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# How is the Constraint-Induced Movement Therapy affecting stroke patient's quality of life?

A literature review

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<p>Stroke is one of most prevalent disease worldwide and its cost to society is immense. Most patients sustain some level of disability and dependence after stroke. A challenge in stroke rehabilitation is that patient enduring upper limb paresis develop compensation strategies to overcome pain and frustration from not being able to realize functional movement. This is called learned non-use. Taub understood from research on monkeys that preventing the use of the healthy upper limb supports recovery of the paretic limb. He developed a therapeutic protocol called Constrain-Induced Movement Therapy (CIMT) which shows promising (Taub, 1968).</p> <p>Based on ICF framework, rehabilitation should tend to bring therapeutic outcomes at the level of body functioning, activity and participation taking into consideration individual and environmental factors. This means that the ultimate goal of rehabilitation is to increase patient's quality of life. In this literature review how Constraint-Induced Movement Therapy or some adaptation of it affects stroke quality of life was studied. To that end in 2015 a research was conducted in PudMed, CINAHL, Cochrane Library and PEDro databases based on searching queries using combinations of keywords "Constraint-Induced Movement Therapy. Stroke Impact Scale and Quality of Life. From this searches 15 articles were selected for analysis.</p> <p>From the selected articles it appears that CIMT has a good therapeutic potential for the patients eligible for the therapy. Patients whom may benefit from it must have mild hemiparesis with some level of wrist and carpal extension as well as satisfactory cognitive function (Mini Mental Scale evaluation &gt; 24). Modified-CIMT using much shorter therapeutic sessions are as efficient as the original CIMT protocol which makes it safer to patient and more accessible to therapist in terms of logistic and resources.</p> <p>It appeared that quality of life was too often not addressed as a primary outcome but it is changing in the literature. From this review it seems that CIMT has a positive effect on quality of life of stroke patients though really mild and mostly on the physical aspects of it like level of activity and realization of Activity of Daily Living (ADL). Patients would benefit from re-administration of the treatment and home based practice which here in Finland should be easy to implement.</p>	
Keywords	CIMT, Forced-Use Therapy, quality of life

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<p>Aivoverenkiertohäiriön on yksi eniten esiintyvistä sairauksista maailmassa. Siitä aiheutuvat kustannukset yhteiskunnalle ovat erittäin korkeita. Suurimmalle osalle potilaista jää aivoverenkiertohäiriön jälkeen jokin toiminnanrajoitus.</p> <p>Aivoverenkiertohäiriön jälkeisen kuntoutuksen haasteena on se, että potilas, jonka yläraaja on vammautunut, kehittää korvaavia käyttötapoja välttääkseen raajan toiminnanrajoituksesta aiheutuvaa turhautumista ja kipua. Tämä kutsutaan ns. opituksi käyttämättömyydeksi. Taubin mukaan apinoilla tehty tutkimus osoittaa, että terveen käden käytön estäminen auttaa vammattutuneen raajan parantumista. Hän on kehittänyt tehostetun käden käytön kuntoutusohjelman (Constraint- induced movement therapy, CIMT), jonka tulokset vaikuttavat lupaavilta (Taub, 1968).</p> <p>Perustuen ICF viitekehykseen, kuntoutuksen avulla pitäisi pyrkiä saavuttamaan tuloksia toimintakyvyn, aktiivisuuden ja osallistumisen tasolla mukaan lukien henkilökohtaiset ja ympäristötekijät. Tämä tarkoittaa, että päätavoitteena kuntoutuksessa on kuntoutujan elämälaadun koheneminen. Tässä kirjallisuuskatsauksessa on pyritty vastaamaan kysymykseen miten tehostetun käden käytön kuntoutusohjelma tai sen sovellutukset vaikuttavat aivoverenkiertohäiriöpotilaan elämänlaatuun.</p> <p>Artikkeleista ilmenee, että tehostetun käden käytön kuntoutuksesta vaikuttavat hyötyvän potilaat, kenellä on lievä toispuolihalvaus ja ranteen ojennus mahdollista sekä tyydyttävällä tasolla oleva kognitiivinen suorituskyky (arvioituna Mini Mental Scalen avulla). Modifioidulla tehostetun käden käytön kuntoutusohjelman avulla toteutettu kuntoutus vaikuttaa olevan yhtä tehokasta kuin alkuperäinen menetelmä.</p> <p>Katsauksen tutkimuksissa elämän laatu ei ole ensisijaisena tulosmuuttujana, mutta se on muuttamassa kirjallisuudessa. Tästä kirjallisuuskatsauksesta ilmenee, että tehostetun käden käytön kuntoutusohjelmalla on myönteinen, mutta melko vähäinen vaikutus elämänlaatuun aivoverenkiertohäiriöpotilailla koskien ensisijaisesti elämälaadun fyysisiä tekijöitä, kuten aktiivisuutta päivittäisiä toimintoja. Potilaat voisivat hyötyä hoidon uudelleenjärjestelystä ja kotona tehtävästä harjoittelusta. Tämän pitäisi olla helppoa toteuttaa Suomessa.</p>	
Avainsanat	CIMT, Forced-Use Therapy , elämänlaatu

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## 1 Introduction

Stroke is the third leading cause of disability in humans after cancer and heart infarction. In the last 5 years it was the second most common cause of deaths, causing nearly 9 % of all deaths worldwide (Memish, 2010) It is estimated that each year nearly 6 million people die from stroke and another 5 million are left dependent on others, requiring a lot of post traumatic care. Although the preventive treatment has improved in industrial countries, the number of stroke increases because of ageing population.

In Finland, the stroke is the fourth most common cause of death after coronary heart disease, cancer and dementia. Stroke occurs in about 14 000 cases per year. From the “official statistic Finland” office the outcomes are devastating: more than one third of patients die, 15-30% of them stay permanently disabled and about 20% of affected persons become institution-dependent (Käypä hoito, 2011). Even though over half of patients are over 75-years old, one in four patients is in working-age and nearly 900 patients per years stay on disability pension (Fogelholm. 2001).

