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Operationalizing Pediatric CIMT: Guidelines for Transforming Basic Principles and Scientific Evidence Into Clinical Practice for Individual Children

CHAPTER HIGHLIGHTS

- Clinical appraisal of children to assess appropriateness for pediatric constraint-induced movement therapy (CIMT)
- Making the clinical decision to recommend pediatric CIMT
- Operationalization: Linking critical features of pediatric CIMT to components of a treatment plan
- Supplemental components of pediatric CIMT
- Developing a fidelity measure of pediatric CIMT
- Becoming qualified to deliver evidence-based forms of pediatric CIMT
- Tension between the ideal and practical: Strategies for providing signature pediatric CIMT to children of different ages, temperaments, and functional levels
- How to keep a child engaged in high-intensity therapy.

KEY TERMS

ACQUIREc therapy
Applied behavioral analysis
Alternative pediatric CIMT
Cerebral palsy
Compensatory movements
Forced use
Hemiparesis
Massed repetitive practice
Modified pediatric CIMT
Neuroplasticity
Prompting techniques
Shaping techniques
Signature pediatric CIMT
Standardized treatment logs
Unilateral motor impairment
Varied repetitive practice

This chapter describes the history and diversity of research and clinical practice in the field of pediatric constraint-induced movement therapy (P–CIMT). Scientific evidence shows that this approach to rehabilitation for children with **hemiparesis,** a condition in which one side of the body is markedly impaired in terms of voluntary control, strength, coordination, speed, accuracy, and functional use compared with the other side, produces clinically meaningful improvement in use of the arm and hand in a relatively short period of time (Brady & Garcia, 2009; Hoare, Imms, Carey, & Wasiak 2007; Huang, Fetters, Hale, & McBride, 2009;

Sakzewski, Ziviani, & Boyd, 2009; Taub et al., 2007; see Chapter 2, "Pediatric CIMT: History and Definition," for the history and a summary of P–CIMT research findings).

However, many urgent questions remain unanswered regarding the optimal protocol for P–CIMT in terms of its intensity or dosage, the type and duration of constraint, and the specific therapeutic techniques used during the treatment sessions. (See Chapter 16, "Reasearch Priorities: Understanding and Transcending the Limits of Our Current Knowledge to Inform Best Practices in Pediatric CIMT," for a proposed future research agenda that addresses many important issues, including the effects of repeated treatment epochs, combined therapeutic approaches, use of technology, and individual differences in response to treatment interventions.) Practitioners worldwide have embraced the central ideas supporting the delivery of P–CIMT and begun to experiment in their own clinical practices with a wide range of modifications.

This chapter provides useful information to practitioners and families so they can understand and apply the central ideas of P–CIMT. Guidelines for clinical planning and practice to maximize clinical benefits and link measurement of progress to participation in therapy are included. To achieve high-quality systems of care that implement evidence-based treatments in a timely and equitable manner to all children who are eligible, practitioners and policymakers need to work closely to ensure that all key stakeholders are well-informed and prepared to implement treatments with high fidelity to the original protocols that produced benefits.

Michie, Fixsen, Grimshaw, and Eccles (2009) emphasized the importance of providing standardized descriptions and reporting about complex intervention behavior. Indeed, clarity about complex interventions is vital to the field of implementation science, which represents the translation of clinically efficacious treatments into routine, community-based clinical service. In other words, the goal of bringing the behavior of health care professionals in line with evidence-based practice can be realized only if the field produces "greater clarity about the functional components of those interventions. These should then be matched to population, setting, and other contextual characteristics" (Michie et al., 2009, p. 40). Thus, this chapter provides the functional components of P–CIMT and how they can be adjusted for different children, clinic settings, and functional or occupational outcomes.

CLINICAL APPRAISAL OF CHILDREN TO ASSESS APPROPRIATENESS FOR P–CIMT

Children with hemiparesis frequently face a long-term reality of everyday challenges as the result of injury to their nervous system, primarily at the central nervous system or brain level. The current understanding of the cause of **cerebral palsy (CP)** for most children diagnosed early in life (within the first 2 years) is that a prenatal stroke (i.e., damage to the brain during the fetal period that results in cell death and brain lesions caused by altered blood supply to specific regions of the brain; Govaert, Ramenghi, Taal, DeVries, & deVeber, 2009; Özduman et al., 2004) or, more likely, a series of prenatal strokes occurred, attributable to a variety of possible factors that result in damage to the developing brain.

For most children, stroke and CP are not inherently progressive conditions, that is, the primary brain lesion will not change over time. For children who develop hemiparesis after the age of 2 years, the acquired brain injury can be caused by many factors, including head trauma (most commonly from automobile injuries, sports injuries, and physical falls; Broman & Michel, 1995), infections, extended very high fever associated with diverse conditions, and other diseases that increase the risk of stroke (e.g., sickle cell disease. See Chapter 4, "Motor Development and Physical Growth in Children With Cerebral Palsy," for more details about biomedical considerations related to CP).

To date, P–CIMT appears to an effective treatment strategy for children with **unilateral motor impairment** (i.e., when one side of the body displays measurably lower functional competence or strength than the other side), regardless of the specific cause of their neuromotor impairment. Hopefully, future research findings will provide greater specification about the relationship among the etiology, timing of brain injury, and extent and location of brain injury and the variation in individual children's responses to P–CIMT. Thus far, most of the studies on individual differences in response to P–CIMT (post hoc) have not detected any consistent differences associated with the child's age, gender, or initial severity of functional impairment (e.g., DeLuca, Case-Smith, Stevenson, & Ramey, 2012; DeLuca, Echols, Law, & Ramey, 2006; Gordon, Charles, & Wolf, 2006). These studies, however, often had fairly small sample sizes that limited their power to detect such differences.

