**Shoulder Pain and Injury Prevention Program for Individual’s with Paraplegia**

**Needs Statement**

In the United States there are 250,000-400,000 individuals living with a spinal cord injury (SCI) and about 50% are classified as having paraplegia as a result of the injury.1 Out of these individuals with paraplegia, 60% report experiencing shoulder discomfort.2 Shoulder pain/injury is often a result of manual wheelchair use and a variety of daily functional activities that rely heavily on upper extremity weight-bearing.3 Manual wheelchair users have reported performing 14-18 transfers daily with the use of both upper extremities.4 This increases a manual wheelchair user’s risk of obtaining structural and physiological changes to the joint causing a degenerative upper extremity condition and chronic pain.3, 5

The consequences of chronic shoulder pain can have a significant impact on an individual’s daily life. If shoulder pain inhibits an individual’s ability to perform transfers, propel a manual wheelchair, or perform self-care needs, than he/she can lose independence and overall, exhibit a decrease in quality of life.4 Research reports that 28% of those who reported shoulder pain were also experiencing a decrease in independence.4 Additionally, a decrease in quality of life can lead to decreased self-efficacy affecting the emotional, social, and financial aspects of health as well.

Surgical intervention for impingement syndromes and/or other injuries are not optimal for individuals with paraplegia due to the need remain non-weight bearing for at least six weeks post-surgery. This causes a decrease in ability to perform functional activities and an overall decrease in independence that many cannot afford to lose during rehabilitation3, 4 Therefore, other solutions for intervention must be created in order to improve pain without compromising the level of functional independence of the individual.

Currently, the only programs in Charlotte addressing shoulder pain/injury are for individuals with SCI immediately post-injury in inpatient or outpatient rehabilitation. There are no current programs in place for individuals with chronic SCI that specifically address chronic shoulder pain/injury prevention. Additionally, there are many rehabilitation hospitals, SCI athletic associations, and support groups in Charlotte and the surrounding areas in which individuals can be recruited from. An evidence-based program addressing upper extremity pain and function will allow individuals who are of various durations of post-injury to benefit from education and exercise without the risk of “capping out” of insurance visits to outpatient physical therapy.

**Background**

The proposed 12-week program will focus on education, functional movement training, and a shoulder home exercise program aimed at decreasing shoulder pain and preventing shoulder injuries. A protocol driven transfer education course has been shown to improve the techniques and biomechanics of transfers placing individuals with paraplegia at decreased risk of upper extremity injury; 4 however, education alone has not shown to be consistently effective in reducing pain and injury in manual wheelchairs.3 For this reason, this program will consist of education on risks/prevention and biomechanics of functional activity in addition to a shoulder home exercise program.

Over time, individuals with paraplegia often adapt a forward head posture with protracted shoulders as a result of weak trunk musculature and wheelchair propulsion. This often leads to individuals with paraplegia demonstrating tight anterior shoulder muscles and weak posterior shoulder muscles.5 Shoulder exercises consisting of strengthening the rotator cuff muscles have demonstrated a positive effect in decreasing shoulder impingement in both individuals with and without paraplegia. By strengthening these muscles, individuals can increase control and decrease the amount of stress on the joint during weight bearing.4, 5

Furthermore, performing an anterior shoulder-stretching program in supplement to a posterior shoulder strengthening program has improved pain and function in individuals with paraplegia by creating a more balanced shoulder joint complex.4.5 Currently, the most effective home exercise program consists of both scapular strengthening exercises and shoulder stretching exercises6, therefore, the home exercises utilized in this program will consist of both shoulder strengthening and stretching exercises that can be performed independently at home with minimal equipment.