The economic aspects of stroke in Finland are considerable. Stroke is considered to be the third most expensive disease (1. mental disorders, 2. dementia, 3.stroke) due to long hospitalization and disablement, its annual cost is 1.1 billion Euros, which is 7% of the health care budget (Fogelholm. 2001).

It is therefore really important to help stroke survivors to get back into active and independent life. To that extent a relatively new form of therapy was initiated in the 80's by Taub. Constraint-Induced Movement Therapy (CIMT) and related treatment like modified Constraint-Induced Movement Therapy or Forced Use Therapy (FUT) for the rehabilitation of patient enduring functional impairment of movement following stroke were developed to overcome the learned non-use through “repetition and principles of task-specific and context-specific motor learning” (Peppen et al 2011).

The Constraint-Induced Movement Therapy approach seems promising enough that KELA (Social Insurance Institution of Finland) ordered a project for geriatric rehabilitation where they studied the effect of Constraint-Induced Movement Therapy on 270 stroke patients, being 65 to 85 years old, from 2008 to 2012. The research conducted by Karttunen suggests that physical and cognitive condition of patients improved (Karttunen 2014).

For the purpose of standardization and promotion of communication quality among health professionals, the World Health Organization developed an International classification of functioning, disability and health framework (ICF) to assist them in that task. The ICF identified three domains for human functioning: the body or body part (impairment), the whole person (activity) and the whole person in relation to his/her social context (participation). The last two domains are under influence of personal and environmental factors. Using the framework one can follow or progress through the person's condition and support her/ his rehabilitation better without neglecting one or the other components defining human functioning (WHO, 2002).

This bachelor thesis reports through a literature review that constraint-induced movement therapy has a therapeutic benefit with a marked interest upon stroke patient's quality of life improvement or sustainability. Regularly studies analyze a therapeutic effect normalized to a negative control or in some cases to another therapeutic procedure. Evaluation of patient's quality of life following stroke is of primary importance nowadays when multidisciplinary rehabilitation involving physiotherapist, occupational and speech therapists as well as nurses, doctors and social workers working hand in hand with patient towards patient-centered therapy goals is the current standard of neurological rehabilitation (Buckley, 2013).

Quality of life, falling under the participation domain of the ICF, may improve following constraint-induced movement therapy. Health is defined by the World Health Organization (WHO) as "A state of complete physical, mental, and social well-being not merely the absence of disease". As such while measuring the level of health of a patient and assessing the effect of health care one must evaluate the evolution of the frequency and severity of disease as well as measuring how the treatment did affect the patient's quality of life. Quality of life is a multi-dimensional evaluation of different aspects of one's life encompassing to physical, mental, emotional, and social functioning. One often speaks about health-related quality of life when one considers assessing quality of life in relationship to health and disease particularly how health status does affect one's quality of life (WHO, 2005).

Combining measures of quality of life with other evaluation measurements of a patient's health status can be really useful in evaluating how a specific treatment provides benefits to the patient overall. This makes the patient an evaluator of his/her own condition and

as such a part of rehabilitation team which is typically a central aspect of neurological care including stroke patient care. Particularly because health-related quality of life can be followed and measured overtime giving valuable insights about the person's health status progression (Buckley, 2014).

Other advantages coming with measuring a patient's health-related quality of life are that therapist gets a better understanding of how the person is affected by the disease improving the connection and interaction between the patient and the rehabilitation team. Similarly patients can feel to receive a better care as they are treated in a more holistic way meaning considering their physical, mental, emotional and social functioning (WHO, 2005). Therefore it seems to be really important to implement measurement of quality of life in therapeutic care though it apparently is not yet routinely used. According to Wu, so far Constraint-Induced Movement Therapy or modified version of it usually measure effects on activity level rather than the outcomes of activity participation like health-related quality of life (Wu, 2007).

This bachelor's thesis offers to review the literature on that matter and discuss the current use of quality of life assessment in Constraint-Induced Movement Therapies care.

## **2 Constraint-induced Movement therapy family in stroke rehabilitation**

### **2.1 Basic research background**

#### **2.1.1 Principle**

Based on early twentieth century studies from Munk (1909) as well as Ogden and Franz (1917), Taub and coworkers observed experimentally on single limb deafferented non-human primates that those animals would not use the insensate limb (Knapp, 1958). Nonetheless if forced to develop behavioral strategies to bypass the learned non-use for that limb by restricting the healthy limb for few days those animals will resume using their deafferented limb (Taub, 1968). In parallel the use-dependent cortical reorganization of motoric pathways has been proposed as a concomitant mechanism generating positive outcome from Constraint-induced therapy (Liepert, 2000).

### 2.1.2 Learned non-use

Learned non-use can be described as a suppression of use of an affected limb following a stroke, injury or experimental deafferentiation. Suppression of limb usage is a result of unsuccessful attempts to use the affected limb. Ineffective realization of movement may lead to injury, pain, frustration which feedback negatively the usage of that limb. It is thus the patient's negative experience which leads to the tendency not to use the affected limb and to use the non-affected limb instead in a positive reinforcement feedback loop leading to compensatory behavioral patterns. However, the learned non-use can be overcome by restricting usage of the healthy limb therefore forcing the person to use the paretic limb (Taub, 2006).

It is important to notice, especially in the context of communication of the physiotherapist or occupational therapist with the patient, that speaking of sensory non-use does not relate to the idea that the person makes a conscious choice of not using available sensory input. It rather means according to Taub that the remaining afferent input is not responded to by the central nervous system. That could be because the signal does not reach a certain threshold to trigger a response or that it would be too weak to counteract another sensory input thus leading to an inappropriate answer from the central nervous system or no answer at all (Pidikiti, 2014).

