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Constraint-Induced Therapy: Remediation of the Upper Extremity and Its Application in Occupational Therapy

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CONSTRAINT-INDUCED THERAPY: REMEDIATION OF THE UPPER EXTREMITY AND ITS APPLICATION IN OCCUPATIONAL THERAPY

A Scholarly Project

by

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TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Introduction

Stroke is the third leading cause of death in the United States, compiling of more than 500,000 new strokes taking place each year (Banasik & Copsted, 2000). Of these people who have experienced a stroke, 150,000 survive and there are approximately 4 million people in the United States today who have experienced a stroke (Banasik & Copsted). Among long-term survivors (>6 months), 48% have hemiparesis and 53% cannot perform activities of daily living skills (ADLS) independently (Banasik & Copsted).

One of the most widely accepted definitions of stroke is “a loss of brain function caused by disruption of the blood supply, usually leading to permanent sensory, motor, or cognitive deficit” (Bear, Connor & Paradiso, 2001) or is also referred to as a “brain attack.” More and more individuals are surviving strokes each year due to better acute care, reduced stroke severity, as well as earlier and more accurate diagnosis, but stroke survivors continue to experience significant physical disability after traditional rehabilitative therapies have plateaued (Gresham, Duncan, & Stason, et al., 1995).

Because clients that have experienced a stroke feel as though there are not other options after discontinuation of treatment, further research and protocols must be specifically designed to address this need. Constraint-induced therapy (CIT) (as presented by Taub and Wolf) is an option for remediation of the affected upper extremity post-stroke and further analysis of this therapy must be made to help clients reach their maximal physical potential.

Constraint-induced Therapy

An occupational therapist's focus for clients who have experienced a stroke is to help them reach their maximal functional level of independence. One method of intervention in this process is through constraint-induced therapy (CIT) and its remediation of the upper extremity.

This new and highly researched type of therapy is currently under utilized across the nation because of the lack of education on this subject, along with the lack of knowledge on how to implement constraint-induced therapy into current stroke rehabilitation programs.

Constraint-induced therapy can be described as a strategy used to engage clients in activities that prohibit overcompensation with the non-affected or less affected upper extremity, which forces the more affected limb to be utilized (Woll and Utley, 2001). CIT has been organized into a variety of rehabilitation interventions and requires specific activities that force the central nervous system into reorganization/neural plasticity. By the completion of CIT, the client may be able to conquer learned non-use through these activities that are practiced continuously and carefully monitored by the therapist to acquire maximal results.

Through this scholarly project, a comprehensive literature review will be compiled. Articles and information will be accumulated from various medical journals, and medical textbooks, creating a broad perspective from all aspects of medicine and rehabilitation. This background information will focus on the strengths and weaknesses of constraint-induced therapy, as well as the most effective execution of this type of therapy into hospital and rehabilitation settings. Also, successful clinical examples of CIT programs integrated into the rehabilitation continuum will be incorporated into this project. This will give a "working perspective" of how a program is managed at a facility and will examine the different aspects of constraint-induced therapy that are integrated into functioning programs.

By organizing and bringing together this combination of both the medical research perspective and professional occupational therapist applications, a thorough analysis of constraint-induced therapy for the upper extremity can be made. Clinical guidelines on implementing this type of program into a hospital or rehabilitation setting will also be presented in an easy to read booklet. First in this booklet, a theoretical orientation of constraint-induced therapy will be explained. Criteria for inclusion into the CIT program will be described, as well as goals for the program. Location and environment of the program, inclusion criteria, methods of referral, group size, termination from the group, and the target population will be offered, along with group formats and activity samples. Occupational therapists can utilize this information to better serve their clients that have experienced a stroke by trying a new and effective approach to upper extremity remediation.

Terminology

For a thorough understanding of the presented material of the scholarly project, the following terminology and understanding was used throughout the project.

AAUT - Actual Amount of Use Test examines the actual use of an upper extremity by rating 21 items. It looks at frequency of arm use, and quality of movement (Kunkel, Kopp, Muller, Villringer, Taub, and Flor, 1999).

ADL - Activities of Daily Living are basic activities participated in daily and include eating, grooming, bathing, dressing, and community mobility (Aquaviva, 1996).

AMAT - Arm Motor Ability Test assesses the motor ability of the hand and arm function during ADL tasks. Speed of task performance, as well as functional ability and quality of movement is recorded (Kunkel, et al., 1999).

ARA- Action Research Arm Test is a 19-item test divided into 4 categories (grasp, grip, pinch and gross movement), with each item graded on a 4-point ordinal scale (0 = can perform no part of test, up to 3 = performs test normally)(Page, Sisto, Levine, Johnston and Hughes, 2001).

BI - Barthel Index measures basic activity of living function (Domerick, 2000).

CIT - Constraint-induced therapy is a form of "forced use," discouraging the use of the unaffected extremity by restraining it in a mitt and encouraging active use of the hemiplegic arm to maximize or restore motor function (Domerick, Edwards, and Hahn, 2000).

FIM - Functional Independence Measure is a functional measure that focuses on 18 items in the areas of self-care, sphincter control, mobility, locomotion, and communication and social cognition. It is a measure of disability and is most useful for description of disability (Banasik, and Copstead, 2000).

Learned non-use - substantial neurological injury to a limb leading to depression in motor and/or perceptual function resulting in reduced ability to move affected limb (Page, Sisto, Johnston, Levine, and Huges, 2002).

