PEPS training program developed for stroke patients

PEPS: a socially interactive **P**eer group regulated **E**xercise **P**rogram developed for **S**troke patients. A study into effects of two different ways of doing the exercise tasks.

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Content Pages

Introduction

Each year more than 17 million people in the world are experiencing a stroke (Crichton et al., 2016). There are no prevalence or incidence data for the whole of Bangladesh but the risk factors for stroke (obesity, high blood pressure, tobacco smoking, physical inactivity and diabetes) in the population are high (World Health Organization, 2018). Stroke prevalence estimations regarding the rural areas of Bangladesh only mention 1.96 per 1000 inhabitants (Saha et al., 2018).

At the Centre for the Rehabilitation of the Paralysed (CRP) we offer rehabilitation to stroke patients and this number is increasing each year. That implicates that this patient group is one of the main diagnosis categories within our rehabilitation centre.

Stroke is worldwide acknowledged as a major cause of mortality and is one of the most prevalent causes of various kinds of serious disablement in various domains of life in stroke survivors (Wang et al., 2016; Doussoulin et al., 2018).

Stroke survivors often will experience restricted participation in various domains e.g. in using public transportation and in working, not being able to fulfil the job requirements. That is why they are easily losing their broad circle of former social contacts and are at risk for social deprivation, especially so if they also suffer from problems in speech understanding and speaking (aphasia).

Up and above they also show limitations in common daily activities, which implies that they often need help or have to use assistive devices in e.g. washing themselves, toilet use, walking and moving around, and doing household chorus like preparing food and cleaning. The main impediments here are the muscle weakness, spasticity and impaired control predominantly over one of the arm/hands, which are very common after stroke (Pang et al., 2007; Reed et al., 2010; Batool et al., 2015). Evidence shows that approximately 33% to 66% of patients with upper limb paresis shows only minimum functional recovery at 6 months after stroke. Therefore, patients mainly rely on their unaffected arm/hand to perform daily activities and refrain from using the impaired arm/hand, or only use it for stabilizing objects. (Taub et al., 1993; Waller & Whitall, 2008; Smania et al., 2016). We call that: 'learned no use'. However, it is known that also after a stroke new connection could be made in the brain when strenuously training tasks. This mechanism is applied in the stroke rehabilitation program under study by an evidence-based method called 'Constraint Induced Movement Therapy' (CIMT). In CIMT the use of the non-paretic hand is hindered by wearing a mitten, so that the patients are forced to perform tasks predominantly with the paretic hand (Barzel et al., 2015).

The original CIMT protocol includes three main elements:

1. Constraining of the non-paretic hand to force the use of the paretic hand/arm throughout 90% of the waking hours (Taub et al., 2013).
2. Repetitive task-oriented training of the paretic arm/hand for 6 hours per day in 10 consecutive weekdays. Repetitive, because is it known that 600-800 repetitions per task must be made for getting new connections in the brain.
3. Adherence-enhancing behavioural methods, developed to promote the use of this technique in the patients' daily environment, outside the therapeutic setting.

Although CIMT trials are showing variations in the kind of tasks to be trained, the time/duration of practice per day and the intensity or duration of the therapy, they all published significant effects of CIMT in stroke rehabilitation compared to traditional therapy (Mclntyre et al., 2012; Wu CY et al., 2014), such as improvement of the quality of movement and the frequency in which the paretic limb is used (El-Helow et al., 2015; Liu et al., 2017; Shi et al., 2011; Singh et al., 2013). A systematic review by Kwakkel et al. (2015) showed those effects among 467 published trials. Although CIMT or modified versions (mCIMT) are worldwide considered the most effective rehabilitation treatment for improving the functioning of the affected arm/hand in stroke, this treatment is not yet applied in Bangladesh. To overcome this flaw in our rehabilitation, we have made a comprehensive program for CIMT application. Our purpose is to study if better effects by CIMT might also be found in stroke patients in the situation in Bangladesh.

Development principles

We have studied the various CIMT and mCIMT publications and developed together with stroke patients and therapists a program to apply in our CRP setting, with all training activities and tasks tuned in to our culture. We explicitly strive for a method that invites participants to engage in maximal social interactions within the peer group of stroke patients. Long-lasting relationships with and support from peers may help patients to maintain a regimen of exercising on their own.