### 2.1.3 Use-dependent cortical reorganization.

Stroke by destroying and injuring structures in the brain leads to a complex reorganization of affected brain area where it occurred. A reduction in motor cortex excitability in the paretic muscles as well as a decrease in cortical representations areas were observed in the subacute phases of patients whom had stroke (Traversa, 1997). This could be due to a poor reorganization of the impaired neural system in correlation to a damaged motor function or an expression of learned non-use.

Still, beside the injury-related cortical reorganization another mechanism occurs which is use-dependent cortical reorganization. This phenomenon is the result of stimulating the affected limb in behaviorally relevant tasks by repetition of the movement controlled by corresponding cortical loci and associated motor tracts. It is possible that stroke patient's motor function recovery occurs partly because of that mechanism countering the deleterious consequences of a stroke. Use-dependent cortical reorganization seems to

be an important component of Constraint-Induced Movement Therapy as shown by Liepert et al. This phenomenon was mostly discovered and studied using the painless and non-invasive focal transcranial magnetic stimulation technology which allows to reproducibly map and investigate the somatotopical organization of the motor cortex (Traversa, 1997).

The rehabilitation methods we consider in this thesis are meant for the treatment of stroke survivors with a mild to moderate hemiparesis. Specifically they are meant to regain some motor function and foster a more independent use of the affected upper limb. It is extremely difficult in rehabilitation procedure to characterize an easily replicable therapy protocol. At the difference of many medical endeavor in which one can easily repeat a specific intervention using definite protocols subsets (e.g. pharmaceutical dosage, administration, duration) Whyte et al consider that the “Complex interactions between clients and clinicians and the fact that most rehabilitation protocols contain multiple treatment component within a treatment system pose a substantial challenge to characterizing rehabilitation interventions.” Therefore paying close attention at characterizing rehabilitation protocols will allow for replication and spreading of the intervention effectively (Whyte, 2003). The interventions described here are the constraint-Induced Movement Therapy (CIMT), the modified constraint-Induced Movement Therapy (m-CIMT) and the Forced-Used Therapy (FUT).

## 2.2 Constraint-Induced Movement Therapy (CIMT)

Constraint-induced Movement therapy (also known as the Taub training) uses therapeutic elements which were already used in neurological rehabilitation procedures though they most often were not combined together neither given at similar intensity. The constraint-induced movement therapy has been developed as a “therapeutic package” with as a most important goal apart from improving motoric self-efficiency to help the patient to transfer the benefits of therapy home and in the realization of Activities of daily living (ADL) tasks. This is because most often rehabilitees get back to a learned non-use behavior with their most affected limb despite clear and efficient improvement in the laboratory or clinic environment.

To that end the constraint-induced movement therapy was designed to promote motoric upper limb rehabilitation and behavioral changes in patients through a so called “transfer package” which will be described further (Morris, 2006).

The constraint-induced movement therapy protocol contains three main elements themselves consisting of different subsets. From Taub et al those elements are to practice first repetitive, task-oriented training of the more-impaired upper limb for several hours (usually 6h) a day for 10 or 15 days (depending on the severity of the initial deficit); second to apply a “transfer package” of adherence-enhancing behavioral method designed to transfer gain made in the research laboratory or clinical setting to the patient real-world environment; and thirdly to constrain the patient to use the more-impaired upper limb during waking hours over the course of the treatment, sometime by restraining the less-impaired upper limb (usually 90% of the waking hours). Those elements and sub elements are listed in table I from Morris (Morris, 2006).

Table I. -Component and subcomponents of the constraint-induced movement therapy protocol

<b>Repetitive, task-oriented training</b>
-Shaping
-Task practice
<b>Adherence-enhancing behavioral strategies (i.e., transfer package)</b>
-Daily administration of the motor activity log (MAL)
-Home diary
-Problem solving to overcome apparent barriers to use the more affected upper extremity in the real world situation
-Behavioral contract
-Caregiver contract
-Home skill assignment
-Home practice
-Daily schedule
<b>Constraining the use of the more-affected upper limb</b>
-Mitt restrain
-Any method to continually remind the participant to use the more-affected upper extremity

Table 1 lists the different component of the original Constrain-Induced Movement Therapy protocol. The first element of repetitive and task orientated training that shows to be efficient is called shaping. Shaping is a practical methodology where the physiotherapist decomposes the target behavioral or functional objectives in a series of “successive approximations” so that at any moment the challenges faced by the patient are small. As such the patient goes smoothly through an array of increments requiring small improvement to be successful (Taub, 1994). The second element task practice addresses the completion of a full functional task that requires many steps to be done like eating, folding

clothes, making coffee for example. The repetition of the task is meant to prevent/overcome the learned non-use and to induce activity dependent cortical reorganization (Morris 2006).

### 2.3 Modified constraint-induced movement therapy

Many systematic review of literature showed that constraint-induced movement therapy has a positive effect though mild on upper limb motor function (Corbetta, 2015; Kwakkel, 2015; Hakkennes, 2005). However Constraint-Induced Movement Therapy may prove difficult to set up for number of reasons. The original protocol is really much time consuming and requires personal supervision from therapist for a large part of the day for 10 to 15 days. It is also challenging for the rehabilitee whom might get stressed from the heavy load of training and be at a higher risk of falling. Some concerns were also made that the high volume of training may lead to increased hemiplegic shoulder pain which is a common complication of stroke (Ploughman, 2004). This is not to mention that it was reported by Page et al that a majority of patients do not wish to participate in a 2 weeks Constraint-induced movement therapy program and would probably not comply with the therapeutic procedure as measured by a survey of therapist and stroke patients (Page, 2001).