Although P–CIMT leads to improved upper-extremity (UE) functioning, it does not totally eliminate the condition of hemiparesis, nor is it expected to do so. Accordingly, P–CIMT is most accurately viewed as (1) an evidence-based therapy approach applicable to a diverse group of children with hemiparesis and (2) an effective rehabilitation strategy to be incorporated into a longer-term and broader, multiyear treatment plan for each child (rather than a singular, stand-alone treatment). P–CIMT needs to be considered part of a longer-term plan because the majority of children with hemiparesis also face challenges beyond just having reduced or altered function of their UE. Typically, a child with

hemiparesis is likely to show measurable differences relative to his or her typically developing age-matched peers in multiple, age-appropriate activities. These other areas of altered development for many children with hemiparesis may include one or more of the following:

- Neuromotor impairments that affect the child's posture and postural control
- Reduced mobility (e.g., ambulation) skills with lower efficiency, more effortfulness, increased injury risk, and possible need for orthoses (e.g., ankle–foot orthotics, crutches, walkers, wheelchairs)
- Impaired or delayed speech and language development
- Decreased or atypical facial expressiveness
- Sensory and perceptual impairments (e.g., increased or decreased sensitivity to touch, pressure, pain, heat or cold, spatial–body awareness)
- Delayed or uneven neurocognitive functioning, as displayed in the prefrontal cortex executive function (EF) skills (key areas are sustained attention, planning, working memory, response inhibition, emotional self-regulation, behavioral flexibility, anticipating and valuing the future, and evaluating one's own behavior in relation to that of others) and overall tested intelligence
- Social–emotional challenges, likely attributable to a combination of basic brain changes associated with the original injury, limited or atypical environmental opportunities to acquire a full repertoire of social and emotional competencies, and additional demands and frustrations associated with the child's primary disability
- Additional medical problems and comorbidities (e.g., elevated rates of seizures that may further exacerbate other aspects of the child's overall pattern of development, autism spectrum disorders, behavior problems).

Many of the associated differences in the development of children with hemiparesis are likely to reflect conditions secondary to their primary diagnosis, such as limited social–emotional skills, behavioral problems, and growth disorders. (See Chapter 4, "Motor Development and Physical Growth in Children With Cerebral Palsy," for an overview of CP and development.) It also is true that many children with a primary diagnosis of CP are quite healthy and have few or no additional problems in their overall development in other domains.

MAKING THE CLINICAL DECISION TO RECOMMEND P–CIMT

The decision to recommend providing P–CIMT for a given child occurs within the context of the total appraisal of the child's clinical, social, and educational needs and the child's life situation. Almost all children with hemiparesis are excellent candidates for P–CIMT, provided the therapy delivered adheres to the central components of P–CIMT as tested thus far (Table 7.1). As in all ethical and informed health care decisions, professionals should never base their recommendation to a client and family primarily on factors such as cost, convenience, and local availability. Instead, the recommendation should be guided by the reasonable expectation that a given treatment—in this case, P–CIMT—will result in improved health outcomes, increased functional use of the UE, prevention of secondary and atypical compensatory behaviors, and improved quality of life.

Although P–CIMT is no longer a new form of rehabilitation, it has not yet been formally adopted as a standard of care. Many practitioners seek additional information about when and for whom to recommend this treatment. The clinical decision-making process to consider P–CIMT is supported, in part, by extensive scientific evidence that the usual and customary forms of therapy for children with hemiparetic CP do not, in fact, produce significant benefits (see Barry, 2001; Butler & Darrah, 2001). These forms of usual and customary therapy, still widely prescribed and implemented, often involve low-dosage therapy sessions that last about 1 hour and occur either 1 or 2 times per week and continue for many months throughout the year, using general principles of neurodevelopmental therapy, along with an eclectic combination of rehabilitation practices (e.g., prompting, encouragement, undirected practice, modeling or imitation, direct facilitation, range-of-motion exercises, play or activities of daily living that require use of the impaired UE).

Unfortunately, these traditional pediatric therapy approaches used by both occupational therapists and physical therapists lack evidence that they produce measurable and long-lasting benefits. Recognizing that the usual and customary therapies children with CP receive do not meet standards for being evidence-based increases the need to search for and apply forms of therapy that have demonstrated positive effects and that offer greater likelihood of producing notable functional improvement. Thus, practitioners are advised to actively look for evidence from rigorous clinical trials, particularly those that are later replicated and those that show sustained gains for children similar to those they are treating, to support their clinical decision making and choice of therapy protocols to implement.

In the eagerness to increase the provision of evidence-based P–CIMT, it is vital that implementation adhere to the components of the therapy protocols that have produced results. If high fidelity to the treatment model is not maintained, P–CIMT is at risk for being considered a poorly defined therapy approach that is so weakly or incompletely delivered that practitioners and families alike may incorrectly conclude that it is not effective in producing change in clients.

Table 7.1 FIVE ESSENTIAL OR CORE COMPONENTS OF P–CIMT IN SIGNATURE AND MODIFIED PROTOCOLS

FIVE ESSENTIAL COMPONENTS OF P–CIMT	SIGNATURE OR TRADITIONAL P–CIMT	MODIFIED P–CIMT
1. Constraint of the less-impaired or unimpaired UE	Constraint of the less-impaired or unimpaired UE for the majority of waking hours and during active treatment	Constraint of the less-impaired or unimpaired UE at least during active treatment
2. High dosage (likely minimum threshold: 2-hr sessions per day for 5 days/week) for at least 2 weeks	High dosage of therapy in a concentrated period of time involving active treatment for a minimum of 3 hours per day for 5 days/week for at least 2 weeks	High dosage of therapy in a concentrated period of time with a minimum of 2 hours/day for 5 days/week for multiple weeks
3. Use of shaping techniques and repetitive practice with task variation	Use of shaping techniques to review, extend, practice, and refine skills that use formal operant learning techniques with immediate feedback and reinforcement in all treatment sessions	Use of shaping techniques to review, extend, practice, and refine skills as an active component of treatment
4. Learning functional skills in natural and diverse settings	Learning functional skills in natural and diverse settings (i.e., treatment is in these settings)	Treatment may occur in clinics, although emphasis is on functional skills for use in natural and diverse settings
5. Transition (posttherapy) planning for maintenance of gains	Posttherapy planning to promote functional bilateral and unilateral UE development and continued practice of new skills with more-impaired UE	Posttherapy planning to promote functional bilateral and unilateral UE development and continued practice of new skills with more-impaired UE

Note. P–CIMT = pediatric constraint-induced movement therapy; UE = upper extremity.