MAL - Motor Activity Log is a semi-structured interview measuring how patients use their affected limb for activities of daily living in the home (Page, et al., 2002).

Shaping - Continuous extension of motor capacity by increasing a small increment beyond the performance level already achieved (Miltner, Bauder, Sommer, Dettmers, and Taub, 1999).

Stroke (or cerebrovascular accident, CVA) - loss of brain function caused by disruption of the blood supply, usually leading to permanent sensory, motor, or cognitive deficit (Bear, Connor, and Paradiso, 2001).

WMFT - Wolf Motor Function Test is used to measure the ability of patients to perform 19 simple limb movements and tasks with the affected arm. Two items measure strength and 17 items are timed and scored (Page, et al., 2001).

In Chapter I, information on stroke and constraint-induced therapy is presented. Also provided is the background for why constraint-induced therapy is underutilized in rehabilitation programs, as well as the anticipated product of this project. The terminology utilized throughout has been identified and defined. Chapter II focuses on the review of literature on CIT in both standard and modified protocols. Neural reorganization and constraint-induced therapy, clinical considerations for administration, and client and therapist perceptions of CIT are examined. This literature serves as the basis and formulation of the presented modified constraint-induced therapy program, which is presented in Chapter III. The project's limitations and clinical implications are offered in Chapter IV, with final recommendations and summary revealed in Chapter V.

CHAPTER II

REVIEW OF LITERATURE

In recent years, the research on constraint-induced therapy has grown, and because of this abundance of information, boundaries were set to review the literature presented. Chapter II begins with the summarization of standard constraint-induced therapy research and then moving to modified CIT examination. A through understanding of the varieties of constraint-induced protocols used must be appreciated to strengthen the following sections of the literature review.

The subsequent section includes the neural reorganization of the brain and constraint-induced therapy, which supports the efficacy of this program. Also presented are clinical considerations for administration of a CIT protocol. Included within this review is compliance for mitt adherence and the client's awareness of their deficits and their motivation to participate in the protocol.

Research focusing on the therapist and client perceptions of CIT is examined to understand the negative and positive points of view on this new therapy. Following up the literature review are conclusions made based on the presented information after a thorough analysis was made.

Standard constraint-induced therapy research

Freeman (2000) took an in-depth look at neurophysiological theories and their effects on motor recover and unilateral spatial neglect of the affected upper extremity is examined. He also studied how constraint-induced therapy could be integrated into occupational therapy practice by reviewing Taub and Wolf's pilot study on this subject.

As reported by Freeman (2000), Taub and Wolf's research consisted of nine patients who had experienced a stroke (>1 year) and were randomly assigned to an experimental group (4 patients) and a control group (5 patients). The experimental group's unaffected upper extremity was restrained during waking hours for 12 successive days, receiving therapy 7 hours a day during the week (Monday-Friday). The control group also received therapy for this same amount of time, but the focus of intervention was on the use of the hemiplegic arm, and restraint of the unaffected limb (Freeman).

Following the research project, the experimental group displayed an increase of 38% on movement tasks using the hemiplegic arm and a 28% improvement during activity of daily living tasks (Freeman, 2000). Meanwhile, the control group displayed no noteworthy improvements. A two-year follow-up was collected of these same participants. Gains from the participants who had partaken in the experimental group maintained these same results. Results demonstrated a 97% increase in the number of activities that the participants were able to take part in after treatment as opposed to before treatment (Freeman).

Additional research was completed using the standard constraint-induced therapy protocol. Kunkel, Kopp, Muller, Villringer, Villringer, Taub, and Flor (1999) completed research to investigate the effects of this therapy using pre-treatment and post-treatment measures and a 3-month follow-up after the constraint-induced therapy protocol were completed.

The researchers recruited five chronic stroke patients (median time after stroke was 6 years), each displaying moderate motor deficits. All participated in constraint-induced therapy for 14 days (10 days of actual therapy, 6 hours each day), wearing a sling on their nonaffected hand for 90% of waking hours. During therapy, the focus was on repetitive, purposeful tasks that included shaping (Kunkel, et al., 1999).

There was a considerable amount of improvement among all subjects in the results of the Arm Activity Ability Test (AMAT) and Wolf Motor Function Test (WMFT), especially in the performance of activity time and in the quality of the movement (increase of 124%). Also, when examining the utilization of the affected extremity in "real world" situations using the Actual Amount of Use Test (AAUT), the results presented an increase of 98% (Kunkel, et al., 1999).

Through this study there is evidence that people with chronic strokes can decrease deficit of their affected upper extremity by means of constraint-induced therapy. It is not likely that the participants displayed improvement due to spontaneous progress in motor function since they were all post-stroke several years. The 3-month follow-up demonstrated improvements were retained, which suggests that constraint-induced movement therapy could have a long-term treatment effect (Kunkel, et al., 1999).

van der Lee, Wagenaar, Lankhorst, Vogelaar, Deville, and Bouter (1999) also wanted to explore the possibility that constraint-induced therapy implemented for two weeks was more effective than the more popular and widely used Neuro-Developmental Treatment (NDT) in the same amount of time. Sixty-six chronic stroke patients (median time since stroke onset was 3 years) participated. The NDT and constraint-induced therapy groups each received verbal feedback, stimulation, and, if necessary, hands-on facilitation of movements and inhibition of inappropriate muscle contraction during treatment sessions.