To address those issues Page et al contrived a modified version of the original constraint-induced movement therapy with much lower intensity training like 2h per day for 10 to 15 days and shorter constraint time for example 6h per day for 2 to 3 weeks. This program by page et al was shown to be relevant for a wide range of motor disability in chronic and subacute patients and might be particularly pertinent for elderly rehabilitees (Page, 2001).

The original CIMT has been modified by many different groups where many possible variation were successfully undertaken and expressing therapeutic benefits. Those modification though keeping the core of the constraint-induced movement therapy did distribute the volume of training over longer period of time, shorter restriction of the healthy upper limb during the day, as well as not including a “transfer package” nor using behavioral strategies (Wolf, 2015).

Despite displaying high potentials the large variety of modified constraint-induced movement therapy protocols require a systematic review and a meta-analysis of trials using either original or modified constraint-induced movement therapy (Wolf, 2015).

## 2.4 Forced-use therapy

Along its development and because the constraint-induced movement therapy protocol requires a lot of resources, Page et al in a survey observed that a majority of therapist could not apply the shaping therapy for lack of resources, mainly time. As concerns were also raised about patients safety, compliance to the protocol, worsening of hemiplegic shoulder pain and not knowing either which aspect of the treatment regimen influences the positive results from therapy, Ploughman et al devised a protocol to find out if constraint of the affected arm without additional shaping training would show therapeutically beneficial (ploughman, 2004).

In this protocol patients wore a mitten on their less-affected hand (from fingertips to elbow) for up to 6h a day, starting progressively from one hour a day until the end of the rehabilitation period. Despite needing to study larger groups of patients Ploughman et al concluded from their research that rehabilitees arm function actually improved 20% (Ploughman, 2014) from the other approaches they evaluated.

## 2.5 Eligible Stroke patients for Constraint-Induced Movement Therapies

It is really important for the physiotherapist as well as for the rehabilitation team to choose approaches and technics from which the patients can profit the most and improve the best their condition. For this reason it is fundamental to select patients carefully for a specific therapy protocol. This way physiotherapist may expect the better outcome as well as not giving patient unrealistic expectations over the results of the rehabilitation method used (Nijland, 2011). Thus it is necessary for the physical therapist or clinician to evaluate key factors for the upper limb function eliciting accessible prognosis.

Studies from Stinear shows that the voluntary ability to extend the wrist and fingers witnesses the integrity of the corticospinal tract system (Stinear, 2010). This seems to be a natural criterion for patient's selection as there is no possible movement if there is no function (Wolf 2015). The most common motor criteria being active extension  $20^{\circ}$  at wrist,  $10^{\circ}$  at metacarpophalangeal and interphalangeal joints (Corbetta, 2010). Those condition are usually found in patient whom endured a stroke generating a mild to moderate impairment of hand or arm function.

One should also take into account that constraint-induced movement therapy is long and challenging so patients must be motivated and understand what their participation requires. Furthermore there is a correlation between patient's compliance and their Mini Mental Scale Examination (MMSE) score, which should be at least 24 (Ploughman 2004). Other criteria like severe aphasia, inability to communicate in rehabilitation language, inability to consent (e.g. dementia) and life threatening comorbidity are to be considered as exclusion criteria (Barzel, 2013).

### **3 Reporting results of Constraint-Induced Movement Therapies**

Physiotherapists are aiming at supporting and promoting individual's health and their ability to function independently. Developing and/or using methods to improve customers conditions requires proper evaluation of patient's physical and cognitive condition to make those rehabilitation program efficient and safe. Structured and active collaboration between physiotherapist, occupational-, speech therapist, nurses and doctors is the base for successful rehabilitation. In this way therapists measure therapeutic outcomes along a range of individual's functional development based on the ICF framework (i.e from body function to activity and then participation). The further away from evaluating body function the more external factors and subjective interpretations forms making evaluation of participation (Quality of life) more difficult to assess (Brenner et al. 1995)

This is why traditionally physiotherapist and rehabilitation team in general tend to evaluate patient's condition from gross to finer motoric capability and then cognitive levels. They address the general level of disability and step by step go deeper into the analysis of the patient's ability to function. For this reason in the case of stroke rehabilitation the outcomes measured for a specific therapy, here Constraint-Induced Movement Therapy, are going from general disability level as a primary outcome and then proceed to finer measurement of physical and cognitive patient's condition as secondary outcomes (Corbetta, 2010). To save paper all mentioned tests in the following section are available at Rehabilitation Measures Database (Rehabilitation Measures Database, 2010).

Disability is often evaluated using the Functional Independent Measure protocol (Keith1987). To address more subtle changes in patient's motoric control like the arm motor function therapist and clinicians often use the Wolf motor function test (WMFT). This test addresses the levels of upper-extremity impairment by measuring the difference in 15 timed tasks that evaluator gives to the patient prior and after the therapy. It can as

well be given at “follow up” time too to follow the evolution of the patient’s condition. Characterization of stroke patient’s impairment/ recovery through evaluation of perceived motor function, amount of use and quality of use is usually measured the Motor Activity Log (MAL) procedure. The Motor Activity Log (MAL) was devised by Taub et al 1993 as a semistructured interview for hemiparetic stroke patients to assess the use of their paretic arm and hand functional level of independence during activities of daily living. It does generates two scores given for each activity of the test, 1 for the amount of use (AOU) and 1 for the quality of movement (QOM) of the paretic arm. The test allows to compare for the evolution of the patient’s ability to use their paretic upper-extremity. To a similar end a really popular test to evaluate arm motor impairment is the Fugl-Meyer motor Assessment (FMA). The Fugl-Meyer motor Assessment assesses the severity of the motor impairment and as such is most often used in constraint-induced movement therapy to evaluate the improvement of motor function from therapeutic intervention (description and scoring in annexes 2). When patient’s condition allows a finer motor control from the paretic limb hence a higher dexterity it is important to evaluate the quality of finer motor control of the fingers as measured for example with Nine Peg Hole Test (NHPT).