One great practical challenge in working in this field is that specialized training in the use and application of new techniques such as P–CIMT often is not readily available. Further, the training offered has not yet been consistently monitored for its quality, rigor, and adherence to the scientific evidence. Most clinics, as well as community-based or school-based therapy programs, face another barrier for treatment recommendation—namely, these programs are designed primarily to provide weekly, usually 1-hour, therapy sessions, often in the clinic or hospital setting or during school hours. Logistically, these providers would need to redesign their operations and reschedule their practitioners so that they could deliver the much higher dosage and higher density protocol of P–CIMT to children.

Another major obstacle for these traditional, clinic-based operations is how to deliver the therapy in natural home and community environments rather than in a clinical setting. The dominant model of clinic-based services supports the way customary therapy services are billed, approved, and reimbursed for a fixed number of therapy visits from third-party payers, usually with reauthorization for ongoing treatment sessions or those beyond routine care.

OPERATIONALIZATION: LINKING CRITICAL FEATURES OF P–CIMT TO COMPONENTS OF A TREATMENT PLAN

A review of scientific findings and clinical reports reveals that many practitioners have conducted their own review of the published findings and tried to determine how to provide at least some of the features of P–CIMT to the children being served. It is a concern that in many places children are receiving therapy labeled as "constraint-induced therapy" when, in fact, the therapy does not replicate or contain the key P–CIMT elements that produced significant and lasting benefits in rigorous clinical trials (e.g., see letter to the editor by Ramey, DeLuca, Case-Smith, & Stevenson, 2012). Administering only some (rather than all) of the essential elements of P–CIMT and creating convenience-based adaptations that are not sufficiently supported by rigorous scientific evidence may waste time and money, fail to realize full benefits for individual children, and, in some cases, possibly cause unintended harm.

Therapy modifications that do not sufficiently adhere to a specified treatment protocol that has demonstrated significant

benefits may fail to produce intended benefits and place a child in a situation that could lead to unexpected negative (iatrogenic) side effects.

The most widespread examples of inappropriate and ineffective forms of "alternative" CIMT include the following:

- Children receiving only 1 or 2 relatively brief sessions (usually less than 2 hours) per week that involve placing constraint on at the start and then taking it off at the end of each session. These very low dosage therapy sessions with only brief intervals of applying constraint seldom produce clinically significant benefits for the child. Repeated application of the constraint also can be frustrating for both the practitioner and the child.
- Use of constraint only without the intensive shaping therapy component (other than having parents and teachers encourage the child to use his or her arm) has been problematic and ineffective.
- Improper casting or splinting techniques have caused constriction of fingers and thumb or created undue physical stress on other parts of the arm and elbow.

Research and experience show that very low therapy dosages with limited, improper, or no-constraint approaches should never be labeled as P–CIMT.

Five central features or essential therapeutic components of P–CIMT qualify a multicomponent treatment program as being a form of evidence-based P–CIMT (also see Table 7.1):

1. Constraint of the less-impaired or unimpaired UE in a systematic way during the course of active treatment;
2. High dosage of therapy in a relatively concentrated period;
3. Primary reliance on **shaping techniques** (i.e., systematic procedures in which behavior is progressively modified through a sequence of activities by applying reinforcement for increasingly higher levels of performance) that include structured opportunities for repetitive practice that focus on increasing ease, speed, accuracy, and control of movements as well as extending new skills into the child's everyday behavioral repertoire;
4. Learning functional skills in natural and diverse settings; and
5. Transition to or planning for posttherapy activities.

Together, the five central features of P–CIMT are a bundled package of rehabilitation techniques aimed at engaging a child in a treatment course of P–CIMT. Excluding any one of these features disqualifies the treatment from being considered P–CIMT. Adhering to this operationalized definition promotes identifying a specific protocol (amenable to measuring its fidelity of implementation) for each P–CIMT intervention while still providing latitude for adaptation, individualization, and accommodation over the course of therapy for a given child.

Forms of children's constraint-induced therapy are designated as one of three primary categories—(1) signature, or standard; (2) modified; and (3) alternative—following the recommendations recently proposed for classifying adult constraint-induced therapy forms (Blanton, Wilsey, & Wolf, 2008; Reiss, Wolf, Hammel, McLeod, & Williams, 2012). Both **signature P–CIMT** and **modified P–CIMT** interventions include all five core components; in contrast, forms of alternative P–CIMT contain only some of the five components. This chapter focuses on versions of signature and modified P–CMIT, because many have produced considerable and lasting (i.e., 6 months post treatment) benefits.

For "alternative" P–CIMT protocols, the practitioner must identify a rationale for their selection and the evidence that supports the variations selected. If the alternative P–CIMT protocol lacks empirical support, the practitioner needs to explain this fact to the parents and child and indicate why a modified or signature form of P–CIMT was not selected. This conversation increases clarity in communication between practitioners and families and may provide opportunities to explore other treatment options. When an alternative P–CIMT protocol is identified and subjected to rigorous evaluation, the specific components of the protocol can be evaluated as a package in terms of impact on the outcomes for the types of children for whom the alternative P–CIMT was developed.

The five essential P–CIMT components (constraint, high dosage, shaping and repetitive practice, natural environments, and transition planning) will be described next in operational detail.

CONSTRAINT

The first component of P–CIMT is constraint of the less-impaired or unimpaired UE in a systematic way during the course of active treatment. The theory is that this intervention will redirect the child's attention to use the more-impaired UE and perhaps reduce competing sensory–motor activity and reliance on well-established habit patterns that do not include active use of the more-impaired UE in play and daily activities.

