2013

# Predictors of Outcome Following Standardized Rehabilitation for Patients with Shoulder Pain

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# PREDICTORS OF OUTCOME FOLLOWING STANDARDIZED REHABILITATION FOR PATIENTS WITH SHOULDER PAIN

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DISSERTATION

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Rehabilitation Sciences
in the College of Health Sciences
at the University of Kentucky

By

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2013

ABSTRACT OF DISSERTATION

PREDICTORS OF OUTCOME FOLLOWING STANDARDIZED REHABILITATION FOR PATIENTS WITH SHOULDER PAIN

Shoulder dysfunction is frequently treated and persistent symptoms are common. Differential diagnosis of shoulder injuries can be challenging and knowledge of a diagnosis alone does not appear to be enough information to predict outcomes. Determination of a set of factors that predict outcome would assist clinicians in making the most effective treatment decision for patients with shoulder pain. The purposes of this dissertation were to investigate patient-clinician agreement in an orthopedic population of patients with shoulder pain and to determine what combination of factors best predicts positive patient-reported outcome following standardized rehabilitation in patients with shoulder pain.

In the first study, it was determined that patient-clinician agreement was moderate to good. This further supports the use of patient reported outcomes as an appropriate approximation of "true" outcome. In the second study, patient-nominated functional limitations were reduced to 14 categories for inclusion as candidate predictors in the prediction model. In the third study, we observed that the combination of absence of neck pain, shorter duration of symptoms and report of exercise as a functional limitation were associated with greater odds of positive clinical outcome following 6 weeks of standardized rehabilitation. Due to limited sample size, generalizations cannot yet be made to other samples. Future investigation of this model in a larger sample and subsequent external validation in a separate sample are necessary to further develop the model for clinical use.

KEYWORDS: shoulder, clinical prediction, rehabilitation

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June 4, 2013
Date

PREDICTORS OF OUTCOME FOLLOWING STANDARDIZED REHABILITATION FOR PATIENTS WITH SHOULDER PAIN

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# DEDICATION

This work is dedicated to my family for their unconditional love, support and encouragement.

To my parents, Pat and Sharon, who modeled the importance of hard work, a good attitude and a heart for service.

To my sister, Mollie, for being my best friend and sounding board despite the hundreds of miles and hours of travel that separate us.

And to my fiancé, Jamie, who has shown me love and grace even when the stressors of life (and this dissertation) have caused me to be less than kind. I can't wait to see what adventures are ahead for us.

# ACKNOWLEDGEMENTS

I would first like to thank Dr. Ben Kibler for allowing me to serve as a research assistant with Lexington Clinic Orthopedics and Sports Medicine. Dr. Kibler graciously agreed to fund the position which provided unparalleled research experience, without which this dissertation would not have been possible. I also extend the most sincere thanks to my advisor and committee chair Dr. Tim Uhl. He has pushed me to my limits while providing constant support and encouragement, molding me into a better researcher, educator and clinician. I would also like to thank my co-chair Dr. Tony English as well as my other committee members, Dr. Tim Butterfield, Dr. Esther Dupont-Versteegden and Dr. Heather Bush for their time, energy and valuable feedback throughout this process. Finally, thank you to my friends and family for their support, friendship and love throughout the last four years.

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# Chapter 1 Introduction

## Background

Shoulder injury is a common problem that requires significant time for recovery. Shoulder pain accounts for approximately 15% of all musculoskeletal complaints.[1,2] In the US alone, 8.9 million office visits were made to physicians for the primary complaint of shoulder symptoms in 2006.[3] Persistent symptoms and complaints have been reported in 40-60% of patients one to three years after seeing a physician for shoulder pain.[4-7] Further documenting this problem, shoulder injury resulted in a median of 21 work days missed among US workers in 2010, nearly twice that of all musculoskeletal disorders. Difficulties in diagnosis, presence of concomitant injury and lack of standardized treatment plans may contribute to the time loss and persistent symptoms experienced by patients with shoulder pain.

Specific diagnosis of shoulder injuries is difficult to make and differentiation between categories of shoulder disorders is challenging.[8,9] One confounder with shoulder injuries is that pathologies are often found in combination not in isolation making both diagnosis and management very difficult. In a report of 140 shoulder surgeries for superior labral injuries, 72% of the patients had concomitant tissue damage of the rotator cuff or remaining labrum.[10] To further confound the issue of shoulder pain, a recent systematic review on diagnostic accuracy of the shoulder examination concluded "the use of any single shoulder physical examination test to make a pathognomonic diagnosis cannot be unequivocally recommended."[8] It is also difficult to differentiate between multiple classifications of shoulder disorders. Only moderate inter-rater agreement was observed on the classification of shoulder disorders based on clinical exam, particularly when patients demonstrated high pain severity, chronic complaints and bilateral

involvement.[9] These studies would indicate that our ability to diagnosis a specific pathology in the shoulder is not very good.

