

# **GRASP**

## **Graded Repetitive Arm Supplementary Program:**

**A home-work based program to improve arm and hand function in people living with stroke**

# **GUIDELINES & MANUAL**

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The GRASP Program was developed in Vancouver, Canada by Janice Eng, PhD, PT/OT and Jocelyn Harris, PhD, OT with valuable assistance from Andrew Dawson, MD, FRCP and Bill Miller, PhD, OT and with funding from the Heart and Stroke Foundation of BC and Yukon.

This manual has been prepared based on current scientific evidence. Health and medical knowledge is constantly changing. Users of this material should periodically review this material to ensure that the content is consistent with current reasonable clinical practice. It is the responsibility of the practitioner or exercise instructor, relying on experience and knowledge of the client, to determine the appropriate treatment for each individual. The GRASP authors, contributors and supporting institutions shall not be liable for any damages, injuries, claims, liabilities, costs or obligations arising from the use or misuse of this material. If you have or suspect you have a health problem, you should consult your health care provider.

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## **GRASP (Graded Repetitive Arm Supplementary Program)**

This is the Instruction Manual and Guidelines for GRASP. Please read this first prior to using the three GRASP books (level 1, 2, and 3). The GRASP books can be downloaded at [www.rehab.ubc.ca/jeng](http://www.rehab.ubc.ca/jeng) (go to “Our Exercise Manuals”).

### **Effect of stroke on arm and hand function**

Stroke is the number one cause of neurological disability in Canada today. About 85% of patients admitted to hospital for stroke present with problems with their arms and hands. Stroke-related physical impairments such as muscle weakness, pain, and spasticity can lead to a reduction in the ability to use the stroke-affected arm and hand in daily activities. In fact, the avoidance of using one’s stroke-affected arm is so common, that there is even a name for it “learned non-use syndrome”. Unfortunately, not using the stroke-affected arm can lead to a further loss in strength, range of motion, and fine motor skills. These can then result in contractures, pain and severe bone loss (osteoporosis).

### **What is GRASP?**

Greater amounts of upper extremity therapy during inpatient rehabilitation can improve the ability to use one’s arms and hands. However, shrinking resources make it difficult to deliver even the current amount of therapy, and impossible to deliver more therapy. Thus, novel methods which are practical, inexpensive and well-received by patients and clinicians are needed to deliver greater amounts of therapy. GRASP is a novel method which is practical and inexpensive to deliver greater amounts of therapy with a focus on functional tasks of the upper extremities.

GRASP is a self-directed arm and hand exercise program which is supervised by a therapist, but done independent by the patient (and with their family if possible). This program has been designed to improve arm and hand function in people living with a stroke and serves as a complement to the regular therapy that one receives in the hospital. It was not meant to replace existing therapy services, but to add critical upper extremity practice time for the patient. Patients undergoing inpatient stroke rehabilitation are surprisingly inactive. Further, the amount that patients use their affected arm is extremely low especially outside of their regular therapy. There are multiple benefits of a supplementary inpatient upper extremity practice program: it increases the potential for functional recovery, facilitates the eventual transition to self-managed exercise programs post-discharge, prevents the “learned non-use” syndrome commonly found after stroke, engages the client in the therapy process, places an expectation of active participation on the patient, promotes independent activity, and facilitates family involvement.

### **Research evidence behind GRASP**

A community-based group upper extremity program was first developed in Vancouver, Canada by Janice Eng, PhD, PT/OT, Marco Pang, PhD, PT and Jocelyn Harris, PhD, OT. This functional program of upper extremity strengthening, fine motor tasks and repetitive functional tasks was found to improve outcome measures of the Wolf Motor Function Test and Fugl-Meyer

Upper Extremity Assessment in people with chronic stroke. The randomized controlled trial involved 63 people with chronic stroke.