HIGH DOSAGE

High dosage of therapy in a relatively concentrated period is defined as a minimum of 2-hour daily sessions for 5 to 7 days per week, usually over multiple weeks, yielding a minimum total dosage of 30 hours, although most of the efficacious dosages have had a total between 60 and more than 126 hours (Taub et al., 2007).

High dosage of therapy was a cardinal feature of the adult form of constraint-induced therapy (see Chapter 1, "History and Theory of CIMT for Adults With Stroke," for the history of adult CIMT), and independent studies support the conclusion that high-intensity therapy can be beneficial

(e.g., Gordon et al., 2011). Acquisition of new behavioral skills requires considerable effort, particularly at first, for these new skills to become more proficient and eventually to be as automatic and natural as skills for the less-impaired UE. This high-dosage and concentrated therapy is hypothesized to be a critical feature of P–CIMT.

Similarly, theories of **neuroplasticity,** which is the ability of the nervous system, particularly the brain, to structurally and functionally change, postulate that reshaping the architecture and functional efficiency of the brain is closely linked to use; therefore, higher levels of use lead to new areas of activation and larger or more integrated areas of neuromotor representation and functional activity in multiple brain regions and functional brain networks (Gillick & Zirpel, 2012).

SHAPING AND REPETITIVE PRACTICE

Primary reliance on shaping techniques includes structured opportunities to review, extend, and repeatedly practice (massed and varied) new and refined skills. Shaping uses a combination of strategies to prompt, reinforce, and continuously refine and improve behavior. Shaping for a given type of UE movement or skill begins with a functional behavioral assessment of both the task and the child's initial level of performance. **Massed repetitive practice** refers to many repetitions of the same or highly similar behavior within a concentrated continuous time (i.e., high density of repetition with minimal rest intervals between repetitions). **Varied repetitive practice** refers to implementing the behavior with intentional differences, such as pushing an object to one side, then pushing to the other side, then pushing forward, or lifting different size blocks and placing them in different places when returning them. Massed practice can improve the automaticity, ease, and confidence, with which the child can complete a specified motor act or movement. Variation in practice helps the child understand the diverse ways in which a particular behavior can be displayed and adapted, helping increase the realization that many motor behaviors can increase in their functional value through these variations in how they are used.

Formal shaping procedures belong to a large class of techniques used in the field known as **applied behavior analysis,** which is an area of study that invovles the systematic and intentional application of scientific principles of learning and reinforcement with the goal of improving behavioral outcomes. (*Note:* This field is a specialty area in psychology and education in which professionals can earn formal certification. For an excellent book on applied behavior anlaysis, see Cooper, Heron, & Heward, 2007).

Most UE functional activities involve multiple components that eventually chain together. **Prompting techniques** represent a class of widely used therapeutic techniques in which a stimulus is applied to promote or induce movement or a particular neuromotor behavior. Prompting techniques are often incorporated into shaping procedures. Examples of prompting include verbal guidance and instructions, visual displays (e.g., photos, videos), positional prompts (e.g., placing a child in a sitting position that facilitates easier movement from the shoulder or elbow), and touching or stimulating a body part (e.g., a tap to the elbow to help the forearm move forward, a gentle push from below a finger to elicit an upward movement of that finger). Practitioners also frequently model (demonstrate or show) the behavior in a way that is easy for the child to observe and then try to imitate.

Once a child shows an effort to initiate a behavior in the direction of the intended function, the practitioner provides reinforcement immediately. The practitioner and parents individualize the reinforcement for each child on the basis of the child's likes, interests, motivators, and dislikes. Varied reinforcement over the course of the session, rather than overly rigid or mechanical actions, provides stronger and more enduring results. For young children, reinforcers should include a mix of verbal praise, smiles, clapping, offering small rewards that can accumulate (e.g., stickers, small healthy snacks), or doing something silly (e.g., making a funny sound, a gentle tickle that the child enjoys). For older children, immediate verbal reinforcements help the child identify more (vs. less) successful efforts. Older children often enjoy setting up rewards that include engaging in a favorite activity after achieving an identified goal for a particular portion of the therapy session.

As a child shows progress in measurable ways, such as the behavior becoming more predictable, more accurate, faster, better coordinated, or stronger, the practitioner increases the expectations for subsequent performance in gradual increments. This can involve describing the higher expectations, demonstrating the "next level" for the child, or using direct physical prompting. As the practitioner continues this shaping approach—an approach that the child soon learns will invariably include demands for successively higher levels of performance—he or she adjusts the reinforcement so that it is directly contingent on the child attaining this higher level (i.e., the practitioner withholds reinforcement previously offered for lower levels of performance the child already achieved.)

In addition to gradually modifying new behaviors, the practitioner and child can work as a team to have the behaviors generalize appropriately to similar activities, with variations in how the new, improved behaviors are used. After achieving a certain level of performance or after an extended session of shaping, the child often chooses to review and rehearse the behavior on his or her own. Thus, repetitive practice can follow

formal shaping activities at intermittent periods throughout the day and over the course of the following days and weeks. While practice is occurring, some feedback to children is helpful, particularly to prevent loss of recently learned skills or to minimize developing idiosyncratic accommodations to complete a task (which later may take considerable effort to drop from the child's repertoire). Continuously building upon a child's recent achievements and eventually thinning or reducing the reinforcement schedule (particularly for older children who more readily recognize the inherent value and enjoyment related to new UE skills) become part of the cycle of this high-intensity therapy.

Although a written description of shaping may make it appear simple to enact, practitioners often need at least several weeks of intensive practice to become proficient in this technique. When a practitioner provides reinforcement that is time-delayed or generic and insufficiently specified and linked to actual moment-by-moment behavior, the shaping techniques are far less successful at producing the intended advances in a given skill or voluntary movement. Practitioners typically can benefit immensely from observing an expert P–CIMT therapist. In addition, they can refine their own competencies by receiving feedback on their administration of these techniques, either during in-person sessions or guided review of videotaped sessions.