There is evidence that a specific diagnosis by itself is not an accurate predictor of outcome. Results from a multi-center trial identified that no feature of a rotator cuff tear (size or amount of tendon retraction) was associated with outcome following non-operative management[11]. Furthermore, the presence of an anatomic lesion doesn't necessarily indicate that the patient will experience any symptoms. For example, asymptomatic patients with confirmed rotator cuff tears did not demonstrate a clinically significant decrease in function compared to those with an intact rotator cuff.[12] This suggests a need to look beyond the diagnosis. The federal government, through the Centers for Medicare and Medicaid Services (CMS), has identified this deficit also and states that diagnosis is a poor predictor for the type and duration of therapy services that may be required and has mandated that functional limitations be assessed and reported by therapists.[13]

Since diagnosis is difficult to make and may not accurately predict outcome, other factors need to be investigated. Functional limitations consider issues beyond tissue pathology and structure to include activity and participation implications of the disease state. A health condition or diagnosis may describe the anatomy involved, but it may not explain how the anatomical injury affects the individual patient's life or dictates the type or extent of dysfunction a patient may experience. The CMS is starting a process to better track outcome by requiring treating health care providers to indicate the current level of functional limitation and expected level of function at the end of care when submitting claims.

The classifications of functional limitations used by the CMS are taken from the International Classification of Function, Disability and Health (ICF). The ICF provides an existing framework for helping health care providers with this transition in clinical thinking by incorporating parameters in addition to the health condition or diagnosis. The ICF model provides a description of how a patient experiences and is affected by a health condition. By considering the problem of shoulder pain through the lens of the ICF model, it becomes evident that investigating patient factors such as functional limitations and physical impairment parameters (e.g. strength, range of motion, pain) may be better predictors of outcome than simply the diagnosis or health condition.

Health care providers are faced with the challenge of working with patients who have conditions that are difficult to diagnose using traditional medical models and are a major cause of lost work time. One constant is that across nearly every shoulder diagnosis a patient is recommended conservative intervention including physical therapy to initially address shoulder pain.[14-16] A systematic review reports that there is evidence to support that therapeutic exercise reduces symptoms in patients with rotator cuff pathology.[17] The level of success across several shoulder disorders varies from 50-80% [16,18,19] which may be due to the high rate of concomitant injury and lack of a definitive intervention approach. Arming clinicians with the ability to determine which patients are more likely to have a positive outcome with non-operative rehabilitation will help direct treatment decisions, make treatment more efficient and improve patient care. This is further supported by the federal government as CMS has recognized the need to develop a system for classifying clinical cohorts in order to determine what services will be

needed. The current goal is to categorize patients with shoulder pain in order to provide better and more consistent treatment outcomes.

A number of studies have been conducted with the purpose of investigating prognostic factors of shoulder pain. However, strong evidence for the association of demographic factors with outcome following standardized rehabilitation for shoulder pain is unclear.[20] Many of the studies available are not of high quality and a great deal of variation exists with respect to follow up time, the type of outcome assessed, population and statistical analyses employed.[21] A systematic review published in 2004 examined prognostic factors for shoulder disorders.[21] In a general medical population, there is strong evidence that high pain intensity predicts poorer outcome and moderate evidence that longer duration of complaints and high disability score at baseline predict a poorer outcome.[21] In an occupational population, strong evidence exists only to support that age (45-54 years) predicts poorer outcome.[21] The authors identified that no studies of sufficient quality have been conducted in secondary care (e.g. orthopaedics) and two other reviews state that limited evidence is available to assist in making clinical recommendations for patients with rotator cuff tears.[20,22] This identifies a substantial gap in the literature as many patients with persistent shoulder pain are referred to orthopaedic physicians for more specialized care.

Clinical prediction is one way to account for the multiple potential factors contributing to outcome and is becoming more popular in orthopaedics and rehabilitation. Clinical prediction supports evidence based practice because it is an integration of empirical and clinical evidence and provides quantitative estimates of outcome probability using statistical models. A need for more carefully derived and validated

prediction models in orthopaedic surgery has been identified.[23] In orthopaedic surgery, interventions often aim to increase quality of life rather than survival. As such, prediction models that express risks explicitly by estimating the probability of treatment success would benefit both clinicians and patients.[23] The ability to predict the likelihood of a positive outcome following an intervention of standardized rehabilitation from information collected at the initial evaluation would assist clinicians in making the most efficient treatment decision for each patient.

One comprehensive multivariable model has been developed and validated for prognosis of shoulder pain at 6 weeks.[24,25] Longer duration of symptoms, gradual onset of pain, psychological complaints, report of repetitive movements at least 2 days per week, and high pain severity in the shoulder and in the neck at presentation are associated with persistent symptoms. One limitation to this model is that it was developed in patients treated with a wait-and-see approach or injection; only 10% of patients in the study were referred to physical therapy.[24] The Dutch population studied by Kuijpers et al[24,25] is different from the population of patients who report to orthopaedic surgeons in the US, as they are generally prescribed therapeutic exercises.[14,15] As such, it is reasonable that the factors that predict outcome following rehabilitation may be different from a population treated primarily with medication, injection or a wait-and-see approach. No comprehensive clinical prediction model has been developed for patients with shoulder pain treated with rehabilitation.