Before officially starting the program, we have given a 7 days training to 6 qualified therapists in how to provide the specific PEPS program. Therapists were randomly allocated to either the experimental (3 therapists) or the control group (3 therapists). The experimental group therapists were trained to supervise if the patients were doing all tasks with the paretic hand

while wearing the mitten on the non-paretic hand. The control group therapists had to supervise if the patients were doing all tasks bimanually. Both groups of therapists were forbidden to share their training knowledge with each other as part of study protocol. Moreover, therapists have no idea which group is the control, and which is the experimental group. In other words: they were blinded for the intervention.

We offered this program in addition to the more individually focused rehabilitation as usual. This extra training program was provided in the evenings after official working time.
Our program explicitly focuses on adherence-enhancing behavioural methods together with repetitive task-oriented training, and the training being peer regulated. That includes:

1. Patients are training in a group together with other patients with a stroke (groups 6-8 persons, max group size 15).

2. One of the patients is chosen and assigned as a 'leader', based on natural characteristics as being social outreaching, respectful and easily understanding new tasks. He/she announces the next exercise task (with support of the therapist) while the therapist is there mainly for helping and correcting patients if needed.

3. Tasks are fine-tuned to the Bangladesh' situation and available exercise material and included tasks regarding gender-specific clothing, manipulation of small and bigger objects and tasks that needs also cognitive solutions.

4. Within the training there are various kinds of socializing tasks, and at the last training day they will together prepare and eat a meal.

5. Patients are encouraged to sing, tell stories, share experiences, compliment and encourage each other during the sessions.

6. Patients were encouraged to perform the trained tasks by themselves at home as well, and to report about that during the sessions.

The above method is the kernel of the 4 weeks program, and short as well as long term effects will be studied. As primary study question, we addressed the specific way of manually executing the tasks, in two study groups: a control group and an experimental group. The kernel PEPS-method was applied in both the control and experimental group. But the control group mainly performed the exercise tasks bimanually, as in as usual' therapy sessions (**PEPS-bimanual**), whereas the experimental group performed the exercise tasks with forced use of

the most affected hand (wearing a specially designed -not warm- mitten at the non-paretic hand; **PEPS-MIT**).

We examined and compared the effects of the two training methods in two groups (control and experimental) each consisting of 70 patients. Effects were measured at the start and at the finish (4 weeks later) of the training period, and at 3 months, 6 months, and 9 months follow-up, with respect to arm/hand functioning on various activity tests, ADL performance and self-perceived health, and on adherence to long-lasting self-training at home. We did so in two branches (Savar and Mirpur) of the Centre for the Rehabilitation of the Paralysed (CRP) in Bangladesh.

Patients were at random assigned to one of the two groups and both the assessors and involved therapists were blinded for the study as were the patients themselves.

Our hypothesis is that the applied adherence-enhancing behavioural method will have dominant effects, and that the methods: 'bimanually (PEPS-bimanual)' versus 'forced use of paretic arm/hand by wearing a mitten' (PEPS-MIT) will show equal improvements in the short and longer term. As soon as the results are known, we will add that to this description of the program with evidence based recommendations to apply either the PEPS-MIT method or the PEPS-bimanual, or to apply the peer regulated program PEPS with no recommendations for either way of training.

General description of the PEPS program

All tasks were practiced in supervised peer regulated group intervention sessions. The program consists of a four-weeks peer group therapy. We believe that favourable patient outcomes might, in the future, encourage therapists to offer the PEPS method in outpatient services since such strategy reduces therapists' time and burden in comparison to individual treatment only.

The group program includes fun games and activities to reduce strenuous burden for the patients (making fun, laughing, facilitating strong group feelings with the same problems and working together to overcome these problems) while training in those extra hours. According to Reed et al. (2010) and Lee et al. (2018), evidence shows that traditional therapy can help stroke patients, but fun group activities tend to get the job done better because they are more entertaining and feel less overwhelming.

In order to make the program culturally accepted all activities were based on common and gender specific Bangladeshi tasks.

Inclusion Criteria for participation:

Both sub-acute and chronic stroke patients who need upper limb rehabilitation, males and females. Further inclusion criteria in addition to the stroke diagnosis were: patient must show between 10 to 20 degrees of active wrist extension and 10 degrees of active finger extension; 20 points or more on the Mini-Mental State Examination scale; age range 18–75 years and first stroke.