An area of difficulty and controversy for some practitioners is that many children can and do creatively adapt to their physical and motoric impairments, commonly referred to as **compensatory movements**, which are those movements made to accomodate to an injury or disability that disrupt or prevent completing movements in the typical (i.e., nonimpaired) manner. The problem is that many of these adaptations limit the child's subsequent attainment of more complex or efficient levels of functional motor behavior. Moreover, these accommodations often add to the visible stigma of the child's disability. Whenever possible, practitioners should focus on shaping procedures that will allow a child to complete the UE "occupation" in as typical or normative a fashion as possible (taking the child's age into consideration). This encouragement and shaping of normal motor patterns also help facilitate subsequent bilateral or bimanual progress, in which the child will be able to use both UEs in a coordinated, supportive, or synergistic manner. However, practitioners also need to accept a child's atypical movements to some degree, so that the child experiences success. This acceptance is an important area for individualization; practitioners who received training that emphasized "normality" as the primary outcome goal often encounter less functional progress and experience difficulty in maintaining a child's level of enthusiasm, interest, and willingness to "try harder." Excellent sources for more details about the basic theory, principles, and practices used in applied behavioral analysis (ABA) are the textbooks by Cooper (2007) and Alberto and Troutment (2012).

NATURAL ENVIRONMENTS

The fourth component of P–CIMT is learning functional skills in natural and diverse settings to promote their maintenance and generalization to other settings. The principle of learning in natural environments is not unique to P–CIMT, but almost all of the clinical trials and case histories emphasize that the treatment occurs in the child's home or a homelike setting, and often the therapy occurs while the child is playing, participating in daily activities, or engaging with peers, such as in a camp-like or school setting. In contrast, customary treatment often takes place in a clinic where the child has few opportunities to realize how the therapy sessions relate to the everyday rhythms and expectations that he or she experiences. Natural environments have long been shown to promote both generalization and maintenance of new behaviors, rather than learning and practice that occurs in unfamiliar or therapy-only settings (Cooper et al., 2007). Chapter 9, "Alternative Pediatric CIMT: Understanding the How and Why of Clinical Variations in Pediatric CIMT," discusses examples of clinic-based approaches that also engage children in home-based tasks to promote generalization of new behaviors.

TRANSITION PLANNING

The final component is formal transition planning for posttherapy activities that recognize the child's primary functional activities and the importance of continuing to gain both bilateral and unilateral competencies to support future development.

An interesting and somewhat distinctive feature of P–CIMT is that it almost always includes working closely with the child, the child's parents, and other adults (e.g., teachers, community therapists) to establish a way to promote continued use of the new UE skills. There are at least two compelling reasons for this transition planning:

1. Children primarily function using both of their arms and hands.
2. Many children have ambitious goals for improving their voluntary use of the impaired UE, so withdrawing high-intensity therapy can disappoint them.

With the impaired or less-functional UE being far more capable after intervention, there will be new opportunities to use this UE, along with the less- or unimpaired UE to achieve greater daily success. Sometimes P–CIMT includes a formal, multiday bilateral training period; other times, this phase occurs after the P–CIMT therapy ends as the child returns to his or her typical pattern of daily life. In the United States, almost all children with

hemiparesis will continue to receive some form(s) of therapy and other assistance after receiving P–CIMT if they are participating in early intervention or special education programs (Batshaw, 2000). Having explicit plans and ideas for how to promote continued progress and prevent any regression toward non-use of the more-impaired UE is particularly important.

Many children who are verbal and engaged in educational and recreational activities have their own high goals for improving their voluntary use of the impaired UE. For these children, the withdrawal of the high-intensity therapy that produced rapid and observable improvement can sometimes be disappointing. Children thus often look forward to having a plan for how to "work hard" to continue to "get better." Many parents express high interest in learning to implement some of the shaping and reinforcement techniques as well as improving their ability to observe and encourage their child in effective use of the more-impaired UE. Practitioners can help parents and older children think about ways to reward their use of new skills in everyday activities. They often design plans to reinforce use of the more-impaired UE in everyday tasks by setting aside "special" activities that can be completed only with the weaker extremity. Even for adults recovering from a stroke, the feature of transition planning has been recognized as key to long-term improvements (e.g., Morris, Taub, & Mark, 2006).

SUPPLEMENTAL COMPONENTS OF P–CIMT

Table 7.1 on page 118 presents the five essential components of P–CIMT in terms that identify two acceptable variations that have been used in the reported scientific and clinical literature: (1) signature, or standard, P–CIMT and (2) modified P–CIMT. In addition, P–CIMT often includes several other treatment aspects that are likely to be valuable and often are used in many other forms of pediatric therapy, such as setting individual goals through collaborating with the child and parents; providing supportive instruction to parents to assist their child in using and refining new and more complex skills the child acquires; and identifying effective reinforcers, motivating activities, and appropriate rewards for the child (as well as learning about any other social, emotional, and health issues that should be considered over the course of P–CIMT).

Exhibit 7.1 lists many other components or features of P–CIMT therapy that are mentioned in published studies as being integrated with the other core elements. These features are not considered unique to P–CIMT and are unlikely to be sufficient by themselves to produce large and enduring functional improvements. Rather, they might be considered as child-friendly and promotive factors in almost any form of pediatric rehabilitation.

DEVELOPING A FIDELITY MEASURE OF P–CIMT

The science of pediatric rehabilitation is well supported by having systematic therapy protocols in the form of manualized treatment guidelines. This manualization of interventions promotes clarity in planning and implementing the therapy and facilitates establishing measures of adherence to the protocol. In other words, the manualization of P–CIMT interventions helps ensure that the delivery of the therapy remains true to the underlying philosophy, principles, and procedures for which there is evidence of efficacy with specific client populations. Although many practitioners once relied on their own clinical impressions and experiences as adequate to guide their work with clients, there is strong consensus that more rigorous evidence and documentation of the content of therapy, as well as dosage, are needed.