Following the success of this trial, we developed GRASP (Janice Eng, Jocelyn Harris) with invaluable assistance from Andrew Dawson, MD, FRCP and Bill Miller, PhD, OT. GRASP has been tested in a multi-centred randomized controlled trial with 103 sub-acute stroke patients (generally in their first month post-stroke) in the province of British Columbia, Canada. Two of the sites were large urban centres, while the other two were smaller cities. In the province of British Columbia, stroke patients are admitted to an inpatient rehabilitation program following stabilization of their medical needs in acute care. The average length of inpatient rehabilitation is 4 weeks. Both the GRASP and control group (educational program) received standard inpatient stroke rehabilitation (daily physical therapy and occupational therapy). The site coordinator (physical therapist or occupational therapist) instructed the GRASP group in the exercises or instructed the Control group in the educational module (information on stroke, nutrition, pain management, bone health management, etc). Both the GRASP and Control group then did their respective programs as “homework” on their own with occasional checks by the therapist.

The GRASP group demonstrated improvements in arm and hand function (Chedoke Arm and Hand Activity Inventory, Action Research Arm Test), use of the hand (outside of therapy) and grip strength. In addition, the GRASP group had less depressive symptoms following the trial. A variety of arm and hand exercise programs for people living with stroke have been developed, but the GRASP program stands alone in showing that it is effective with very little resources (therapy, equipment) required. The tasks in the program were selected for their 1. proven effectiveness in improving upper extremity function, 2. ease of performing without specialized or expensive equipment, 3. ability to be progressed and graded, 4. safety with minimal chance of injury, and 5. task-specificity and meaningfulness to the patient.

The following publications and their abstracts serve as evidence for our upper extremity programs for people with stroke.

Pang MY, Harris JE, Eng JJ. A community-based upper-extremity group exercise program improves motor function and performance of functional activities in chronic stroke: a randomized controlled trial. *Archives of Physical Medicine and Rehabilitation*. 2006 Jan;87(1):1-9.

**OBJECTIVE:** To assess the effects of a community-based exercise program on motor recovery and functional abilities of the paretic upper extremity in persons with chronic stroke.

**DESIGN:** Randomized controlled trial.

**SETTING:** Rehabilitation research laboratory and a community hall.

**PARTICIPANTS:** A sample of 63 people (> or =50y) with chronic deficits resulting from stroke (onset > or =1y).

**INTERVENTIONS:** The arm group underwent an exercise program designed to improve upper-extremity function (1h/session, 3 sessions/wk for 19wk). The leg group underwent a lower-extremity exercise program.

**MAIN OUTCOME MEASURES:** The Wolf Motor Function Test (WMFT), Fugl-Meyer Assessment (FMA), hand-held dynamometry (grip strength), and the Motor Activity Log.

**RESULTS:** Multivariate analysis showed a significant group by time interaction (Wilks  $\lambda=0.726$ ,  $P=0.017$ ), indicating that overall, the arm group had significantly more improvement than the leg group. Post hoc analysis demonstrated that gains in WMFT (functional ability) ( $P=0.001$ ) and FMA ( $P=0.001$ ) scores were significantly higher in the arm group. The amount of improvement was comparable to other novel treatment approaches such as constraint-induced movement therapy or robot-aided exercise training previously reported in chronic stroke. Participants with moderate arm impairment benefited more from the program.

**CONCLUSIONS:** The pilot study showed that a community-based exercise program can improve upper-extremity function in persons with chronic stroke. This outcome justifies a larger clinical trial to further assess efficacy and cost effectiveness.

Harris JE, Eng JJ, Miller WC, Dawson AS. A self-administered Graded Repetitive Arm Supplementary Program (GRASP) improves arm function during inpatient stroke rehabilitation: a multi-site randomized controlled trial. *Stroke*. 2009 Jun;40(6):2123-8.

**BACKGROUND AND PURPOSE:** More than 70% of individuals who have a stroke experience upper limb deficits that impact daily activities. Increased amount of upper limb therapy has positive effects; however, practical and inexpensive methods of therapy are needed to deliver this increase in therapy.

**METHODS:** This was a multi-site single blind randomized controlled trial to determine the effectiveness of a 4-week self-administered graded repetitive upper limb supplementary program (GRASP) on arm recovery in stroke. 103 inpatients with stroke were randomized to the experimental group (GRASP group,  $n=53$ ) or the control group (education protocol,  $n=50$ ). The primary outcome measure was the Chedoke Arm and Hand Activity Inventory (CAHAI), a measure of upper limb function in activities of daily living. Secondary measures were used to evaluate grip strength and paretic upper limb use outside of therapy time. Intention-to-treat analysis was performed. Group differences were tested using analysis of covariance.