Exclusion Criteria: Persons with other neurological disorders, bilateral stroke, recurrent stroke history and unstable cardiovascular disease were excluded from the study.

Number of training sessions

We offered this two hour program in each of the 5 session-days per week, during 4 weeks in total (that is a 40 hours program in total).

Additionally, PEPS-MIT groups were encouraged to wear the mitten for three hours a day at home.

The behavioural strategies of further self-training at home included a treatment contract and daily use of the activity check list, which was signed by both patient (if possible) and caregiver. Each day patient's caregiver submits the activity check list to therapist and the therapist gives feedback.

Outline of Training levels and principles

Training Levels

Level 1 (Gross Arm movement)

- ✓ Activating wrist and finger extension through proximal control of the shoulder girdle.
- ✓ Motor control of the arm, emphasizing protraction of the shoulder and extension of the elbow.
- ✓ Motor control of the arm, emphasizing wrist and finger extension.
- ✓ Motor control of the arm in different directions, emphasizing wrist and finger extension.
- ✓ Motor control of the arm in different directions, emphasizing extension of the elbow in combination with a finger grip.

Level 2 (Grasps / grips and gaming)

- ✓ Improving the cylinder grip with the focus on extension of wrist and fingers.
- ✓ Improving the pinch grip, with the focus on the extension of the fingers and wrist.

Level 3 (In-hand manipulation and gaming)

- ✓ Improving the in-hand manipulation of objects and fine motor control of the hand.
- ✓ Improving motor control of the intrinsic muscles of the fingers and the hand.

Level 4 (ADL and playing games)

- ✓ Improving dexterity with other gross movements of the body, including the lower extremities.

Other applied training principles

In the original CIMT protocol repetitive training consists of ‘shaping’ and ‘task practice’. We apply these principles to both methods of fulfilling the tasks: Bimanually and Mitten-wearing. However, the ways of using and integrating the paretic hand and arm during the tasks are totally different: as a combined effort with the non-paretic arm/hand in the Bimanual execution of tasks or as task-execution exclusively with the paretic arm/hand in the Mitten-wearing situation.

1. Shaping of Tasks

Shaping: During each session, shaping principles play a dominant role. Shaping is defined as a training method in which a motor objective is approached in small steps by successive approximations (Wolf et al., 2006). For instance, the task difficulty can be incrementally increased in accordance with a patient's capabilities, or the requirements for a speedier performance can be progressively augmented. The main objective is to encourage the patient to use the paretic upper limb repeatedly to overcome (or prevent) learned non-use and to induce activity-dependent cortical reorganization (Nijland et al., 2013). Also, feedback provided during shaping should be immediate and specific and emphasize only positive aspects of the patient's performance to motivate the patient to apply continued and maximal effort. In the present study Shaping was mainly applied at levels 1 and 2 of the treatment.

2. Task practice: Task practice is a less structured way of training than shaping. Task practice is defined as a training method in which functional tasks are practiced. It is implemented mainly at level 3 and level 4 of the treatment, when a patient has successfully completed levels 1 and 2 and is able to integrate the improved control of the extensors in functional unilateral tasks like eating, cutting vegetables, cleaning a table, ironing or writing. However, therapists need to focus on finger extension and prevent compensatory movements.

Selecting daily tasks: Tasks like folding and unfolding a towel, wiping the table, clipping on clothes, washing own face, holding a shopping bag, arranging the scarf (women) or topi (man), drying dishes, mixing rice were to be performed in both a standing and siting position. Other tasks are making a drawing, and weekly there was one-day preserved for gardening activities.

Selecting games as fun tasks: Connect four, Master mind; Passing hat whom you like; Chair round; Pillow passing game, Dutch throw, Ring Throw, Snakes and Ladders (one hand use).

Week-to-week Protocol summary

Conventional Treatment	PEPS	Duration
Yes- one hour	Yes – 2 hours	2h for 5 day a week, for 4 constructive weeks

1st Week Intervention

Types of Exercise	Prescriptive guideline	Comments
1. Gross arm movements		Before starting group practice warming-up exercise /relaxation techniques for 5 min
1.1 The swing exercise	15 min	
1.2 The pushing away exercise	15 min	
1.3 The hand-on-table exercise	10 min	
1.4 The wiping table exercise	15 min	10 min break after an hour treatment
1.5 The reaching exercise	15 min	
1.6 Ball passing game	15 min	
2. Grasp and release		
2.1 The cylinder grip exercise	15 min	
2.2 The disk grasp exercise	10 min	
2.3 Thera -putty exercise or Ball passing game	10 min	
	Total :120 min	