There is a high priority to develop valid and reliable measures for assessing the fidelity of implementation of P–CIMT that has produced measurable gains. Specifically, we propose that the five core elements (described earlier) form the centerpiece of a general fidelity measure, with additional and adjunctive components added as appropriate. These measures will also further a more rapid acceleration of clinical knowledge that can be shared, consistent with the idea of moving toward precision practice (see "Introduction" to this text) in a manner that incorporates advances from basic science, rigorous clinical trials, and ongoing clinical practice as new treatments move into large-scale implementation.

BECOMING QUALIFIED TO DELIVER EVIDENCE-BASED FORMS OF P–CIMT

In many fields of health care and rehabilitation, particular treatments require specialized training and sometimes certification. To date, no formal qualifications have been required for training and certification in the delivery of evidence-based P–CIMT. Some clinical groups, however, have developed training programs for both students (preservice training primarily in pediatric occupational therapy and pediatric physical therapy) and practitioners (often as part of continuing education available in professional workshops and training courses offered by experts in tested forms of P–CIMT).

The signature and modified forms of P–CIMT are distinctive as a multi-element treatment package; they extend beyond the rehabilitation techniques covered in the majority of pediatric occupational and physical therapy programs as well as the preparation of pediatric physiatrists, whether as doctors of medicine or doctors of osteopathic medicine.

Exhibit 7.1 Supplemental Components Often Included in P–CIMT Protocols

Common treatment features that accompany signature and modified P–CIMT include

- Setting treatment goals in a partnership that includes contributions from the child, the parents, and the practitioners
- Identifying rewards and motivators for the child that can be used in shaping and repetitive practice activities
- Setting times and places for the therapy that are "family friendly" and varied
- Including periods for free or unstructured play-based activities that readily permit practicing new and improved UE skills
- Having parents learn some of the techniques of P–CIMT and setting up activities for practice during nontherapy times
- Using technology in ways that facilitate treatment goals rather than distract from therapy goals
- Meeting with other professionals who provide clinical and other services to the child and family to help explain P–CIMT and to coordinate and share information.

Note: P–CIMT = pediatric constraint-induced movement therapy; UE = upper extremity.

Although not all of the essential treatment features are novel, their integration into a single program of treatment is novel. Perhaps the two most novel and demanding aspects of P–CIMT are its

1. High intensity, particularly when the sessions last 3 to 6 hours in duration and are provided 5 to 7 days per week for 2 to 6 weeks (and sometimes up to 10 weeks), and
2. Use of rigorous, skillful application of shaping (successive approximations to achieve a given neuromotor outcome) and repetitive practice techniques.

In addition, many different forms of constraint can be used for children, which require expertise in semirigid, flexible casting and splinting for children of different ages and with different clinical concerns.

Accordingly, many practitioners seeking to become qualified in P–CIMT can benefit from additional professional education and training opportunities, ranging from the study of written P–CIMT protocols or manuals to observational learning to formal course instruction. Ideally, for practitioners who have not been formally trained and supervised in P–CIMT as part of their preservice or in-service instruction (currently available at only a few institutions), receiving detailed feedback from more-experienced P–CIMT practitioners when they provide this therapy for the first several children would be extremely valuable.

For both signature and modified P–CIMT, the intervention has engaged practitioners who are trained and qualified in their locales. Practitioners usually are the direct providers of P–CIMT, although some studies have combined practitioner-delivered therapy with parent-delivered therapy, and some have relied extensively on parents delivering the therapy. (See Chapter 9, "Alternative Pediatric CIMT: Understanding the How and Why of Clinical Variations in Pediatric CIMT," and Chapter 10, "Group-Based Models of Pediatric CIMT: Special Camps, School-Based Treatment, and Home Environment Models," for more details about modified and alternative forms of P–CIMT in which parents receive training and actively participate in the intervention.) Because P–CIMT has been applied and studied in many countries, differences exist in the preparation and designation of professionals who work in the field of pediatric rehabilitation. For example, in the United States, variations occur in each specialty area and most states in terms of standards for board certification and licensing, including how to administer and oversee the testing process and how to document continuing education credits and activities, usually following national guidelines (e.g., National Board for Certification in Occupational Therapy, Federation of State Boards of Physical Therapy). Similarly, degree-granting programs in rehabilitation receive accreditation appropriate for their discipline.

For rehabilitation professionals seeking specialized training in P–CIMT, the following strategies may be helpful:

- Study the written P–CIMT protocols and administration manuals that might be available in print (e.g., DeLuca, Echols, & Ramey, 2007), online through a clinic Web site (e.g., Cincinnati Children's Hospital Medical Center, Kennedy Kreiger Institute), or shared directly by scientists and practitioners who have evaluated a type of P–CIMT and produced evidence of its efficacy (through a well-controlled clinical trial) or effectiveness (through clinical reporting of progress monitoring of children receiving the therapy);
- Attend workshops and special courses about P–CIMT offered through major professional organizations at international, national, and regional meetings;
- Participate in formal, in-depth training that may be available, particularly training that affords opportunities to work directly with children and receive in-person feedback about application of techniques (e.g., the Pediatric Neuromotor Research Clinic in Birmingham, Alabama, offered a 40-hour course over 5 days in the implementation of ACQUIREc P–CIMT, a signature

form of P–CIMT, with feedback provided post training using a combination of videotaped therapy sessions and individualized consultation about therapy protocols); and

- Establish professional learning circles locally to exchange information and develop strategies for documenting the delivery of P–CIMT and measuring both its fidelity of implementation (i.e., adherence to the guidelines and parameters of the original protocol; see below) and its effects on children (e.g., measuring pre- and posttherapy competence of each child and including practitioner, parent, and child reports of changes and challenges).

FIDELITY OF TREATMENT: IMPORTANCE OF RECORDING P–CIMT AS DELIVERED TO INDIVIDUAL CHILDREN

Historically, most rehabilitation practitioners have documented the delivery of treatment in the terms required for reimbursement (particularly if a third-party or medical insurance payment is made) and in ways that provide useful clinical notations for the practitioner. No formal requirement or professional expectation exists to maintain **standardized treatment logs,** which are used to systematically document the times of therapy, therapy activities and their targeted goals, and observed progress. Similarly, clinical notes or logs have rarely been shared openly with parents or clients. A new frontier in personalized and participatory medicine, including rehabilitation, would include ways to share treatment progress notes and use them as a basis for ongoing adjustments to therapy and future planning for transition activities after P–CIMT ends.