In all areas, except for the quality of movement using the Motor Activity Log, conditions in the constraint-induced therapy group improved more than the group that received NDT techniques. This was also true in the Action Research Arm test (95% CI, 1.3 to 4.8), which also displayed similar results one year later (van der Lee, et al., 1999).

Constraint-induced therapy has many studies confirming that it produces increases in the amount and quality of the affected arm use after a stroke (> 1 year), but each of these studies have been completed in America. The focus of the study by Miltner, Bauder, Sommer, Dettmers, and Taub (1999) was to see if these same results could be replicated in Germany, where there is a different healthcare system and a different treatment approach to remediation of the upper extremity post-stroke.

The patients displayed significant improvements in all areas of testing (Motor Activity Log: F_{AOU} (1,11)=121.9, P<0.0001; F_{QOM} (1,11)=154.74, P<0.0001, and Wolf Motor Function Test: F_{FA} (1,8)= 10.00, P<0.02; F_{QOM} (1,8)=22.84, P<0.0015; F_{time} (1,1)=4.54, P=0.076). The results displayed that the scores for the MAL did not change significantly between post-4 weeks and 6-month follow-ups, indicating sustained results. The WMFT and the Arm Motor Ability Test displayed similar results, displaying consistent results (Miltner, et al., 1999).

These results provide a foundation that constraint-induced therapy could be replicated and used in other countries, such as Germany. Countries around the world have a different focus on healthcare and rehabilitative treatment, but positive results with constraint-induced therapy continued. This intervention displays versatility and can be carried out in a variety of settings and locations.

Miltner, Bauder, Sommer, Dettmers, and Taub (1999) also illustrate through their results a prolonged effect of constraint-induced therapy compared to NDT according to the ARA test. This challenges NDT's original theory that motor return after a stroke can only happen within the first year.

Neural re-organization and constraint-induced therapy

Cortical reorganization of the brain after a patient has participated in constraint-induced therapy has been a new area of research. This analyzed information displays positive findings. Results imply that CIT can cause neural re-organization of the brain and therefore, provides a foundation for constraint-induced therapy providing longer lasting and more effective results for patients who have experienced a stroke.

An additional pilot study takes these findings a step further, not only examining constraint-induced therapy for chronic upper extremity stroke hemiparesis, but also to see the neural correlates of recovery with functional magnetic resonance imaging (MRI) (Levy, Nichole, Schmalbrock, Keller, and Chakeres, 2001).

The participants were at least 3 months post stroke and were discharged from traditional therapy due to a plateau in progress. The Motor Activity Log and the Wolf Motor Function Test were administered at both baseline and after the completion of training. Compared with baseline, the performance time of the WMFT improved an average of 24% immediately after the completion of constraint-induced training and continued to improve to 33% during a 3-month follow-up (Levy, et al., 2001).

A MRI also was administered. After constraint-induced therapy training, both subjects displayed an increase of activation in the brain. There was an increased amount of

activity bordering the lesion, bilateral activation in the association motor cortices and ipsilateral activation in the primary motor cortex (Levy, et al., 2001).

These results indicate that the participants experienced improvements of motor function in the paretic upper extremity in response to constraint-induced therapy, even though they both displayed no further improvements with traditional therapy. This shows that not only does constraint-induced therapy improve the function and everyday use of
the affected upper extremity, but it also demonstrates plasticity of the brain in the recovery of people who have experienced a stroke.

There are numerous studies on the cortical reorganization of the brain after an injury, but there is limited information on treatment-induced plastic changes in the brain. A study by Liepert, Bauder, Miltner, Taub, and Weiller (1999) focused on examining the reorganization of the motor cortex in stroke patients that were participating in constraint- induced therapy.

In order to test this hypothesis, the researchers used focal transcranial magnetic stimulation (TMS) to map the cortical motor output area of hand muscles (on both sides) before and after 12 days of constraint-induced therapy. These results displayed positive findings. Constraint-induced therapy presented large improvements in motor functions from day 1 before treatment to 1 day after treatment ($t_{12} = -12.781$, $P<0.0001$). Eight subjects participated in both 4-week and 6-month follow-ups that illustrated that the change acquired after treatment had not declined (Miltner, et al., 1999).

After analysis of the TMS, the area of the cortex that presented a response of the involved hand muscle to the stimulation of the contralateral hemisphere was also encouraging. One day before constraint-induced therapy treatment was initiated, there was 40% fewer active positions in the infarcted hemisphere than in the noninfarcted hemisphere. The first day after treatment presented 37.5% more active positions in the infarcted hemisphere than in the noninfarcted, reversing the roles (Miltner, et al., 1999).

These results demonstrate a near doubling of activity in the excitable cortex (Miltner, et al., 1999). This produced more motor response in the affected hand of the patients after constraint-induced therapy was utilized. Because a larger and more prominent area of the brain displayed activity during hand movements, it was suggested that this reorganization occurred on a cortical level (Miltner, et al., 1999). Constraint- induced therapy, which promotes functional arm movements, also produces cortical reorganization of the brain and may help with the treatment of stroke being longer lasting and more efficacious.

Modified constraint-induced therapy research

This information is particularly important because it challenges Taub’s original research on constraint-induced therapy approaches. It scrutinizes the criteria needed for a patient to participate in this new rehabilitation program and the way the protocol is presented. Through this research, constraint-induced therapy can be opened up to a larger population of people who have experienced stroke by experimenting with different subjects.