High resistance upper extremity strength training and aerobic training have also been shown to be effective in improving strength, function, and pain in individuals with paraplegia, but there are many gaps in these studies. First, the majority of the subjects in these studies are typically males with histories of active lifestyles making it difficult to apply these results to females and those who are less active or sedentary. Also, many of these exercises require the use of advanced equipment such as double-poling ergometers or standard ergometers that individual’s will not have access to at home.7, 8

The purpose of this program is consistent with the Health Behavior and Education Model by aiming to provide individuals with the tools to instill self-efficacy.9 Janz et al defines self-efficacy as, “One’s confidence in one’s ability to take action.”9 Self-efficacy will be reinforced by delivering individuals with adequate education/training on how to perform the exercises correctly, perform techniques of functional activities correctly, and how the program can be applied to their daily routines. Through completion of this program individuals will be motivated via verbal reinforcement and verbal follow up to adapt these exercises focusing on shoulder muscle strengthening and stretching with minimal equipment to their lifestyles in order to decrease the risk of developing shoulder pain and to maximize exercise benefits.

**Program Goals**

The goal of the program is to decrease shoulder pain and injury in adult individuals with paraplegia in the Charlotte area through a focus on prevention techniques via an education class, a shoulder home exercise program (HEP), and an optimal functional movement class. Specifically, the program will aim to:

* Improve education of individuals with paraplegia regarding shoulder pain/injury prevention techniques and risks by demonstrating a 15% score increase on educational quizzes at 6 weeks and 30% score increase at 12 weeks.
* Improve functional mobility by demonstrating a 2-point increase in Functional Independence (FIM) score at 6 weeks and a 4-point increase of score at 12 weeks through reduction of shoulder stressors and improved biomechanical technique.
* Improve shoulder pain by demonstrating a 5% decrease in Wheelchair User’s Pain Index (WUSPI) score at 6 weeks and a 10% decrease in score at 12 weeks through reduction of shoulder stressors and improved upper extremity strength/flexibility.
* Maintain 85% adherence to exercise HEP, functional activity modifications, and class attendance at both 6 weeks and 12 weeks through patient exercise/activity log, and through therapist follow up post-session and post-absence of attendance.

**Proposed Intervention**

The program will be 12 weeks in duration with meeting times scheduled for one time each week for three hours each. There will only be one intervention group of individuals for each full program (size varying with the number of volunteers) with one physical therapist appointed for every five individuals. Each week the program will focus on a different educational component.

**Intervention Component I: Shoulder Education Lecture**

The first hour of each session during the 12 weeks will focus on shoulder education regarding function, biomechanics, common causes of injury, etc. Education curriculum will be formatted based on the baseline knowledge of the group of participants pertaining to shoulder health and pain/injury prevention strategies. At each session, patients will attend a lecture on a different topic relating to shoulder education with associated printed handouts distributed to the participants. The depth and difficulty of the information will progress as the program progresses.

**Intervention Component II: Shoulder Home Exercise Program (HEP)**

The second hour of each session during the 12 weeks will focus on the shoulder exercise HEP including demonstration of proper technique by the physical therapist, return demonstration by the client, and modification of shoulder strengthening/stretching exercises. Individuals will be provided with exercise resistance bands, low weight dumbbells, and any other accessible equipment needed for the program. Additionally, a printed handout with verbal descriptions, pictures, and an area to write in the level of resistance, repetitions, and sets of exercises will be provided. Individual’s will be instructed on performing stretching exercises daily and strengthening exercises every other day to avoid decreased function secondary to muscular fatigue.3 The programs will be individually created based on results of baseline tests and progressed via increased resistance, exercise sets, or exercise repetitions as the program advances. Previous evidence reveals that individualized programs are more effective in improving strength/flexibility versus a generalized program applied to all participants.3, 5

**Intervention Component III: Physical Functional Mobility Course**

The third hour of each session during the 12 weeks will focus on functional mobility where the therapists will assess the techniques used, the equipment used, and educate on safety/modifications needed during the functional activities. Baseline data of demonstrations of poor biomechanics and techniques will be used to create the educational components of the functional mobility curriculum. Each session will consist of a different functional activity in which each individual and his/her equipment is assessed and modified as necessary focusing on decreasing risk factors for shoulder injury/pathology. The activities will increase in level of difficulty as the duration of the program continues.