It seems that only when all other functional evaluation have been made therapists extend their estimation to the effect of therapies on patient’s quality of life.

Considering the benefits of a therapy in terms of evolution of the perceived health-related quality of life of the patients is highly valuable as it enhances the quality of the therapeutic care. It allows the patient to have a greater control and satisfaction on the therapeutic approach by empowering him or her and making him or her a part of the therapeutic team able to give feedback on the chosen method of rehabilitation. Assessment of quality of life is too often treated as a secondary outcome of the therapy. Two commonly used tests to evaluate stroke therapies benefits on quality of life are the Stroke Impact Scale (SIS) (Duncan, 1999) and the stroke-specific quality of life scale (Williams, 1999). The SIS has been largely used to measure Quality of life outcomes in stroke rehabilitation and its domains show strong correlation with functional ability in patients.

They are many ways to think what should be considered as primary or secondary outcomes. Here I mentioned how it is traditionally addressed, through the use of the ICF framework, from general to specific and finally social and cognitive.

## 4 How does the therapy affects patient's quality of life?

### 4.1 Objective

The objective of this review of literature is to determine how Constraint-Induced Movement Therapy or adaptation of that protocol affects perceived health-related quality of life in patient undergoing post-stroke rehabilitation of the most affected upper limb. Alongside the results of this study, the review will ponder over the use of Quality of Life measurements in stroke patient's rehabilitation within the community of therapist using Constraint-Induced Movement Therapy namely physiotherapist and occupational therapist.

### 4.2 Methods and quality of evidence

A literature review was conducted from June 2015 to February 2016. Information retrieval was performed in the following databases: Pubmed, Cochrane Library, PeDro and Cinahl. They were run using the following key words "CIMT" or "Constraint-Induced Movement Therapy" and "quality of life" or "QoL" or "stroke impact scale" or "SIS" and Stroke in different combination. The Stoke impact scale was incorporated as key-word for the query search as domain of this test is used as a marker of quality of life status for stroke patient. Article's bibliographies were reviewed manually to screen for more material which might have been missed on the computed search.

This review of literature is based on quantitative analysis articles made with experimental study design. Only articles from peer-reviewed journals can guaranty adequate level of quality. This gives more robust results allowing for less biases and subjective interpretations. The randomization and the blinding of assessors/ patients for example when possible limit bias by preventing confounding factors so that it assures that results are due to the intervention alone. In a review it is important to rate the quality of articles so that one can compare them. To that extent evaluation measurement have been developed to assess the robustness of the study design and it realization. The higher the score the more trustful is the article in terms of minimizing bias. In this review we used three quality evaluation tools from the Joanna Briggs Institute depending on the study design (critical appraisal tools Randomized Control / Pseudo-randomized Trial, the critical appraisal

tools Descriptive / Case Series Studies and the critical appraisal tools Comparable Cohort / Case Control Studies). Scores for quality evaluation are presented on table 2 (The Joanna Briggs Institute) and were satisfying. RCTs average score for quality evaluation was 8.3/10, the cohort studies got 6/9 but the case study scored fairly poorly at 5/9. The evaluation here was for technical reasons made by one assessor instead of minimally two. This is by itself a bias to this review.

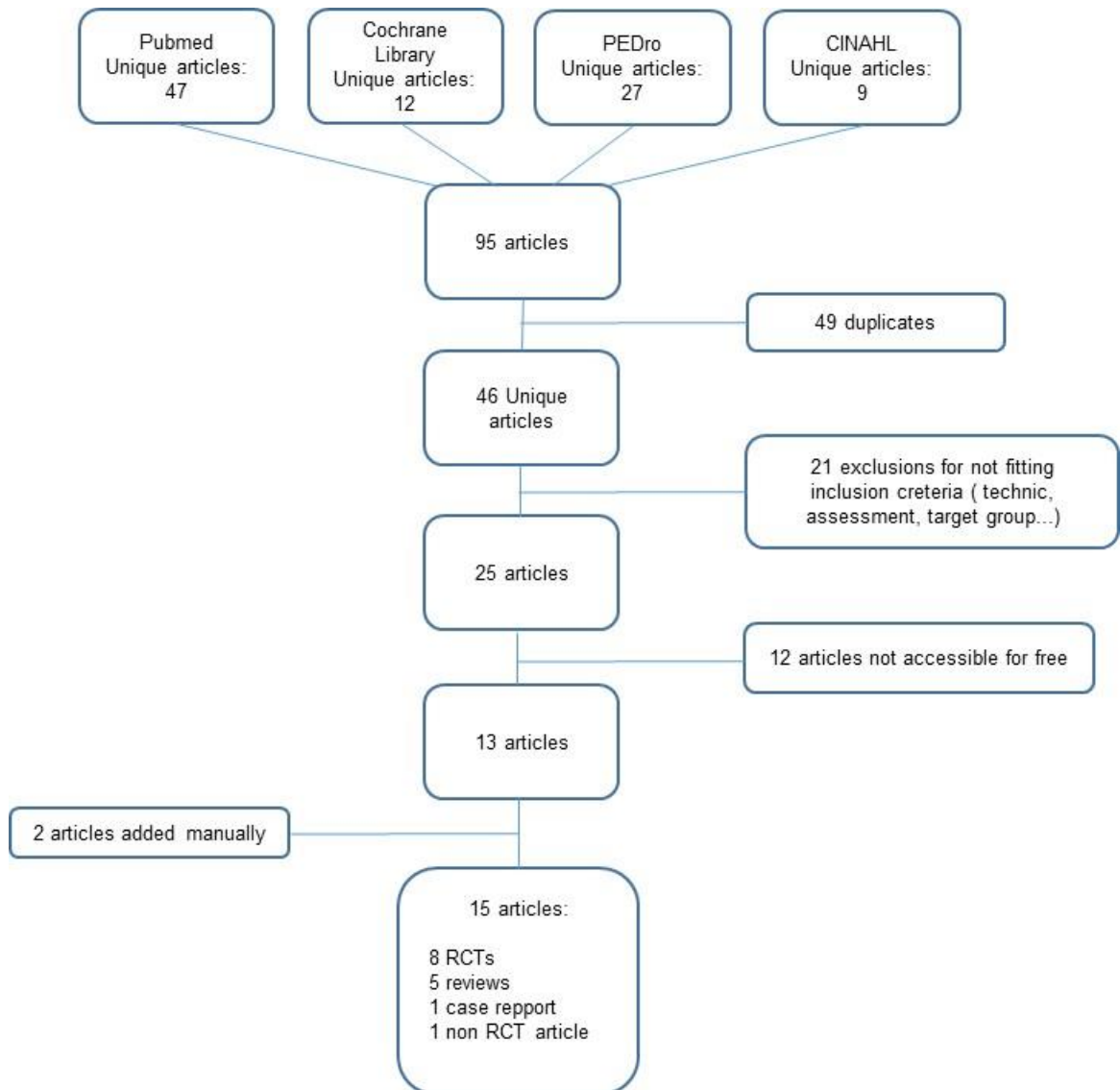
Prior to the database search, criteria for articles inclusion were defined. This thesis would accept any article published in peer-reviewed journal published in French, English or Finnish languages. As objectives of the study relates to relatively recent approaches in stroke rehabilitation, no time limit in the past were set. The study intended to address a target population of adults whom had suffer a stroke and were rehabilitated using some form of stroke therapy given by physiotherapists or occupational-therapists and evaluating patients quality of life. The studies must at least consider some type of Constraint-Induced Movement Therapy in their research but other form of therapies were accepted when the goal was to compare different approaches and their effect on quality of life. Any article that would address other issues than the aforementioned one is to be excluded.