Dromerick, Edwards, and Hahn (2000) examined the possibility of using constraint-induced therapy of the upper extremity 2 weeks after the onset of a stroke. Within this research study, it compared the effectiveness of constraint-induced therapy to traditional occupational therapy rehabilitation methods. Many occupational therapy treatments for the hemiplegic upper extremity concentrate on compensatory techniques, and remediation is seen as secondary to the promotion of independence in activities of daily living (Dromerick, et al., 2000). Constraint-induced therapy, in contrast, concentrates on the restoration and remediation of the limited upper extremity. This pilot study revealed the possibility that constraint-induced therapy could be utilized by occupational therapists during the acute phase of rehabilitation in attempt to overcome learned nonuse and increase remediation of the upper extremity.

Two groups (control and experimental) participated in this study. Each group received the same number of therapy sessions (2 hours per day, 5 days per week, for 2 consecutive weeks), individualized and circuit training techniques, and initiated treatment on rehabilitation day 3 according to protocol (Dromerick, et al., 2000).

Participants in the control group received standard occupational therapy treatment. Its focus was on compensatory strategies, upper extremity strength, range of motion and positioning. In contrast to the experimental group, which wore a padded mitt 6 hours per day, the control group focused on ADLs, upper extremity exercise that included the affected limb as much as possible, repetitive functional tasks and circuit training (Dromerick, et al., 2000).

Results were calculated comparing the Action Research Arm Test (ARA), the Functional Independence Measure (FIM) and Barthel Index (BI) prior to and after treatment for both groups. After fourteen days of treatment, the participants that partook in the constraint-induced therapy (experimental) group displayed significantly higher scores in the ARA compared to the control group ($F_{1,15}$=11.70, P<0.003). There were no significant differences in the BI scores at discharge, but the FIM scores presented higher scores for the experimental group, especially in upper extremity dressing (t=2.16, P<0.04) (Dromerick, et al., 2000).

In another research study of acute recovery application of CIT, Blanton and Wolf (1999) examined the utilization of CIT as soon as four months after the occurrence of stroke, while adhering to the standard mitt and exercise schedule of the standard constraint-induced therapy protocol. Researchers wanted to examine the possibility of this type of therapy earlier in a person's stroke rehabilitation, trying to gain more independent function for the patient as well as attempting to overcome nonuse earlier than previous studies have examined. Coupling two weeks of constraintment of the non-impaired upper extremity, along with the practice and repetition of functional and purposeful movements of the limited upper extremity, may be a helpful and possible solution to remediation of the arm in as little as 4 months.

The results suggested that the participant improved in the Wolf Motor Function Test, comparing the scores from both pre-treatment to post-treatment, and post-treatment to 3-month follow-up. The Motor Activity Log also displayed improvements, engaging the participant's affected upper extremity in more activities, as well as improvements in how well she performed while engaging in these same activities (Blanton & Wolf 1999). Even though this study included only one subject, it indicates the need for further research in the use of constraint-induced therapy with patients who have experienced a stroke prior to one year.

A further study inspected the effectiveness of a modified constraint-induced therapy protocol administered to a patient who had experienced a stroke less than one

year. Page, Sisto, Johnston, Levine, and Huges, (2002) examined the effect of this therapy within 5 months post-stroke.

The patient met the inclusion criteria, which was the same criteria used in previous standard CIT studies. Because most outpatient stroke therapy is covered by Medicare, the researchers decided to structure their intervention to fall within the 30-session limit and the participant was involved in occupational therapy and physical therapy 3 times a week, 30 minutes each, for 10 weeks. In addition, the participant's nonaffected upper extremity was restrained every weekday for 5 hours. These hours of restrainment were initially identified as the patient's time of most frequent arm use, and restrainment resulted in 250 hours during the 10-week period. This can also be compared to the traditional CIT protocol indicating 140 hours of upper extremity restriction.

After intervention, results demonstrated a 6-point improvement on the ARA and a 20-point improvement in the FMA. MAL scores also improved between the pre and post testing sessions (4.3 compared to 3.0 and 2.2 on a 5-point scale)(Page, et al., 2002). The WMFT displayed improvements in both the ability to perform a task, and the time taken to complete a task. The participant also showed an increased ability to move her affected upper extremity out of synergy and improvements in fine motor control (Page, et al.).

Likewise, Page, Sisto, Levine, Johnston, and Hughes (2001) wanted to examine the effects of a modified constraint-induced therapy protocol on six patients between 2 and 6 months post stroke. Two patients participated in half-hour physical and occupational therapy sessions 3 times a week for 10 week, two other patients participated in constraint-induced therapy and the last two received no therapy.

The participants that were included in the constraint-induced therapy group displayed improvements on the FMA, ARA, and WMFT. The MAL confirmed that the patients improved in the quality of and amount of affected limb use (Page, et al., 2001). The patients that participated in the traditional therapy group, as well as the group that received no therapy, displayed no improvements (Page, et al.).