**RESULTS:** At the end of the 4-week intervention (approximately 7 weeks poststroke), the GRASP group showed greater improvement in upper limb function (CAHAI) compared to the control group (mean difference 6.2; 95% CI: 3.4 to 9.0;  $P<0.001$ ). The GRASP group maintained this significant gain at 5 months poststroke. Significant differences were also found in favor of the GRASP protocol for grip strength and paretic upper limb use. No serious adverse effects were experienced.

**CONCLUSIONS:** A self-administered homework exercise program provides a cost-, time-, and treatment-effective delivery model for improving upper limb recovery in subacute stroke.

### **Components of GRASP**

The exercises for both the paper Pang et al. (2006) and Harris et al. (2009) have components of strengthening, range of motion, weight-bearing, and trunk control. In addition, gross and fine motor skills are practiced. Both unilateral movements of the stroke-affected arm/hand are practiced, as well as bilateral functional movements. GRASP was developed as a homework program because we know that more therapy produces better results, but it is difficult to get more therapy in our current health care setting. A loss of joint range is common following stroke

due to weakness, muscle stiffness, spasticity and inactivity. Muscle weakness is addressed through functional strengthening. The ability to use the arm is dependent on trunk control. Thus, a number of the exercises involve trunk movements (e.g sitting and reach to the ground, sitting and arm push-ups on a table). Altered bilateral coordination is evident following a stroke and improvements in movements are best accomplished by utilizing functional movements and postures under challenging conditions (eg, rolling a ball from one hand to another, opening a jar, drying with a towel). In addition, it is known that many repetitions are required for improving motor learning. Thus, exercises are generally done in “sets” of 5 or 10 and then repeated as tolerated.

#### Range of motion and stretching

There is increasing evidence that contractures commonly develop post-stroke and interfere with upper extremity function. It is important to maintain extensibility of the muscles to promote subsequent strengthening through full range of motion.

#### Functional strengthening

Previously, clinicians discouraged muscle strengthening post-stroke, however, intensive muscle strengthening has not been found to increase spasticity. Furthermore, strengthening has been found to be effective in improving upper extremity function in sub-acute stroke. We have also found that upper extremity muscle strength is the major predictor of bone density and the ability to perform activities of daily living which involve the upper extremities. Graded weights and theraband can be used to strengthen the shoulder, elbow and wrist joints. Theraputty can be used to strengthen the hand muscles. In addition, common items, like cans (for a lift and reach task) and jars (lid tightening and releasing) are useful for utilizing in functional strengthening tasks.

#### Weight-bearing through hand

With a reduction in arm use, there is reduced loading to muscle, bone and sensory receptors. Controlled weight-bearing through the hand is one method to increase muscle activation without weights (e.g., while sitting, lean forward on hands on table and perform a partial push-up). In addition, weight-bearing will help to reduce the known bone loss which occurs early post-stroke. Bone loss is a major predictor of upper extremity fractures resulting from a fall. For weight-bearing through the hand, it is important to place the hand in a flat, open position with the wrist in a neutral alignment with the forearm. The patient may require assistance to attain this position. Our program was not designed for those stroke patients with a fixed, closed hand.

#### Trunk control

Better trunk control is known to facilitate arm reaching. Thus, exercises to challenge trunk movements are important for upper extremity function.

#### Repetitive paretic arm practice

Forced-use of the upper extremity has produced strong evidence of functional improvements primarily in chronic stroke, although more recent studies have utilized sub-acute stroke. Varying accuracy and speed requirements are integrated within the fine motor and gross motor tasks.

#### Repetitive bilateral arm tasks

The majority of daily tasks are bilateral. Repetitive bilateral arm training has been shown to improve arm and fine motor function. Bilateral tasks are realistic of the many activities of daily living which require bilateral arm and hand coordination. Tasks include folding towels or clothes, doing buttons and zippers, and bilateral arm strengthening exercises (theraband).

### **Facilities**

The GRASP program has been undertaken in a rehabilitation hospital setting and most patients undertook the exercises in their room or the common room if there was one. Once patients were discharged, they undertook the exercises in their home. Note, that as our primary purpose was to assess the effectiveness of GRASP in the sub-acute inpatient phase, we did not provide any formal encouragement for patients to continue GRASP once discharged. Likely our long term results would have been even better if we had monitored this activity after discharge.