#### 4.3 The therapy results in mild improvement of patient's quality of life.

Knowledge of quality of life is clinically relevant as it supports physiotherapists in identifying those persons at risk to whom treatment benefits overall. It also helps in planning adequate treatment by creating hypotheses of the types of activities that may support patient's ability to function.

Using the aforementioned keywords in databases queries bred up 46 non redundant articles of which 21 were excluded for not fitting the selection criteria and another 12 were excluded for not being available for free. To the 13 selected articles 2 were manually added to the study making a total of 15 articles included in this bachelor thesis. The detailed outcome of the databases search is presented in figure1.

Figure 1. Searching process



Results are presented below and summarized in appendix 1. In the same line as the ICF framework several authors in their studies consider that long term improvement of quality of life is the ultimate/ primary goal of rehabilitation (Hsu, 2009). Interestingly in the oldest study included in this bachelor thesis, Hakkennes and Keating in a systematic review of the literature on the effect of constraint induced movement therapy following stroke analyzed 14 randomized controlled trials and none of them assessed the treatment effect on quality of life. They pointed out that quality of life measurements must be implemented into further researches (Keating, 2005).

Results of the effect of constraint induced movement therapy on quality of life are confusing probably because whether positive or not the effect is not dramatic. In a review of

literature on the topic, Kwakkel and Wolf analyzed randomized controlled trials for constraint-induced movement therapy (51), modified constraint-induced movement therapy (44) and forced-use therapy (6) and concluded that those treatment have no effect on patient quality of life (Kwakkel, Wolf 2015). Paradoxically in two other articles led by Wolf did the authors measure positive outcome on quality of life after treatment. Wolf and Sawaki in a large scale trial named EXCITE (Extremity Constraint-Induced Therapy Evaluation) analyzed that the effect of constraint-induced movement therapy given early (3 to 9 months) or delayed (15 to 21 months) from the stroke onset would display statistically significant and clinically relevant higher efficiency in upper limb function and perceived quality of life measured by MAL (Motor Activity Log) and SIS (Stroke Impact Scale) respectively. The effect did persisted up to 2 years after treatment but the early group showed higher score supporting the idea that rehabilitation must start as soon as possible (Wolf, Sawaki 2010). Finally on a case report by Rowe and Wolf evaluating long term effect of constraint-induced movement therapy they measured that a positive effect of the therapy including on physically related health-related quality of life aspect evaluated by SIS five years after treatment took place (Rowe, Wolf 2009).

Pulman wrote a systematic review in 2013 on the efficacy of different therapeutic techniques on upper limb hemiparesis to improve health-related quality of life in stroke patient. Their study reported six articles addressing the effect of constraint-induced movement therapy which all were analyzed too in this bachelor thesis. Four of them were considered to be effective in increasing patient's quality of life among which three were randomized controlled trials using reliable and accurate measures (Wolf, 2010; Lin, 2009; Dettmers, 2005 and Wu, 2007). The other two studies were considered as irrelevant. The Rowe study for being a case report hence not statically relevant and the Dahl study about which it was argued that the results may have been biased as the traditional therapy group participants were promised to be given the constraint-induced movement therapy after the experiment and its 6 month follow up ends. Still the research from Dahl and co-workers showed no difference in quality of life for patient's following a constraint-induced movement therapy or a traditional therapy but both groups quality of life measures increased after treatment (Dahl, 2008). Pulman and Buckley concluded that constraint-induced movement therapy intervention supports quality of life mainly in its physical component and that future research for upper limb rehabilitation should be designed to consider the mental health or psychosocial components of quality of life (Pulman, Buckley 2013).