For many patients post-stroke, CIT may not always be an easy option. Practice schedules, extensive wearing of restrictive mitts, and poor reimbursement all contribute to the hesitancy to use this new type of the therapy. Even though the CIT protocol has numerous studies that show the efficacy of the program, it may be challenging to complete due to restricted reimbursement from managed care plans. Through a modified constraint-induced therapy program, which could possibly be more realistic to implement in the clinic, patients can make functional gains of patients, as well as overcome learned nonuse. *Clinical considerations for administration of a CIT protocol*

Another aspect that needs to be considered in the successful implementation of a constraint-induced therapy program is the assurance that the participants will adhere to the wearing of the mitt. A variety of interventions must be used to find the most accurate way for a client to participate in the protocol.

Researchers have experimented with many different interventions to alleviate this

potential problem. The participants were required to use an activity log in many of the studies (Freeman, 2000; Levy, Nichole, Schmalbrock, Keller, & Chakeres, 2001; Page, Sisto, Johnston, Levine, and Huges, 2001, & 2002). This log expected each person to write down the exact time that they wore and removed the mitt during home hours. Many of the studies required the participants to wear the mitt for 90% of the day, for 14 consecutive days, taking it off for bathing, using the restroom or any other activity that would jeopardize safety without use of the unaffected limb (Freeman; Levy, et al.;
Page, et al.).

Researchers Page, Sisto, Johnston, Levine, and Huges, (2002) established a different focus to ensure patients were wearing the restrictive mitt. They concentrated on the adherence to the protocol by completing in-clinic interviews every 2 to 3 weeks, and weekly calls to the participant's home. These combined methods produced positive results.

The study by Levy, Nichole, Schmalbrock, Keller, and Chakeres (2001) also produced positive results with their interpretation of mitt adherence. A behavioral contract was established between the therapist and client. The client had promised, in writing, to follow the wearing schedule throughout the entire treatment phase.

Also, a specific wearing schedule was implemented. The client had specific guidelines when to precisely wear and not wear the mitt. A list of requirements and specifications was presented.

In research by Miltner, Bauder, Sommer, Dettmers, and Taub (1999), the importance of education and including the client's significant other and family in the wearing mitt schedule was accentuated. Their input on usage and quality of the affected arm usage was also incorporated into the study.

Freeman (2000), along with a study by Blanton and Wolf (1999) focused on the importance of the client's awareness of deficits and limitations. Those who are not aware of restrictions or are not motivated for intervention are cautiously considered for participation in this extended, and restrained, but beneficial treatment.

Therapist and client perceptions

In a study presented by Page, Levine, Sisto, Bond and Johnston (2002), the researchers explored what patients who had experienced a stroke and their therapists thought about the standard constraint-induced therapy protocol as offered by Taub. The patients that were polled presented a variety of concerns. Sixty-eight percent of patients stated that they would not participate in constraint-induced therapy, and sixty-five percent reported they were "somewhat unlikely" or "not at all likely" to wear the restrictive mitt as prescribed independently. Of the individuals that stated that they would participate, the logistical aspects of constraint-induced therapy were of greatest concern. The patients that stated that they were not likely to participate in constraint-induced therapy presented: 1) "length of time wearing the restrictive mitt" (68.5%), and 2) "number of days in therapy" (60.1%) and 3) "number of hours in therapy" (63.6%) as the biggest barriers to participation. Over 54% of the patients questioned were "somewhat unlikely" or "not at all likely" to make all therapy sessions, and 50.8% reported they would be "somewhat unmotivated" or "extremely unmotivated" to participate in constraint-induced therapy sessions (Page, Levine, Sisto, Bond & Johnston, 2002)

Eighty-three percent of these same patients stated that they would consider constraint-induced therapy if there was an alternative or modified version available. The participants requested a protocol to offer similar results and benefits without the restrictions (e.g. length of time practicing each shaped task) (Page, Levine, Sisto, Bond & Johnston, 2002).

Researchers of the motor learning theory suggests this to be a realistic possibility and have found through research that many different practice schedules of exercises can and will produce the same outcomes (Page, et al.). Data also presents that repeated, functional arm use during therapy displays positive results, even during shorter treatment sessions, over an extended period of time (Page, et al.).

Therapists also displayed similar concerns. Over 68% replied that when comparing constraint-induced therapy to other protocols, that it would be “very difficult” or “difficult” to administer (Page, Levine, Sisto, Bond & Johnston, 2002). They also reported the most challenging aspect of the protocol would be having the patients participate in a challenging 6-hour protocol daily (Page, et al.).

Other concerns the therapists presented were the patient’s safety, and the inducement of fatigue. Sixty-eight percent of the therapists highly assumed that constraint-induced therapy would not be covered through the United State’s managed care programs, while another 85.9% reported their facility did not have the supplies or resources to administer this protocol (Page, Levine, Sisto, Bond & Johnston, 2002). Time restraints, and the impact on the rest of their caseload would also make therapists hesitant to administer the constraint-induced therapy protocol (Page, et al.)

Each of these concerns could be addressed and overcome in a modified constraint-induced therapy protocol. To ensure the satisfaction of both the therapist and the client, these adjustments can be integrated into a program. These are of utmost importance in the formulation of a program to address the needs and wants of those participating.

Conclusions

Studies suggest that the standard constraint-induced therapy protocol is an effective method for the remediation of the upper extremity. It improves the motor function and the use of the upper extremity effected by rising above learned nonuse of that arm and inducing use-dependent cortical reorganization. This differs from conventional rehabilitation approaches where the focus of intervention is on the use of substitution, compensation and concentrating on the "true" recovery of the stroke. It also serves as an alternative treatment method for the patient after he or she has plateaued from traditional rehabilitative methods.