**Site Parameters**

The program will take place at Carolinas Rehabilitation-Main in Charlotte, NC. The city and surrounding areas are located on the free Charlotte transportation system, CATS, which individuals may use if transportation is needed.10 If an individual does not have access to a bus route, than the program will set up transportation services for him/her. This facility is chosen for its easy accessibility of wheelchairs due to its current function of providing inpatient and outpatient physical therapy services to a variety of neurologically impaired individuals. Specifically, the program will be held in the outpatient facility on the first floor with access to a projection screen for teaching, a large area for practicing the HEP, and therapy mats and other equipment for the functional mobility portion of the course. The program will be held in the evening to avoid clinic hours and to accommodate those who hold jobs during the day.

**Assessment**

All outcome measures will be performed at the initial session to gather baseline data, at six weeks, and at twelve weeks. The measures will be used to track each participant’s progress and to alter the difficulty of the program as needed. All therapists will be trained to administer the outcome measures and the same therapist will assess the same individual at each measurement to provide consistency.

The shoulder education portion of the course will be assessed through a short quiz to test the participant’s knowledge pertaining to shoulder health and pain/injury prevention strategies. Test questions will consist of 20 multiple choice and short answer questions. Each test will be graded on a 20-point scale to easily compare improvements in performance. The quiz will also include a comments section for individuals to provide additional feedback regarding program structure, curriculum, and future needs. If an individual demonstrates a significant decrease in score, a follow up interview with the individual will be conducted in order to address any barriers to learning he/she is experiencing.

For the second component, the shoulder exercise HEP, a comprehensive manual muscle test (MMT) and range of motion (ROM) assessment of all upper extremity muscles will be performed. The results of these assessments will serve as baseline data to be used to create each individual’s HEP. Each participant’s HEP will vary depending on which shoulder muscles need to be targeted for strengthening and stretching exercises and to determine the level of resistance, or duration of stretch needed for each exercise.

Additionally, the Wheelchair User’s Pain Index (WUSPI) will be used to assess each individual’s level of pain intensity with a variety of functional activities. These results will assess whether or not the shoulder exercise HEP is improving an individual’s pain during daily functional tasks. The WUSPI is a 15-item questionnaire with a visual analog scale for evaluating shoulder pain during transfers, wheelchair mobility, dressing, bathing, sleeping, and various individual ADLs.3, 11,12 The WUSPI is widely accepted and often chosen by researchers in studies due to being previously validated as demonstrating a high internal consistency, high reliability, and high test-retest reliability. The WUSPI is scored on a scale of 0-150.12 If an individual experiences an increase in upper extremity pain during the program, a reassessment for shoulder pathology will be performed as well as modifications to the HEP made. If shoulder pain continues to increase, the shoulder HEP may be discontinued until the issue is resolved in order to decrease the risk of damage to the shoulder joint.

Finally, the functional activity performance component will be measured via the Functional Independence Measure (FIM). The FIM measures a variety of tasks on a 7-point scale in order to determine an individual’s level of disability for numerous transfers, wheelchair mobility, and ADLs. The individual’s FIM scores will aid the therapists in determining whether the improvements in biomechanics and/or functional activity techniques are leading to the individual’s ability to achieve a higher FIM, thus gaining more independence. The FIM has been validated for individuals with SCI and has been found to have a high internal consistency and reliability when applied to the population.12

**Limitations**

The main limitations of the program will be loss to follow up throughout the 12 weeks, decreased accessibility and/or transportation to the clinic site, development of shoulder injuries, and/or need for surgical intervention. If an individual is not improving throughout the program or is not being motivated he/she may decide to discontinue participation before the program concludes. The program will aim to prevent this by performing weekly follow ups with individuals to assess their HEP progress, forming a support system with other participants, and performing a follow up for anyone who cancels or does not show up to a session.