### **Equipment**

GRASP participants were given a bag of equipment which consisted of:

- Hand gripper to provide resistance for grip strength exercises. The gripper should offer low to moderate resistance and the patient should be able to squeeze the gripper to its full range. Often standard gym grippers are too difficult for stroke patients. We purchased our grippers from a medical supply store which are more expensive, but had a low resistance.
  - Theraputty (from a medical supply store and different resistances are available)
  - Light weight. We used a small 1 pound circular rubber weight which went around the wrist.
  - Ball (e.g, tennis ball)
  - Clothes pegs
  - Lego pieces
  - Plastic jar and lid
  - Hand towel (long enough to dry back)
  - Paper clips
  - Beanbag
  - Target board. We used a plastic sheet (about 2 X 3 feet) with large target circles on it.
- A variety of fine motor equipment can be substituted, however, it is critical that the weight, hand gripper and theraputty be part of the kit.

### **Who is appropriate for this program?**

The group upper extremity program by Pang et al. (2006) utilized people with chronic stroke (greater than one year post-stroke). The GRASP study by Harris et al. (2009) utilized people with sub-acute stroke who were admitted for rehabilitation (usually within 2 weeks of their stroke).

The GRASP protocol is appropriate for people who are able to actively elevate their scapula (shoulder shrug) against gravity. In addition, they require palpable wrist extension (grade 1). Thus, if the patient rests their stroke-affected hand palm down on a table, they are able to start to lift the fingers off the table. You may see just a tiny bit of movement on the lift, or you can feel muscle activation if you place your fingers over the wrist joint tendons. Patients who have a

fixed hand and cannot partially open the hand or fingers are not appropriate for this exercise program.

The GRASP study included patients with a Fugl-Meyer score (upper limb subscale) between 10 and 57. The exclusion criteria were unstable cardiovascular status, significant upper limb musculoskeletal or neurological condition other than stroke, Mini Mental Status Exam <20, or receptive aphasia. Our participants were required to have “near-normal” cognition as assessed by the Folstein Mini-mental Test, but this was in part due to the requirement of completing the numerous study evaluation forms. Participants will need to be able to pay attention, follow instructions and mimic exercises for one hour. In addition, participants need to be aware of their safe bounds of ability and report pain or fatigue so that the exercises can be adjusted as necessary. Receptive aphasia and low levels of cognition were exclusion criteria for our study, however involvement of family or caregivers may be able to assist patient with cognitive or aphasia issues.

We’ve had participants who did not speak the language of instruction (in our case, English) but some communication is necessary (perhaps through a family member) to ensure that the participant can follow the instructions and is not experiencing any adverse effects such as pain or fatigue.

### **Teaching the program to the patient**

GRASP was taught by an occupational therapist or physical therapist to the patient. There are three books (level 1, 2, and 3). We prescribed the book level based on the Fugl-Meyer Score where level 1 was appropriate for Fugl-Meyer scores of 10 to 25, level 2 for 26 to 45 and level 3 for 46 to 58. Level 1 is the lowest level and requires minimal, but some hand function. Level 1 patients will be picking up objects such as beanbags or a towel which are easy to grasp, but fine motor skills are not required. Gross motor skills where the two hands are clasped together are also practiced. Level 2 requires more graded control of hand grasp/release and fine motor skills. Level 3 has substantial fine motor tasks and patients should be able to grasp and release objects like clothes pegs, Lego Pieces and small blocks (albeit with difficulty).

Once you have assigned the appropriate exercise manual to the patient, note the following:

1. Each manual has graded exercises within them. For example strengthening exercises start at 1 set of 5 and then increase to 3 sets of 5.
2. In our trial, the therapist taught the exercises on the first visit to the patient and their family if willing to participate. It is important to engage the family if possible, as family involvement with GRASP leads to better outcomes. Each exercise was introduced to the patient and the patient copied the therapist to ensure that they understood the instructions. If the patient has no problem with that grade level, they were started at the next grade level for their independent work. For example, if using level 1 and the subject had no difficulty with 2 sets of 5, you would have them start at 3 sets of 5. There is room at each appropriate exercise for you to check off the box identifying the required sets of exercise repetition.
3. The therapist reviewed the exercises the next day with the patient. If the subject is having no difficulty with the grade (i.e. 3 sets of 5) then raise it to the next grade, 2 sets of 8. Once the subject can do the final grade for the majority of the exercises (over 50%), the next exercise



manual level should be given. After that, the therapist visited approximately once a week to check on the patient and progress the patient to the next book level if necessary.