However, a modified version may be used in place of the standard constraint-induced therapy protocol and still produce similar, successful results. Because research has shown successful results as soon as day 3 post-stroke, and up to many years later, this method could be implemented at various times throughout a patient's stroke recovery. Changes in the number of days of participation in this method, reducing the number of hours to wear the mitt, and reducing the number of in-therapy sessions could all be modified to create an effective constraint-induced therapy protocol.

Even though there are many concerns about the constraint-induced therapy protocol from both the clients' and therapists' point of view, the research suggests ways to overcome these concerns. Using a variety of methods to ensure the adherence of the mitt schedule could be implemented. Another aspect to consider is modifying the program (length of contact therapy hours, number of sessions, etc.) to increase the likelihood of managed care coverage.

Therapists need to carefully evaluate the motivation behind the patient who is willing to participate in constraint-induced therapy. All safety, cognitive and physical testing must also be completed prior to acceptance into the constraint-induced therapy program. This helps make sure the patient will not only be able to physically participate, but will also adhere to the protocol.

A successful constraint-induced therapy protocol would allow a vast number of clinics to utilize CIT with patients who have experienced a stroke as part of a reimbursable therapy regimen. It would not compromise the patient's overall abilities, staffing, or contact hours in the clinic. Also, each of the concerns of the therapists and clients can be addressed and integrated into the program. Through a modified constraint-induced therapy program, patients can partake in another approach toward the remediation of the upper extremity in order to fully participate in a productive and meaningful life.

CHAPTER III

METHODOLOGY

Overview of the product

Constraint induced therapy is a family of techniques uniquely arranged to engage the client in purposeful activities using the affected limb and restraining the unaffected limb. These combinations of limb restriction, shaping and specifically selected repetitive activities all work together to aid in the brain's neural re-organization and increased use of the affected upper extremity.

Through this scholarly project, a comprehensive literature review was compiled. Articles and information were accumulated from various medical journals, medical textbooks, and literature from a variety of organizations, such as the Neuro-developmental Treatment Association. This created a broad perspective from all aspects of medicine and rehabilitation, including occupational therapy. This comprehensive literature review, along with an in-depth look at "working" constraint-induced therapy models presented in Chapter II supported the development of the following constraint-induced protocol, which is introduced in Chapter IV.

According to the research, suggestions from occupational therapists working with constraint-induced therapy programs, and the knowledge base of occupational therapy's framework domain, each aspect of the modified constraint-induced therapy program was intricately designed and selected. Many of the ideas for the shaping techniques came from the Morris and Taub (2001) and Kunkel, et al. (1999) articles. Inclusion criteria was derived from Taub's original research , found in the work by Kunkel et al., on constraint-induced therapy along with the literature from Page, Sisto, Levine, Johnston, and Hughes (2001, 2002) and Blanton and Wolf (1999). The criteria for the client's mitt adherence stemmed from the works of

Page et al., along with van der Lee, Wagenaar, Lankhorst, Vogelaar, Deville, and Bouter, (1999) and Freeman (2000).

Other literature provided the rationale for the CIT program presented in Chapter IV. Miltner, Bauder, Sommer, Dettmers, and Taub's article (1998) helped provide some ideas for the wearing schedule of the restrictive mitt along with activity ideas. Additional occupational and activity ideas were the original work of the writer of this scholarly project, using her experience and education in activity analysis. Finally, Miltner et al., along with Blanton and Wolf (1999), influenced the overall procedure and necessity of massed practice of the activities.

Trends and constraint-induced therapy

There are a variety of trends in the healthcare system and its use of constraint-induced therapy programs. Currently, this type of therapy is under-utilized across the nation because of the lack of education on this subject, along with the lack of knowledge on how to implement CIT into current stroke rehabilitation programs.

Presently, private medical insurance, or Medicare does not typically cover constraint-induced therapy programs. This presents problems and reluctance to incorporate this type of therapy into rehabilitation programs. Many facilities are attempting to incorporate aspects of or modified versions of constraint-induced therapy into the therapy's present treatment sessions.

Only education and more research can alleviate some of these problems. Through this literature review, constraint-induced therapy has been documented as an effective motor treatment for individuals post-stroke. Trends need to be accelerated to incorporate this type of therapy into rehabilitation programs. Facilities can provide their clients that have experienced a stroke an alternative to treatments that are not as effective or have limited research as to their efficacy, and offer the best quality of care possible.

CHAPTER IV

OCCUPATIONAL THERAPY CONSTRAINT-INDUCED THERAPY PROGRAM

Theoretical orientation

When a person's brain is damaged by stroke, it often becomes more difficult to voluntarily move a limb. The person, therefore, tends to use the affected arm less, which leads to shrinkage of the regions of the brain that controls arm movement. This, in turn, makes the movement even more difficult. This results in a vicious downward spiral, during which the person uses the arm less and less. According to the constraint-induced theory, forcing the use of this affected limb through constrainment of the unaffected arm can reverse this nonuse.

