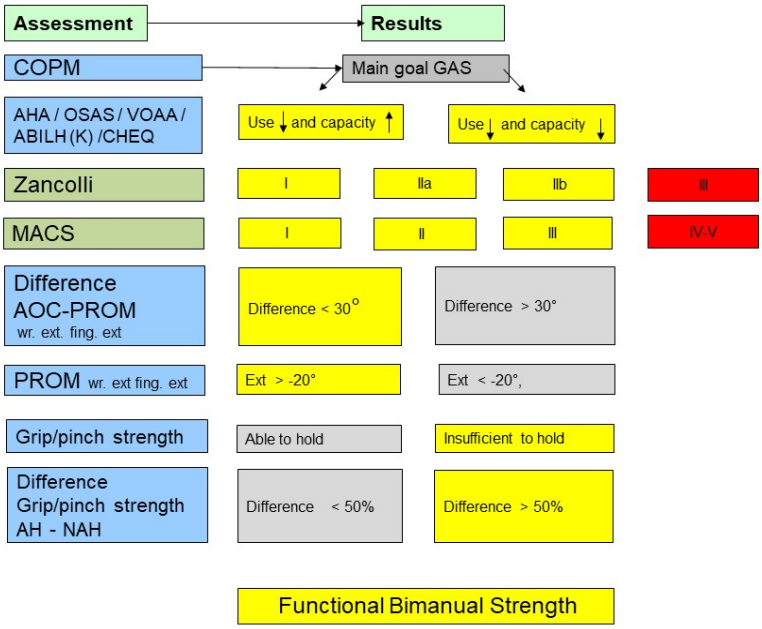

Figure 6. *The blocks in columns 2-5 show the results of the tests. Yellow and grey blocks present specific results on specific tests. Yellow blocks: in combination, they guide the treatment to the Functional bimanual Strength training; red blocks contra-indicate Functional Bimanual Strength training.*

Abbreviations: ABILH(K) = ABILHANDS-Kids ; AHA = Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire ; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; VOAA-DDD-R = Video Observation Aarts and Aarts-DDD-R; wr.ext.fing.ext = wrist extension with fingers extended.

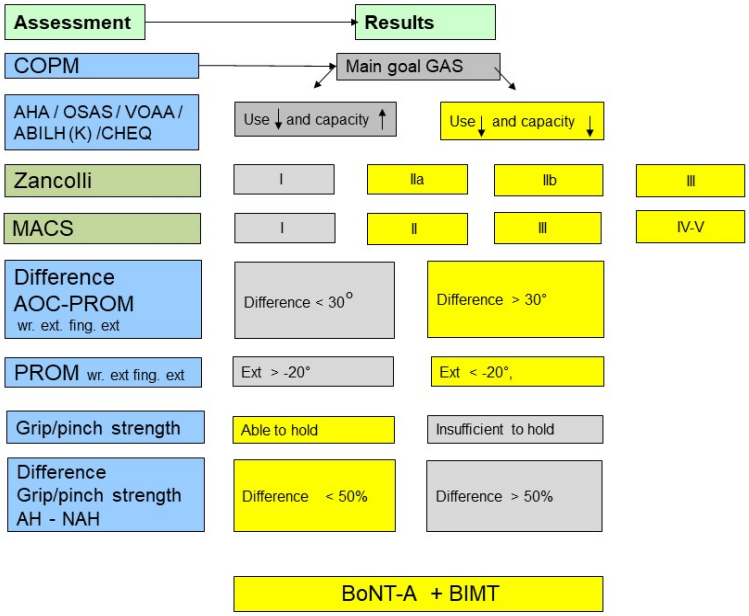

Figure 7. *The blocks in columns 2-5 show the results of the tests. Yellow and grey blocks present specific results on specific tests. Yellow blocks: in combination, they guide the treatment to the BoNT-A + BIMT option.*

Abbreviations: ABILH(K) = ABILHANDS-Kids ; AHA = Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire ; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; VOAA-DDD-R = Video Observation Aarts and Aarts-DDD-R; wr.ext.fing.ext = wrist extension with fingers extended.

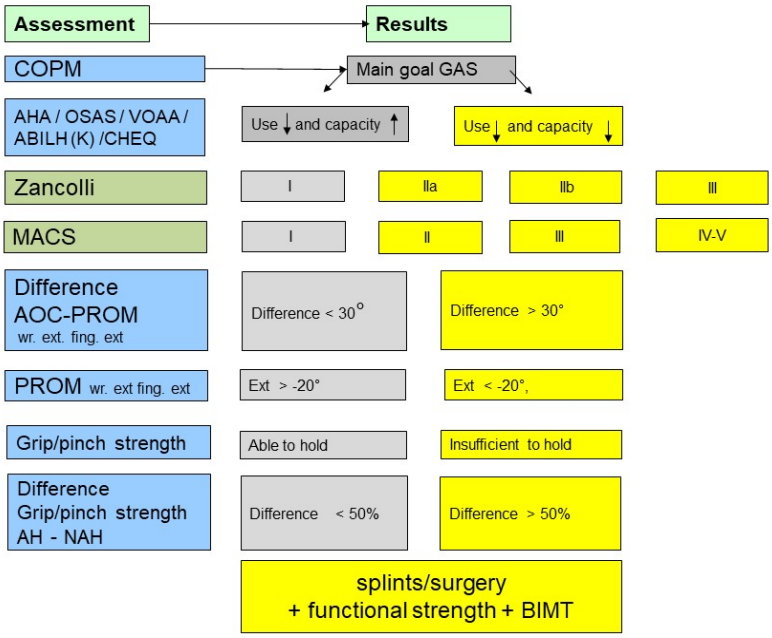

Figure 8. *The blocks in columns 2-5 show the results of the tests. Yellow and grey blocks present specific results on specific tests. Yellow blocks: in combination, they guide the treatment to the combined options for splints/surgery + functional strength + BIMT.*

Abbreviations: ABILH(K) = ABILHANDS-Kids ; AHA = Assisting Hand Assessment; AOC = Angle of Catch; AROM = Active Range of Motion; CHEQ = Children's Hand-use Experience Questionnaire ; COPM = Canadian Occupational Performance Measure; GAS = Goal Attainment Scaling; OSAS = Observational Skill Assessment Scale; PROM = Passive Range of Motion; VOAA-DDD-R = Video Observation Aarts and Aarts-DDD-R; wr.ext.fing.ext = wrist extension with fingers extended.