4. If the subject is on level 3, you can increase the sets and repetitions to 2 sets of 12, then 3 sets of 12. Stop at this level of grading.

#### Additional Tips for Modifying Exercises

1. Some individuals may need a pillow behind their back to maintain an upright position.
2. A pillow on their seat or wheelchair cushion may help elevate them to an appropriate height for the target board exercises.
3. For those individuals with shoulder pain, you can decrease the repetitions and or encourage only partial range, and or encourage more rest breaks.
4. For those individuals with tone, you can decrease the repetitions, decrease the weight (only do anti-gravity), have them rotate between doing the exercise with their non-paretic and paretic arm, encourage more rest breaks, and stretching.
5. For those with high tone in the hand and wrist, you could modify the gripping exercises by using a ball instead of the gripper, using a gripper with less resistance, or even have them open and close their hand.
6. For those individuals that are using major compensatory movements (i.e. shoulder hiking, shoulder abduction etc for reaching) you can have them do the exercises in front of a mirror to encourage proper movement.

Please note: The focus of this program is not to limit movement if the person is unable to do the movement properly. It is important that they are encouraged to keep moving their paretic arm as best they can. Improper movement should not be the cause of omitting an exercise.

**Overview of visits from therapist**

<p><b>First Visit</b> (about 60 min)</p> <p>Document on the sheet provided the level they are starting at.</p>	<ol style="list-style-type: none"> <li>1. Explain the purpose and benefits of the program to the patient and family.</li> <li>2. Explain what is expected of them <ol style="list-style-type: none"> <li>a) exercises are to be done daily</li> <li>b) all exercises in the book should be completed if possible within the 60 minutes</li> <li>c) exercise either for one 60 minute period daily or two 30 minute periods daily</li> <li>d) importance of continuing regular therapy (OT/PT/Recreation) (that GRASP is a program in addition to regular therapy)</li> <li>e) importance of writing down any questions, problems</li> </ol> </li> <li>3. Show patient and family the exercise binder (exercises, log sheet)</li> <li>4. Show patient and family how to do each exercise</li> <li>5. Do each exercise with patient and family</li> <li>6. Assign the appropriate grade of sets.</li> <li>7. Show patient and family how to fill out the log sheet</li> <li>8. Let them know when you will see them again</li> </ol>
<p><b>Second Visit</b> (about 30 min)</p> <p>Ideally, this visit will occur the next day</p>	<ol style="list-style-type: none"> <li>1. Have patient and family demonstrate the protocol exercises to you (i.e. you observe their exercise session)</li> <li>2. Ask the patient and family if there are any problems with the exercises (too easy, too hard)</li> <li>3. Make any adjustments needed to exercises or grading</li> <li>4. Check to see if log sheets are done</li> <li>5. Let them know when you will see them again</li> </ol>
<p><b>Third visit</b> (about 10 minutes, one week after 2<sup>nd</sup> visit)</p>	<ol style="list-style-type: none"> <li>1. Observe 3 exercises (choose one from range of motion, one from strength, and one functional task)</li> <li>2. Ask the patient and family if there are any problems with the exercises (too easy, too hard)</li> <li>3. Check log sheets and pain analogue scale</li> <li>4. Make any adjustments to exercises or grading.</li> </ol>
<p><b>The first 3 visits would ideally occur within the first 10 days of enrollment in the program.</b></p>	
<p><b>Weekly visits</b> (about 10 minutes) until discharge</p>	<ol style="list-style-type: none"> <li>1. Observe 3 exercises (choose one from range of motion, one from strength, and one functional task)</li> <li>2. Ask the patient and family if there are any problems with the exercises (too easy, too hard)</li> <li>3. Check log sheets and pain analogue scale</li> <li>4. Make any adjustments to the exercises or grading.</li> </ol>
<p><b>Last visit prior to discharge</b> (about 10 minutes)</p>	<ol style="list-style-type: none"> <li>1. Explain to the patient and family that they can keep the equipment and binder</li> <li>2. Do not give them an upgraded protocol (unless you intend to monitor beyond this point)</li> <li>3. Explain to the patient and family the importance of continuing the exercises at home</li> </ol>