2nd week

Types of Exercise	Prescriptive guideline	Comments
1. Gross arm movement	35 min for first four sections of intervention	
2. Grasp and release	30 min for all sections	
2.4. Fine motor		
2.5 Heavy pinch	10 min	
3. In-hand manipulation		
3.1 Marvel exercise	10 min	
3.2 Rice mixing exercise	10 min	
3.3 The tissue exercises	10 min	
3.4 Matching exercise (Cube puzzle) /Mastermind game/ Connect four/ Snakes and Ladders	15 min	Small groups will perform different games.

3rd Week

Types of Exercise	Prescriptive guideline	Comments
1. Gross arm movement	20 min of first 1.2 to 1.5 section exercise	
2. Grasp and release	15 min practice of 2.1 to 2.3-5 min per exercise	
3. In-hand manipulation	15 min practice of 3.1 to 3.3 section.	
4. ADL		
4.1 Arranging scarf and Topi or cap	15 min	
4.2 Grooming	15 min	
4.3 Buttoning/zipper/Velcro practice	15 min	
4.4 Cutting vegetables/ Dishes drying	20 min	First two days cutting vegetables, Next two days dish washing and drying, last days' session is gardening.

4th Week

Types of Exercise	Prescriptive guideline	Comments
4. ADL		
4.1 Arranging scarf and Topi or cap	10 min	
4.2 Grooming	10 min	
4.3 Buttoning /zipper/ Velcro practice	10 min	
4.4 Dish washing and drying/ Gardening	15 min	
4.5 Eating cookies	10 min	
5. Gaming		
5.1 Pillow passing game/ Ring throw/ Dutch throw	10 min	If patient group size is 15 then three group for these game
5.2 Connect four/ Master mind game/	15 min	Two subgroups for play two games
5.3 Passing Hat whom you like	15 min	
5.4 Chair round game	15 min	
6. Cooking and meal preparation	One day in last week (After performing some warming-up exercises)	Activities are divided over small groups. Thanksgiving ceremony

Detailed description of exercise tasks

Level 1: Gross arm movements

1.1 The swing exercise

Task description

The patient sits on a chair without armrests. A box with an anti-slip mat/towel is placed in front of the patient, about an arm length away. The patient leans a bit forward to initiate a swing, then swings the arm backward and forward and then the patient places the hand flat on the anti-slip mat.

Aim

1: Activating wrist and finger extension through proximal control of the shoulder girdle.

1.2 The pushing away exercise

Task description

The patient sits on a chair with a table with towel in front. The paretic hand lies on the towel, and the non-paretic arm lies on the patient's lap. The patient pushes the trunk away as far as possible, with the paretic hand fixed on a table.

Aim

Motor control of the arm, emphasizing protraction of the shoulder and extension of the elbow.

1.3 The hand-on-table exercise

Task description

The patient sits on a chair without armrests with a table with a towel. The patient puts the arm on the table and places the hand on the towel and try to fold it.

Aim

Motor control of the arm, emphasizing wrist and finger extension.

1.4 The reaching exercise

Task description

The patient sits on a chair with a scarf (female) and cap (male) in front of him/her at the table. The patient puts the paretic elbow on the table and then places the hand flat on the scarf or cap. Patient will same activity in standing position.

Aim

Motor control of the arm in different directions, emphasizing wrist and finger extension.

1.5 The tipping-chair exercise

Task description

The patient sits on a chair with another chair in front. The second chair is one arm length away from the patient. The patient places the paretic hand on the back of the second chair. The patient gives pressure to the back of the chair to tip the chair, so it is standing on the two front legs. Eventually, the therapist assists the patient to tip the chair. The patient attempts to keep it on two legs as long as possible. Then, the patient lets the chair go as slowly as possible.

Aim

Motor control of the arm, emphasizing isometric, eccentric and concentric extension of the elbow.

1.6 The wiping table exercise

Figure: Wiping Table exercise

Task description

The patient sits/stand in front of table. The therapist holds the cleaning towel in front of the patient about an arm length away. The patient reaches for the towel, grasps it and keeps it still with an outreached arm. Then, the patient tries to make controlled movements with the towel in whatever direction to wipe the table.