The length of the program can also affect the drop out rate.3, 4 Many studies between 8-16 weeks experience significantly lower drop out rates than those conducted greater than 16-weeks long.3, 5,7,8 One study, 24 months in duration, experienced a 50% drop out rate.4 Therefore, this program chose the duration of 12 weeks to allow enough time to see changes, but avoid an increase in drop out rate. Moreover, many individuals with SCI have increased risks of secondary complications such as pressure ulcers, cardiorespiratory issues, fractures, and bowel/bladder issues leading to an overall higher drop out rate to be present within the population.3, 4 Therapists will perform weekly assessments and thorough interviews with each participant in order to prevent these secondary issues, thus attempting to decrease drop out rates.

Due to the varied levels of mobility and independence involved with the SCI population, many individuals depend on others for transportation. Some participants may not be able to attend due to lack of available transportation. The public transportation bus route is not comprehensive and an individual may not have access to public transportation. To prevent transportation from being a barrier to program participation, the program will have a contract with a transportation company to accommodate individuals in need.

A major limitation may be the presence of undiagnosed shoulder pathology such as shoulder impingement, rotator cuff tear, or labral tear. If a participant does have diagnosed shoulder pathology, than his/her shoulder exercise HEP and functional activities can be modified to reduce the risk of further shoulder joint injury. Unknown shoulder pathology could cause an increase in damage to the shoulder joint and increase in shoulder pain, thus cause a decrease in upper extremity function, rendering the program unsuccessful.3, 7,8

Finally, individuals may develop shoulder pathology by injuring him/herself through poor biomechanics during the HEP, through attempting to progress the programs too quickly, or through altering functional activity techniques too quickly. This may cause an individual to experience an increase in symptoms such as shoulder pain, decreased ROM, and decreased function. Demonstrations of significant increases of symptoms may lead to discharge from the program or lead an individual to require surgical intervention. Therapists will prevent this by performing consistent assessments on individuals for increased pain and evaluations of outcome assessments for worsening symptoms.

**Relevance**

A successful shoulder exercise program, proper education, and examination of functional activities have all been related to improved pain, improved functional capability, and overall improved physical fitness. These benefits will lead to decreased risk factors secondary to poor physical fitness and maximized functional independence, thus improving overall quality of life for individuals with paraplegia. Research demonstrates that an increase in quality of life increases self-efficacy leading to increased participation in social activities, increased healthcare autonomy, and increased overall psychosocial health.3, 4,6-8,11

Other populations that may benefit from this program are individuals with Quadriplegia (low cervical or high thoracic injuries). Many individuals with quadriplegia also experience upper extremity pain; however, this pain is often neurogenic in nature or as a result of issues secondary to decreased muscle activation and ROM. Many studies also include individuals with higher-level injuries and found that shoulder HEP and functional mobility training is able to improve pain in this population as well.3, 4,6-8

Additionally, pediatric patients with SCI may also benefit from the intervention. The shoulder exercise HEP would consist of exercises that are activity-based in order to increase participant enjoyment and motivation. For example, a participant would perform ball tosses of varying weights or turn to reach for objects in a game versus traditional exercise. Functional mobility training would also be modified for the pediatric population focusing on basic transfers, ADLs, and basic wheelchair mobility needed for daily activities. Research has shown that those who transition to wheelchair mobility in childhood experience a decreased incidence of shoulder pain than those who made the transition in adulthood; 13 therefore, a program such as this could further prevent children from experiencing chronic pain in adulthood and demonstrate the importance of maintaining consistent physical activity.11

This program is transferrable to other physical therapy settings such as inpatient and outpatient neurological rehabilitation facilities. Inpatient physical therapy settings can increase education on prevention of shoulder pain/injury and the importance of performing regular physical activity for individuals with acute SCI. Additionally, a generic shoulder exercise HEP can be taught and implemented early in the rehabilitation program. Outpatient physical therapy settings can increase education on the biomechanics of functional activities and how to decrease chronic shoulder pain risk factors. For an individual with chronic SCI, a shoulder exercise HEP can be implemented to decrease current shoulder pain and prevent the development of shoulder pathology. Shoulder pain is an important issue for individuals with SCI and should be addressed safely during several stages throughout an individual’s rehabilitation.