When all traditional therapies have failed and the post-stroke client continues to experience difficulty with upper extremity movements, he or she is unable to complete many of the purposeful activities that they were once able to do. In many instances, these clients have low-level endurance, limited motor movement, decreased quality of upper extremity movement, reduced speed of movements, exhibit decreased strength and cannot achieve the range of motion needed to participate in purposeful tasks. Because of the interruption of their previously "normal" routine, these clients can gain an increased level of independence in many functional activities through the interventions used in constraint-induced therapy. These rehabilitative activities are not too difficult for the post-stroke client's physical capabilities, but it imposes a challenge to promote both physical gains and neurological reorganization. Engaging the client in upper extremity movements alone does not make the activity functional or meaningful, which is why matching the client to the appropriate meaningful task is important. Occupational therapists are a perfect match for providing these therapeutic services and for the implementation of a constraint-induced therapy program.

Through constraint-induced therapy activities, the client can work on range of motion, strength, endurance, quality of movement, speed of the movements, and use of the affected upper extremity in order to regain physical abilities. By participating in the presented constraint-induced therapy protocol, a client can work on all these skills while focusing on the ultimate goal of regaining physical functioning and participate as independently in daily life as possible.

Goals for the clients in the OT constraint-induced therapy program

The client will demonstrate achievement of these goals through observation of the upper extremity in activities of daily living and standardized testing.

1. Client will demonstrate increased active range of motion

2. Client will increase endurance

3. Client will increase strength of upper extremity

4. Client will increase quality of movement

5. Client will demonstrate increased speed while performing activities

6. Client will increase use of affected upper extremity during ADLs

Criteria for inclusion into a constraint-induced therapy group

1. Client must have experienced a CVA resulting in partial of an upper extremity

2. All traditional therapies have not gained desired results

3. The client is motivated for intensive treatment

4. The client must present intact cognition (determined through interview)

5. The client is able to communicate

6. The client's standing and walking balance is intact

7. The client demonstrates 10° active movement in fingers and wrist

8. The client demonstrates 3+ strength in shoulder

9. The client displays no visual-perceptual deficits

10. The client must be experiencing difficulty in one or more of the following areas of the upper extremity:

   a) decreased strength

   b) low endurance

   c) limited range of motion

   d) decreased quality of movement

   e) decreased speed during daily activities

   f) decreased use of affected upper extremity during daily activities

Method of referral into the constraint-induced therapy program

A referral from a doctor is needed for reimbursement of outpatient occupational therapy services. Referrals to the constraint-induced therapy program can also be made by occupational therapists and physical therapists that have previously worked with these clients during their rehabilitation, but with little improvements or plateauing of increased independence as a result.

Procedure for a constraint-induced therapy program

Each constraint-induced therapy session will contain three clients per occupational therapist. The client will attend therapy 5 days a week for 2 weeks and each session will last 6 hours. The first day of the CIT program, the following assessments are to be used at the participant's initial admittance to the constraint-induced therapy program. The client should be re-evaluated using these same assessments at the end of the 2-week period to calculate the gains made throughout the CIT program.

1. Wolf Motor Function Test is used to measure the quality and skill of patients to perform 19 simple limb movements and tasks with the affected arm. Two items measure strength and 17 items are timed and scored.

2. Motor Activity Log is a semi-structured interview measuring how/when patients use their affected limb for activities of daily living in the home

3. Arm Motor Ability Test assesses the motor ability of the hand and arm function during ADL tasks. Speed of task performance, as well as functional ability and upper extremity quality of movement is recorded.

The occupational therapist and client together will decide purposeful activities that he or she would like to engage in. The activities or the environment may be modified by the occupational therapist to provide an adequate challenge for the client. The client is able to take rest breaks as needed to reduce fatigue throughout the day. The clients are encouraged to repeat the activities and/or movements for 15-30 minutes each, until the activity becomes too easy, the client is no longer interested in the activity, or if fatigue has occurred. At this time, an alternative activity that focuses on the same motor movements is encouraged.

One time per week, the constraint-induced therapy participants will partake in an activity within a group environment. This will encourage “real life” use of the affected upper extremity in an enjoyable atmosphere. Each group activity will be discussed and agreed upon by all participants. Each participant will be assigned a task in the activity depending on his or her interests and deficits that need to be focused upon. Possible activities include: cooking a meal, gardening, and a building project. The last day of treatment, the end of the 2 weeks, the client will complete the same assessments as he or she did initially.

Mitt adherence

Faithfulness to the mitt-wear schedule can be difficult for clients to adhere to. The client is required to wear the mitt for 90% of the hours that the client is awake. The mitt is to remain on all of the time except during water-based activities such as bathing, toileting and washing of hands. The mitt may also be removed during times the client feels that it jeopardizes his or her safety while completing an activity such as cooking and driving without assistance.

A number of interventions can be made to help the client to adhere to the mitt schedule.

This also provides reassurance for the occupational therapist that the client is fully participating in the program.

1. Education will be provided. Instruction will be given to the client, the caregiver and family on the program and the importance of the mitt protocol at the beginning of the program.
2. A behavioral contract will be signed. This agreement states that the client fully understands the reasons why the mitt must be worn and will remain faithful to its adherence.
3. The client will complete a daily activity log. This requires the client to document when the mitt was worn and taken off at home each day.

How to implement shaping

Shaping is an integral part of the constraint-induced therapy program. This can be defined as a continuous extension of motor capacity by increasing a small increment beyond the performance level already achieved. To implement shaping into a constraint-induced therapy program successfully, special attention must be made to slowly progress the client's performance in all activities. The following guidelines should be considered when implementing shaping into the CIT program.