## **Participant safety**

With an upper extremity exercise program, pain and fatigue are the most likely concerns. Many people with stroke experience some fatigue and shoulder pain. Participants with pain should have the exercises modified to work in a pain-free range. We monitored shoulder pain in our GRASP and control group and did not find any greater pain in the GRASP group. In our trial with people with chronic stroke (Pang et al. 2006), we did have some patients who said they had mild shoulder pain on starting the exercises (week 1 and 2), but this pain subsided as their shoulder strength improved. However, any significant shoulder pain should warrant modification of the exercises.

## **Involvement of therapists and families**

GRASP was taught by a physical therapist or occupational therapist and monitored by this individual. GRASP was not only taught to the patient, but also their family, friends and/or caregiver. The results of GRASP are better if there is involvement from family, friends or a caregiver who can assist with the exercises (track the amount of exercise, motivate the person, help count repetitions, assist with positioning equipment like the target board, etc). We encourage a family member to participate as much as possible in a positive manner.

## **Individualization and progression**

- The program is designed to require minimal “hands-on” assistance to encourage independent ability.
- Exercises are graded in their levels and progressed according to ability.
- Check regularly for any pain. Shoulder pain is common post-stroke and modifications may be required for the reaching exercises to ensure they are performed below shoulder height.
- Rest as necessary

## **Maximizing adherence and having fun**

Adhering to regular exercise (especially on your own) is difficult for everybody. However, a number of initiatives can be done to maximize adherence.

### *1. Emphasize reasons for doing the exercise.*

Most critical is that patients and families understand the necessity of doing these exercises for an hour daily or as much as tolerated within the patient’s fatigue level. It needs to be emphasized that we know that the greatest changes in the brain and physical abilities occur in the first weeks after a stroke and thus, there is a window of opportunity to really maximize one’s abilities during this time period. Secondly, the evidence shows that more use of the stroke-affected arm results in greater improvements in arm and hand function. Thus, we hope the GRASP can facilitate early and intense use of the arm and hand to maximize recovery.

### *2. Seek solutions for poor adherence.*

In cases of poor adherence (participating in less than half of the required time), the therapist should explore reasons behind the non-adherence with the patient to determine whether there are

solutions to these problems (e.g., patient and family require clarification of the exercises, equipment adaptation is required to complete the task).

### *3. Encourage socialization*

Families, friends and caregivers can be involved to motivate and encourage the patient, help with the exercises, record the daily log or simply do the exercises together. Although GRASP was done individually in the clinical trial, some stroke units are now using it as a group inpatient or outpatient program led by a therapist or rehabilitation assistant. Although we have not evaluated GRASP in this manner, there is no doubt that socialization and collegiality will help adherence to the protocol. The Pang et al. (2006) chronic stroke trial was done as a group upper extremity program and the socialization aspect was a major contributor to participants adhering to the program.

### *4. Maximize feedback of performance to the patient*

The exercises were designed to maximize sensory or visual feedback to the patient. Thus, moving a cup of water from one position to another on a target board allows the patient to be aware of their abilities (they may spill water or not reach the target). In addition, you may provide stiffer grades of therapy or a heavier weight or increase the repetitions and make the patient aware of their improvement.

### *5. Create a positive environment for exercise.*

The book and equipment should be easily accessible to the patient and stored in view as a reminder to do the exercises (and not in a closed cupboard where it may be forgotten). We have received feedback the books are easier to use if printed in colour. Some participants may enjoy background music, especially if they were familiar with the music. A selection of CDs of an hour length may help to cue the patient that an hour had passed and they have done sufficient exercises.

## **Future of GRASP**

We will continue to modify GRASP and welcome constructive suggestions. Feedback can be sent to [Janice.Eng@vch.ca](mailto:Janice.Eng@vch.ca)