The relatively new international journal *Implementation Science* (2013), launched in 2007, supports a growing concern that many research findings that could improve health and functional outcomes are not being implemented in a timely and effective manner to yield the intended benefits in routine health care clinical, organizational, and policy contexts. Thus, scientific methods are now being applied to study how to improve the "update" and "scale-up" from discoveries such as those represented in this book. (For two excellent resources about the field of implementation science, see Brownson, Colditz, & Proctor, 2012, and Kelly & Perkins, 2013.) The following quotation from *Implementation Science* (2013) underscores the urgent need in this field:

> Biomedical, social science, organisational, and managerial research constantly produce new findings—but often these are not routinely translated into healthcare practice. Implementation research is the scientific study of methods to promote the systematic uptake of proven clinical treatments, practices, organisational, and management interventions into routine practice, and hence to improve health. In this context, it includes the study of influences on patient, healthcare professional, and organisational behavior in either healthcare or population settings.
>
> The lack of routine uptake of research findings is strategically important for the development of healthcare because it clearly places an invisible ceiling on the potential for research to enhance health. Further, it is scientifically important because it identifies the behaviour of healthcare professionals and healthcare organisations as key sources of variance requiring improved empirical and theoretical understanding before effective uptake can be reliably achieved.

One key aspect of understanding how effectively new discoveries are translated into routine rehabilitation for large populations requires systematic documentation of how these discoveries are specifically used for individual clients. This documentation can be facilitated through the establishment of clinical research networks that involve partnerships among practitioners, clinics or organizations, and investigators. Even without a supportive infrastructure, individual practitioners and practices can develop their own methods for uniformly recording the ways in which they intend to implement (i.e., operationalize) each of the five essential components of P–CIMT and the extent to which the intended treatment plan is fulfilled, using a combination of daily therapy logs, photos or videotapes, and direct measures of treatment and treatment progress.

These documentation strategies benefit clients immensely when individual practitioners also record the challenges and obstacles encountered, and describe the ways they try to solve them. Frequently reviewing and sharing (usually in abstracted and condensed forms) these fidelity of implementation documents with others in a professional network increase the opportunities to accelerate learning about variations in effective implementation and may help prevent some of the difficulties anticipated or encountered. Table 7.2 provides key topics to cover when documenting P–CIMT treatment protocols and fidelity.

TENSION BETWEEN THE IDEAL AND PRACTICAL: STRATEGIES FOR PROVIDING SIGNATURE P–CIMT TO CHILDREN OF DIFFERENT AGES, TEMPERAMENTS, AND FUNCTIONAL LEVELS

The response from professionals to the early reports of case histories and the smaller scale randomized controlled

Table 7.2 KEY TOPICS TO COVER WHEN DOCUMENTING P–CIMT TREATMENT PROTOCOLS AND FIDELITY

P–CIMT ELEMENTS	KEY TOPICS DOCUMENTING THERAPY PROTOCOLS AND FIDELITY
1. Constraint of less-impaired UE	• Type of constraint • Duration of use • Schedule for removing and checking (only if full-time constraint is used)
2. High therapy dosage in concentrated period	• Duration of each therapy session • Total number of therapy sessions • Sessions per week and number of weeks (exact calendar schedule) • Summary • If any sessions were missed or shorter, were compensatory make-up sessions scheduled? If so, when did they occur?
3. Formal shaping and massed and varied repetitive task practice	• Therapy goals • Number and type of activities shaped • Types and schedules of reinforcement used • How often activities shaped • Number and types of activities practiced • How often activities practiced
4. Natural and diverse settings	• Settings in which treatment is provided
5. Transition and posttherapy planning	• Number of posttherapy unilateral activities identified to be completed with impaired UE • Number of posttherapy bilateral activities identified • Types of communication and future planning with parents and family • Types of communication, coordination, and future planning with other professionals treating the child

Note. P–CIMT = pediatric constraint-induced movement therapy; UE = upper extremity.

trials of signature P–CIMT was in many ways surprising. Rather than enthusiastically embracing the results, many practitioners responded with strong concerns and criticisms. Some comments included "This would be too demanding and stressful for both the children and the families," "The costs of this therapy would be excessive," and "We already have an inadequate workforce to serve young children with neuromotor disabilities, and this high-intensity treatment would mean that many children would not receive treatment at all."

These initial cautionary reactions represented an understandable tension for many dedicated practitioners who functioned within existing service delivery systems over which they had little control and that often were slow to change. In fact, the practical and logistical issues do not represent insurmountable challenges; similarly, the costs of high-intensity therapy that produces measurable improvement in outcomes can be well-justified on clinical and ethical grounds, whereas continuing the status quo of providing treatments of a type or dosage that does not produce comparable benefits is far more questionable.

As mentioned earlier in this chapter, providing high-intensity therapy of 3 hours or more per day for many days per week and multiple weeks is difficult, because the family and the child must find sufficient time to dedicate to this. Summers and school breaks often are excellent times for school-age children. However, even when children are attending a day program, practitioners and families often can find time sufficient for the therapy (such as from 3 p.m. to 6 or 8 p.m. on school days, or divided between an early morning session of 1 or 2 hours and then receiving the remaining therapy hours after school and during dinner and family evening times at home). Many families have succeeded in working closely with their child's school to have a 1-month break, obtaining school assignments in advance, some of which can be built into the P–CIMT therapy activities.