The original therapy requires a lot of resources. Patient should be supervised by a physiotherapist or occupational therapist 6h a day for 10 consecutive weekdays. The intensity of the training also raised concern about patient's safety. To address safety, economical burden on health care system and the load on therapist's schedule, modification of the protocol were made. Dettmers distributed it over twenty day and observed that participants expressed large improvement on different aspects of quality of life evaluated by SIS. Partaker in the experiment also reported increase in social participation and communication at six months follow-up (Dettmers, 2005). Concerned by economic consideration in middle- and low-income countries Souza from Brazil compared two modified version of the protocol. They consisted of ten days with 3h per day of supervision for one and 1,5h per day with 1,5h of home practice supervised by caregiver for the second. No significant differences between the two groups concerning quality of life assessed by the stroke specific quality of life test were found after treatment and at 6 months follow-up. Using the 3h of supervision group as a positive control their study lack of strength by not having a control group which did not receive treatment. Though preliminary those results are of economic importance as a patient with less professional supervision would achieve similar benefits from treatment than a patient fully supervised (Souza, 2015). Thrane also used a modified protocol to measure the benefits of early rehabilitation, 5 to 26 day after stroke onset. Ten days of rehabilitation with 2,5h daily practice, a restrictive mitt for 90% of the waking hours and an additional effort put on the transfer package approach (like filling-in the Motor Activity Log daily, write a home diary and perform half an hour of home skills assignment) did not generate significant differences with the control group at six month follow up. Neither on arm impairment level, function or use in daily activities showing that this protocol initiated within one month post stroke onset does not improve long term motor function. Still it is safe to administer and feasible. Some score on WFMT (Wolf Motor Function Test) may suggest that it may accelerate future recovery (Thrane, 2015).

Researchers from Taiwan devised a modified constraint-induced movement therapy based on 2h per day of supervision for 10 to 15 consecutive weekdays with the unaffected hand restrained 6h a day with a mitt. Whether concerned by the capacity of elderly patients over 65 years old to cope with the intensity of the original protocol (Wu 2007) or to compare this protocol to Bilateral arm training (Lin, Chen 2009) or to dose-matched traditional therapy wearing a mitt on unaffected arm (Lin, Hsu 2009) or even searching for predictors of quality of life with that protocol (Huang 2010) they found positive outcome on Quality of Life. From those randomized controlled trials they studied the

changes in motor impairment, daily functioning and quality of life. Participants in the Wu study reported a really important gain in the upper limb motor function evaluated by MAL as well as in health-related quality of life, measured by SIS, though more on the physical domain of health-related quality of life (Wu, 2007). Patients in the Lin, Chen study scored higher on quality of life test measured by SIS (SIS overall  $P=.015$ , ADL/iADL domain:  $P=.004$ , hand function domains  $P=.015$ ) than bilateral arm training group as well as on quality of life assessment (SIS overall:  $P=.003$ ; ADL/iADL domain:  $P=.024$ ; social participation domain:  $P=.009$ ) (Lin, Chen 2009). Patient in the Lin, Hsu study had better scores in overall SIS (SIS overall:  $P=.009$ ) and even 3 domains of the SIS evaluation showed significant and large effect of the modified protocol versus the dose-matched intervention (ADL:  $P=.001$ ; mobility ( $P=.0015$ ); and hand function:  $P=.001$ ) (Lin, Hsu 2009). In the last random controlled trial by Huang screened for the predictors of changes in quality of life in stroke patients after therapy. The predictors evaluated were: age, gender, side of lesion, time since stroke onset, cognitive status, and motoric impairment of upper extremity and activity of daily living. Using a statistical tool, with good validity, Chi-squared Automatic Interaction Detector (CHAID) to analyze the association between the potential predictors and each domain of the SIS measure (strength, memory, emotion, communication, ADL/iADL, mobility, hand function, participation and overall SIS), and functional independence measure (FIM) score they concluded that the activity of daily living performance using the functional independence measure (FIM) is the strongest predictor of stroke rehabilitation outcome after distributed constraint-induced movement therapy. The second most important association they found was age. None of the other potential predictors showed significant association with changes in quality of life at least evaluated by their reliable method CHAID. It must be mentioned that all participants had at least a score of 24 on MMSE (Huang, 2010)

It is of concern that a meta-analysis in a literature review published in the Cochrane Collaboration database by Corbetta et al on Constraint-induced movement therapy for upper extremities in stroke patients concluded that results of studies by Wu and Lin are not conclusive. The meta-analysis did not find significant statistical difference in favor of a quality of life improvement after treatment for the Wu study. Their analysis concluded that the Lin study was beneficial in terms of quality of life improvement but that neither Wu nor Lin studies had quality grade good enough to be considered relevant. They analyzed only two studies concerning quality of life and constraint-induced movement therapy and they were mostly concerned about the way the experiments were designed and run (Corbetta, 2009).

## 5 Conclusions

At the exception of the work from Huang and co-workers (Huang 2008) all studies in this literature review addressed measurements of quality of life as a secondary outcome from the constraint-induced movement therapy. This is understandable as physiotherapists most often work with people's body to promote and support their motor function and ability to function. Still it must not be forgotten that rehabilitation of body condition aims at facilitating patient's independence hence promoting quality of life as emphasized by the ICF framework. In this sense physiotherapist could be using evaluation of quality of life as a tool to test their therapeutic approaches and how it benefits the patient. Physiotherapists could also be designing therapeutic tools where promotion of quality of life is considered as a primary outcome of the treatment. Furthermore as current therapies for neurological patients consider the rehabilitee as a key member of the therapeutic team it becomes fundamental to give (health-related) quality of life measurements more value as outcomes of the therapy to promote patient's participation and motivation. This so far is missing in most of the studies.