Aim

Motor control of the arm in different directions, emphasizing extension of the elbow in combination with a grip.

General shaping progression parameters in level 1:

• Accuracy: Use a smaller target • Distance: Place the target further away. • Height: Increase the height of the target. • Speed/endurance: Increase the number of repetitions in a defined time span. • Assistance: Decrease the hands-on facilitation.

Level 2: Grasp/Grip

Figure: Different Grasp and Grip exercises

2.1 The cylinder grip exercise

Task description

The patient sits in a chair with a table in front. A large cylindrical grasp game is placed on the table. The patient grasps, moves and releases cylinders using a cylinder grip**.**

Aim

Improving the cylinder grip with the focus on extension of wrist and fingers.

2.2 The grasp exercise

Task description

The patient sits in a chair with a table in front. A large disk tree game will be in front of patient. The patient grasps the disk, moves, releases and replacing them using five fingers.

Aim

Improving the grip, by motor control of the intrinsic muscles and extension and flexion of the fingers.

2.3 The pinch exercise

Task description

The patient sits in a chair with a table in front. A large hole peg game is placed on the table. The patient grasps, moves and releases the peg using a pinch grip**.**

Aim

Improving the pinch grip, with the focus on the extension of the fingers and wrist.

2.4 Heavy pinch exercise

The patient sits in a chair with a table in front. Cloth clip with different height game will be provided. The patient grasps, press and releases the stones using a pinch grip.

Aim

Improve heavy pinch.

General shaping progression parameters in level 2:

• Use bigger or heavier objects. • Increase the speed. • Change the position of the task with the game lying on the table.

Level 3a: In-hand manipulation

3.1 The marble exercise

Task description

The patient sits in a chair with a table in front. A tray with marbles is placed on the table. The patient picks up the marbles one by one and holds them in the hand while picking up the next one. The patient tries to pick up as many marbles as possible.

Aim

Improving the in-hand manipulation of objects and fine motor control of the hand.

3.2 The rice mixing exercise

Task description

The patient sits in a chair with a table in front. Two rice plats will place. One tray is filled with water, the other one with rice. The patient places the more affected hand in the water and then in the tray with rice. The patient then uses the fingers tips and the thumb of the same hand to get the rice of the hand.

Aim

Improving selective movements of the fingers and the thumb.

3.3. The tissue exercises

Task description

The patient sits in a chair with a table in front. Tissues are placed on the table. The patient picks up a tissue with the more affected hand and tries to crumble the tissue by opening and closing the fingers and pressing the tissue in the hand.

Aim

Improving motor control of the intrinsic muscles of the fingers and the hand.

General shaping progression parameters in level 3:

• Increase the speed. • Perform the task without support of the elbow on the table. • Use more smooth objects.

Level 4: ADL

4.1 Wearing UL dress (Half task can be acceptable) / scarf / Topi / cap /

Volunteer/care giver will hold shirt / kamiz / scarf or topi, patient will reach it and try to wear it. If cannot perform properly therapist/ care giver will assist.

4.2 Grooming

Washing Face, Hair combing, Putting cream on the face (women) and for the men aftershave.

4.3 Cutting Vegetables, Dish drying in standing/sitting position.

4.4 Gardening

One day in week patients are working in garden for weeding, planting and watering in use of one hand. Patient can perform activities in sitting, squatting and standing position (with support/without support).

4.5 Buttoning / zipper/ Velcro practice with one hand.

4.6 Cooking and meal preparation.

Practice one day in last week. After performing some warm-up exercise patient will do this activity.

Figure: Meal preparation activities

AIM of ADL

Improve fine motor and gross motor movement of body, involving in activities improve functional ability.

5. Gaming

It will perform different level of treatment to develop cheerful environment in peer group setting.

Figure: Gaming

5.1 Connect four/Master mind games/ matching exercise (Cube puzzle)

Two patients are playing for wining game in sitting position.

5.2 Ball passing game

Patients are sitting in circle and passing pillow one another with music.

5.3 Passing Hat whom you like

Patient will select one person then stand up and pointing on /walk towards the person with cap. After that place the cap on the head of that person.

5.4 Chair round game

Patients are going up and down chairs and walking around chairs, then sit on chair.

5.5 Snakes and Ladders

Playing with caregiver/ peer.

5.6 Ring throw / Dutch throw

Practicing in subgroups.

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