- The activities used to involve the client should involve: a) a specific joint and movement that displays deficits, b) the movements that the therapist determines have the greatest potential for improvements, c) an activity that the client finds to be purposeful

- Shaping involves both verbal feedback and reward for participation in and small improvements during the activity
- If the client is displaying difficulty carrying out parts of the movement sequence, the therapist is to help the client engage in the activity by modifying it or participating in hand-over-hand assistance until the client is comfortable continuing independently
- Have the client participate in purposeful activities that are not too difficult for their particular physical capabilities, but also impose a challenge to promote both physical gains and neurological reorganization
- Systematically increase the difficulty level of the activity performed when the client has improved in motor level performance
- Any aspects of the activity can be modified by completing an informal activity analysis of the task and adjust the parameters to increase its difficulty (i.e., the height, speed, placement of the activity, etc.)
- The client's inability to perform certain aspects of the activity is ignored and not reprimanded
- The client is able to change activities if the next activity is focusing on similar movements
- Rest intervals are taken as needed to prevent fatigue

Activity ideas

A variety of meaningful activities can be implemented into the constraint-induced program. The occupational therapist must be able to provide an activity analysis for these activities to match the client's deficits to an activity that specifically addresses them. The selection of daily living skills, leisure, recreational and home management activities are endless. Presented are intervention ideas that could be used in a constraint-induced therapy program, including the use of both fine and gross motor coordination demands of the upper extremity.

- lacing shoes
- gardening
- writing
- grooming
- board games
- hanging clothes on hangers
- folding clothes
- opening containers
- Chinese checkers
- dressing
- computer activities/typing
- sewing

- ironing
- drinking/grasping a glass
- cleaning (vacuum, dust, etc.)
- preparation of food
- building activities (simple birdhouse, etc.)
- eating lunch
- ball games
- dominoes
- painting on paper/walls
- throwing snowballs
- put away groceries
- fishing
- wax the car
- picking fruit from trees
- painting nails
- putting on make-up
- play instruments
- table tennis
- opening jars
- sorting junk drawers
- shaving
- puzzles

Termination from the CIT program

Termination from the program will occur when the client has met any one of the following:

1. The client has met all individual goals
2. The client has reached the end of the CIT program
3. The client does not wish to participate any longer in the program
4. The client experiences increased health concerns that hinders the ability to participate in the program
5. The client and/or occupational therapist feels safety is a concern

CHAPTER 5

RECOMMENDATIONS

Stroke is the third leading cause of death in the United States and evidence-based practice must guide program development to ensure that patients post-stroke are receiving the most appropriate care possible. Constraint-induced therapy is an effective intervention that could be further utilized in rehabilitation programs across the country.

This new therapy, based on promising research evidence, is currently under utilized across the nation because of the lack of education on this subject, along with the lack of knowledge on how to implement constraint-induced therapy into current stroke rehabilitation programs. Through this scholarly project, the information presented will educate occupational therapists on how to develop and implement CIT protocols into their existing programs.

The research presented in the literature review introduces the positive result therapists and other rehabilitation professionals have had using constraint-induced therapy with patients post-stroke. CIT helps these individuals overcome learned nonuse and induce use-dependent cortical reorganization. The participants in the studies displayed encouraging results in independence, speed of upper extremity movements, quality of movements, and use of the affected upper extremity. It proves cost effective in the long run, only utilizing two intensive weeks of therapy versus months.

Even though there is research that confirms positive outcomes using constraint-induced therapy, there are also a variety of limitations that impede the expansion of constraint-induced therapy protocols into rehabilitation programs. Research is currently being completed, but there is not enough evidence to influence the insurance companies to include constraint-induced therapy programs in their coverage.

CIT is most effective with clients that have active wrist and finger movement before participating in the program. There has not been extensive research on the effectiveness of this protocol on clients with less motor return. This limits the number of clients that are actually able to utilize this program.

Another limitation of constraint-induced therapy is that a client must wear a restrictive mitt on the unaffected upper extremity during waking hours. This results in the individual's independence being restricted and he or she may have to rely on a spouse or family member to complete some of their regular routines. This is contrary to constraint-induced therapy's ultimate goal of increased independence.

Also, wearing the mitt is not energy efficient. Fatigue may overcome the participant, so he or she may not be able to complete the activities that they once were able to accomplish. This discouragement could aid in the decision to discontinue to participate in the constraint-induced therapy program.

An additional drawback to constraint-induced therapy may be the client's reluctance to participate in this program because of embarrassment. Initially, the client will be clumsy and awkward until the affected limb overcomes the nonuse and cortical reorganization of the brain starts to occur.

To rise above the limitations presented using constraint-induced therapy in rehabilitation settings, it is recommended that research be expanded. Studies using larger sample sizes at various times post-stroke must be completed to ensure CIT's effectiveness. Another area to include in future research studies is the effectiveness on lower functioning clients. Could CIT be utilized with patients that have less than ten- percent movement in the wrist and fingers? Could CIT be effective for the post-stroke patient that has less than 3+ strength in the shoulder? A further examination into this could expand constraint-induced therapy's client base and assist more individuals on the road to recovery.

By organizing and bringing together this combination of both the medical research perspective and professional occupational therapist applications, a thorough analysis of constraint-induced therapy for the upper extremity was conducted. Questions were presented to challenge the research community on the expansion of constraint-induced therapy studies. The CIT program presented will aid occupational therapists to better serve their clients that have experienced a stroke by trying a new and effective approach to upper extremity remediation.

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