If we keep in mind that the original constraint-induced movement therapy protocol presented in table I (Taub) does not measure patient's quality of life neither its physical components like the realization of activity of daily living, it seems that researchers and therapists are getting more and more aware of the need to take patient's quality of life into account. From Keating's study, in 2005, where none of the 14 random control trials analyzed addressed quality of life, to Buckley's paper, in 2013, including 6 articles and the present review, in 2016, addressing 10 articles on the topic it seems that a trend is rising. Though as reminded by Corbetta and the Medical Advisory Secretariat, Health Quality Ontario review reports that many studies are not rigorous enough to resist a meta-analysis where all required parameters for a suitable scientific experiment are treated. This in their mind invalidates some studies.

The opinion that quality of life improves following constraint-induced movement therapy is getting more popular among stroke therapists and researchers on this tends to support a positive effect of the therapy. Though as Buckley did point it out the benefits of the therapy on quality of life are more visible on the physical aspects of it.

Two major concerns for the use of constraint-induced movement therapy are its cost and how demanding it is to the patient. For example Pink wrote of unpublished data from the

Australian Association of Occupational Therapist Neurological Special Interest Group from where it came out that only ten occupational therapist out of 62 respondent used constraint-induced movement therapy (time being a major factor) (Pink, 2009). Whether we think of how much time consuming it is for the therapists hence expensive to the community or how challenging it might be to patients therefore repelling many studies have been trying to cut down the treatment time by distributing it over a longer period (Dettmers, 2005), modifying it (Wu, 2007; Lin, 2009, Thrane, 2015; Souza, 2015; Huang, 2010), giving a part of the treatment as home work (Souza, 2015) it seems that as little as two hours per day can be as effective a longer session.

In many ways this therapeutic approach seems to be beneficial to the patient and encourage a higher level of quality of life even if mostly on the physical aspects of it. We should also keep in mind that the population of patients to whom it is beneficial is rather small and that the best predictors for improvement are a FIM score below 109 and being younger than 63.5 years old. The therapy and its consequences on quality of life could be more beneficial if patients would get periodic re-administration of the treatment to support and reinforce their upper extremity motor function as suggested by Dahl in 2008. If Constraint-Induced Movement Therapy gets more widely used in Finland based on the positive outcomes, from the KELA ordered study by Karttunen in 2012, many opportunities opened concerning the follow up of patients. In Finland for example where the population is highly connected and its elder population can easily get training and support in information technology from city services there are many opportunities to support the Constraint-Induced Movement Therapy's transfer package from the clinic to the patient's living environment. Therapy continuation assignments could be set on a web page that the patient could follow and follow up could be made with video-call consultation for example. That way the patient's motor control could keep developing and her or his experienced quality of life improve and be sustained.

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## Appendix 1

Presentation of results.

Study (year)	Study design	Participant control	QoL measure	Intervention	Result (QoL)	Quality score (JBI score)
Thrane (2015)	RCT	24 interventions 23 controls	SIS	m-CIMT	Favorable effect on timed measured movement immediately after intervention. Not kept at 6 month follow-up	9 Yes 1 unclear (JBI RCT /10)
Wolf (2015)	RCT	106 early-CIMT 116 delayed-CIMT 0 control	SIS	Early CIMT: directly after enrollment and concealment.  Delayed CIMT: one year after enrollment and concealment.	Positive immediately after treatment, and significantly greater for the early-Cimt group, but not at one year follow up.	8 Yes 1 No 1 N/A (JBI RCT /10)
Dahl (2008)	RCT	18 interventions 12 controls	SIS	CIMT	Both group perceived QoL increased	8 Yes 2 N/A (JBI RCT /10)
Lin (Chen) (2009)	RCT	20 CIMT int. 20 BAT int.	SIS	modified-CIMT Bilateral Arm Training	d-CIMT patient showed higher score for overall QoL and ADL	9 Yes 1 N/A

		20 control			domains compared to BAT group	(JBI RCT /10)
Lin (Hsu) (2009)	RCT	16 d-CIMT int. 16 control int.	SIS	modified-CIMT	m-Cimt group scored higher on QoL than control group. Especially on ADL, hands function and mobility.	8 Yes 1 Unclear 1 N/A (JBI RCT /10)
Wu (2007)	RCT	13 interventions 13 controls (traditional rehabilitation)	SIS	modified-CIMT	Stronger gains in HRQOL for the m-CIMT group. Most of those gains were in the physical domain: strength, ADLs and iADLs.	8 Yes 1 Unclear 1 N/A (JBI RCT /10)
Dettmers (2005)	Before and after study. (No RCT)	11 interventions no control	SIS	distributed-CIMT	Large improvement on different QoL domains: hand function, strength, ADLs and mobility.	5 Yes 2 No 2 Unclear (JBI Cohort /9)
Souza (2015)	RCT	10 participants d-CIMT 3h 9 participants d-CIMT 1,5h	SSQOL	modified-CIMT 3h modified-CIMT 1,5h + 1,5h supervised home exercise by caregiver..	No significant differences on QoL for between each group.	7 Yes 2 No 1 Unclear (JBI RCT /10)

Rowe (2009)	case report		SIS	CIMT	Improvement in ADL's domain up to five years follow-up but not on other domains (memory, emotion and social participation)	3 Yes 4 No 2 Unclear (JBI Case study /9)
Huang (2010)	Meta-analysis from two RCTs	58 interventions	SIS FIM	m-CIMT	Strongest predictors of QoL after m-CIMT are daily performance score measured by FIM and age.	7 Yes 2 No (JBI Cohort /9)
(HR)QoL: (Health-Related) Quality of Life, RCT: Random Control Trial, SIS: Stroke Impact Scale, CIMT: Constraint-Induced Movement Therapy Joanna Briggs Institute (JBI), JBI RCT: JBI critical appraisal tools Randomized Control / Pseudo-randomized Trial, JBI Case study: JBI critical appraisal tools Descriptive / Case Series Studies, JBI Cohort: JBI critical appraisal tools Comparable Cohort / Case Control Studies, Activity of Daily Living: ADL, Functional Independence Measure: FIM.						