**References**

1. North Carolina Spinal Cord Injury Association. Spinal Cord Injuries. NCSCIA Website: <http://www.ncscia.org/trifold.pdf> 2013. Accessed September 15, 2013
2. Pellegrini A, Pegreffi F, Paladini P, Verdano MA, Ceccarelli F, Porcellini G. Prevalence of shoulder discomfort in paraplegic subjects. *Acta Biomed*. 2012;83(3):177-182.
3. Mulroy SJ, Thompson L, Kemp B, et al. Strengthening and optimal movements for painful shoulders (STOMPS) in chronic spinal cord injury: A randomized controlled trial. *Phys Ther*. 2011;91(3):305-324. doi: 10.2522/ptj.20100182; 10.2522/ptj.20100182.
4. Rice LA, Smith I, Kelleher AR, Greenwald K, Boninger ML. Impact of a wheelchair education protocol based on practice guidelines for preservation of upper limb function: A randomized trial. *Arch Phys Med Rehabil*. 2013. doi: 10.1016/j.apmr.2013.06.028; 10.1016/j.apmr.2013.06.028.
5. Curtis KA, Tyner TM, Zachary L, et al. Effect of a standard exercise protocol on shoulder pain in long-term wheelchair users. *Spinal Cord*. 1999;37(6):421-429.
6. Nawoczenski DA, Ritter-Soronen JM, Wilson CM, Howe BA, Ludewig PM. Clinical trial of exercise for shoulder pain in chronic spinal injury. *Phys Ther*. 2006;86(12):1604-1618. doi: 10.2522/ptj.20060001
7. Norrbrink C, Lindberg T, Wahman K, Bjerkefors A. Effects of an exercise programme on musculoskeletal and neuropathic pain after spinal cord injury--results from a seated double-poling ergometer study. *Spinal Cord*. 2012;50(6):457-461. doi: 10.1038/sc.2011.160; 10.1038/sc.2011.160.
8. Dyson-Hudson TA, Sisto SA, Bond Q, Emmons R, Kirshblum SC. Arm crank ergometry and shoulder pain in persons with spinal cord injury. *Arch Phys Med Rehabil*. 2007;88(12):1727-1729. doi: 10.1016/j.apmr.2007.07.043.
9. Janz NK, Champion VJ, Strecher, VJ. (2002). The health belief model. In K Glanz, FM Lewis, B Rimer, (eds.) *Health behavior and health education: Theory, research, and practice,*3rd ed., San Francisco: Jossey-Bass Publishers.
10. Charlotte Area Transit System. CATS Website: <http://charmeck.org/city/charlotte/cats/Pages/default.aspx> 2013. Accessed November, 15 2013.
11. Serra-Ano P, Pellicer-Chenoll M, Garcia-Masso X, Morales J, Giner-Pascual M, Gonzalez LM. Effects of resistance training on strength, pain and shoulder functionality in paraplegics. Spinal Cord. 2012;50(11):827-831. doi: 10.1038/sc.2012.32; 10.1038/sc.2012.32.
12. Rehabilitation Institute of Chicago. Rehabilitation Measures Database. RehabMeasures Website: <http://www.rehabmeasures.org/default.aspx> 2013. Accessed December 4, 2013.
13. Sawatzky BJ, Slobogean GP, Reilly CW, Chambers CT, Hol AT. Prevalence of shoulder pain in adult- versus childhood-onset wheelchair users: A pilot study.*J Rehabil Res Dev*. 2005;42(3 Suppl 1):1-8.