Practitioners have an undeniable need for maintaining high stamina, that is, the focused energy to remain engaged in providing therapy. They also must encourage the child's interest level and monitor for signs of fatigue or possible

distress that would require shifting activities and communicate with the child's parents, who may be present for part or all of the lengthy therapy session. Stamina is needed to provide high-fidelity delivery of the signature form of P–CIMT. Clearly, the practitioner is required to be just as busy and engaged as the child is, sometimes for 6 hours a day or more. Therefore, the practitioner needs to be well rested, well prepared with ideas and supplies for the therapy activities, and well nourished (bringing food and beverages to the setting where the P–CIMT is given). Interruptions such as phone calls or e-mail exchanges are highly disruptive to therapy sessions, so the practitioner also needs to be sure communication with others is handled before or after therapy.

For one of the signature forms of P–CIMT, known as **ACQUIREc therapy** (DeLuca et al., 2007), practitioners often need to spend up to 8 hours in the child's home, because he or she needs to have breaks and child rest or nap times built into the full day. The ACQUIREc practitioner sometimes divides the 6 hours of therapy into 2 separate sessions, one provided in the morning and the other in the afternoon or early evening. For practitioners who have become accustomed to working in 1- or 2-hour sessions, with a break between sessions, providing high-intensity therapy is really a new endeavor. Fortunately, for many practitioners, after several months of this type of schedule, they report experiencing very high rewards through documenting the child's rapid progress, and find the schedule far easier. Not only can children become fatigued, bored, and frustrated, but also practitioners can if they are not well-prepared and mentored.

In addition to surmounting the stamina demands for individual practitioners, most clinics or organizations throughout the world have been designed to provide relatively brief (usually 1-hour) sessions to clients, which is the greatest barrier to widespread provision of high-intensity P–CIMT, thus making it administratively prohibitive to determine how a practitioner can be "reassigned" to work with only 1 or perhaps 2 children for many weeks, often all day. One solution is for P–CIMT practitioners can commit to certain time periods when they provide P–CIMT and in the other months, they can do follow-up or work with children who need relatively short-term therapy. Summer months are ideal for many school-based practitioners to offer P–CIMT to several children individually or to participate in local P–CIMT summer camps that last from 1 to 3 weeks in collaboration with other practitioners and supportive staff and volunteers.

Designating a specialty clinic within a larger pediatric rehabilitation clinic focused on serving children exclusively with forms of evidence-based P–CIMT (adhering to the five core components) has been ideal. Working business models are available, and practitioners can increasingly anticipate that insurance companies will reimburse fully for the forms of P–CIMT that conform to the tested protocols and for which the clinic collects evidence about effectiveness. Fortunately, the core component of delivering the therapy in natural environments means that practitioners do not need to occupy large amounts of space in formal clinics. Similarly, with the exception of the constraint supplies, many of the toys, games, and everyday activities for the long daily therapy sessions already exist in the child's home and in the community.

Becoming a P–CIMT specialist may be ideal for practitioners who prefer working only part-time—somewhere between 50% and 75% time—or for those who would like to have school vacations and summers off. They could schedule their work to accommodate their own personal or family calendars.

HOW TO KEEP A CHILD ENGAGED IN HIGH-INTENSITY THERAPY

For children who are naturally active, curious, and playful, the best form of P–CIMT feels a lot like their everyday lives. Of course, they are being asked to exert new effort and try new activities that are not easily achieved at first, but if an activity is truly interesting and fun, many children are naturally prepared to stick with it. No doubt, there are moments of frustration and a desire to take a rest. The practitioner's energy and good-natured encouragement contribute to a highly positive environment, for most of the time, for children.

Some children do better without their parents directly observing or participating, at least during the early phase of P–CIMT, although some do well with their parents. Parents often "sympathize" in ways that are emotionally challenging when they observe the practitioner engaged in what used to be called *forced use*. **Forced use** refers to the expectation that a child must use the more-impaired UE to complete a task, such as when a skilled practitioner repeatedly insists that the child continue to stay engaged with a task (e.g., "Keep reaching as far as you can, for just a few more times," "I know you are getting a little tired, but do you think you can try to do this again until you can pop 3 bubbles in a row? I will help you keep count," or "This is like getting ready for the Olympics. Let's see what happens if you do this again, just using your [right/left] hand to hit the drum"). Experienced P–CIMT practitioners share that this strong encouragement is very similar to what parents, teachers, and therapists encounter with children in almost all areas of life, when children themselves may show an ever-changing mix of eagerness to try some new and difficult tasks followed by wanting to go back to the old and easier way of doing things.

When practitioners plan for each day and week of therapy and also maintain logs of the activities they engage in and how they relate to the overall goals for a child, they become better

prepared to introduce new and varied activities for both new learning and repetitive practice based on previous activities. Not surprisingly, even very young children can help shape the day and find new things to do that allow them to keep practicing without becoming overly fatigued or bored.

By building on the natural rhythms of the day and taking advantage of the season of the year, many forms of self-care and playful engagement can cause the day to fly by—especially when the practitioner has become highly familiar with how to apply the shaping techniques to almost any activity that occurs. Breaks are important, but they usually are not really breaks from therapy because they involve shifting activities, using different objects and reinforcers, moving to new places, and changing the tone—from more concentrated hard work to sometimes practice and review of something learned earlier or yesterday—or taking on one very difficult task before having a real rest period.

SUMMARY

P–CIMT appears to be a compelling approach to rehabilitation for children with hemiparesis; it often produces significant and clinically meaningful improvements in children's abilities to use their arm and hand in a relatively short time period. In addition, it has been demonstrated that P–CIMT can be implemented in a variety of community and clinical settings; however, there is an urgent need for P–CIMT as an entire treatment package of operationalized componential parts to be explicitly defined and systematically documented.

This chapter identified and operationalized the componential parts that, to date, are distinctive features of the P–CIMT package. The wide range of studies with varying levels of evidence are both the basis for and a demonstration of the need for these definitions. These contradictory yet complementary positions represent, for us, part of the overall scientific process in the development of P–CIMT. It is crucial that rehabilitation treatments follow a trajectory of scientific evidence as they are developed and tested in today's health care arena, which requires evidence-based practice with considerations for efficacy and timely implementation. We hope that this chapter provides guidance for defining the core components and underscores the importance of documentation of both the treatment planned and the treatment delivered.

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