Predicting outcome requires determining the most "true" definition of outcome to be used. Defining outcome across stakeholders can be challenging because orthopaedic surgeons, therapists and patients likely have different goals. As such, a positive outcome

for the patient may not agree with that of the surgeon or therapist. Discordance between patients and clinicians has been reported in assessments of disease severity[26-31], physical functioning,[30,32-35] pain[33,36] and quality of life[36] in a variety of acute and chronic pathologies. In general, patients tend to see themselves as being more severely impacted compared to physician ratings.[26,27,31,33]

Agreement between the patient and physician has been studied most, but there is support for the role of the therapist to be investigated as well. Only one identified study has examined agreement between therapist observation and patient self-reported function.[34] The need to investigate the patient-therapist agreement is further supported by the finding that self-report measures and physical impairment parameters demonstrated low agreement.[37] This indicates that patients and therapists, who likely factor physical impairment parameters such as range of motion or strength into their assessment, may experience discordance as well.[37] Perceptions of health-related assessment and classification may also be different between therapists and physicians. A single word may have multiple meanings or implications to patient treatment among the different professionals. For example, orthopaedic surgeons were more likely to consider tendinopathy as the most important etiology related to impingement, while physical therapists were more likely to consider motion abnormalities as a cause of impingement.[38] Therefore, investigation of agreement between physicians and therapists is also of interest.

The variations in perspectives, goals and biases may result in poor agreement in assessment of change or outcome between the three stakeholders. While discordance has been examined in one time assessments of disease state or impairment, few have

examined the effect these differences in perception may have on the assessment of change over time or outcome following an intervention.[28,39,40] The impact of discordance on orthopaedics is relatively unknown. Two studies have reported fair to good patient-clinician agreement on disease status in patients with low back pain[41] and disorders of the neck-shoulder region[42]. Differences have been reported between patient and physician ratings of pain and overall satisfaction in post-operative total hip arthroplasty patients, but no other studies have examined these relationships with respect to change over time in orthopaedics. The ability to identify which patients are more likely to experience a positive outcome following standardized rehabilitation would help drive treatment decisions and ultimately result in better and more efficient patient care. The patient's perspective should always be considered and is equally important to that of the clinicians making the recommendations for treatment. We need to confirm there is adequate agreement between stakeholders before using any one type of outcome tool as a representation of the "true" outcome.

**The Problem**

Current practice places emphasis on diagnosis rather than patient factors when making treatment decisions. However, the literature indicates diagnosis can be difficult to make[8,9] and a diagnosed anatomical lesion does not appear to provide enough information to predict outcome.[11,13] Therefore diagnosis should not be the primary factor that drives treatment. Perhaps other factors such as physical impairment parameters and functional limitations should be considered by the physician in making treatment recommendations. However, it is currently unknown if physician assessment of response to prescribed treatment agrees with patient assessment. It is necessary to know if patient-clinician

agreement is adequate in order to ensure we are predicting the most "true" assessment of outcome.

**Purposes**

There will be two purposes to this dissertation. 1) examine the agreement between definitions of positive clinical outcome with respect to patient-reported outcome, surgeon-oriented outcome and therapist-oriented outcome and 2) identify a set of factors to aid clinicians in predicting future patient-reported response to therapy at 6 weeks based on information collected at initial evaluation.

**Experimental Aims and Hypotheses**

**Aim #1:** Determine the agreement in assessment of change following 6 weeks of standardized rehabilitation in patients with shoulder pain by examining the agreement of a global rating of change assessment between:

1) patient-reported assessment of change
2) physician-oriented assessment of change
3) therapist-oriented assessment of change

**Hypothesis**: The three perspectives will demonstrate no more than moderate agreement (ICC and $r \approx 0.6$).

**Aim #2:** Determine what combination of factors collected at initial evaluation best predicts response to non-operative treatment at 6 weeks in patients with shoulder pain.

**Hypothesis:** We hypothesize that diagnosis will not be predictive of outcome, but that a combination of body function impairments and functional limitations will be predictive of positive patient-reported outcome.

**Operational Definitions**

Functional limitation: Encompasses both activity limitations and participation restrictions as defined by the International Classification of Function, Disability and Health.

Patient-nominated functional limitations: Patient responses on the Patient Specific Function Scale, in which patients identify 3-5 things they want to be able to do, but are limited because of their shoulder problem.

Patient-oriented outcome: Global rating of change score completed by the patient at follow up.

Patients with shoulder pain: Individuals 16-65 years of age seeking medical attention from an orthopaedic surgeon for pain in the glenohumeral or scapular region. This excludes patients with arthritis, adhesive capsulitis, cervical radiculopathy or scapular muscle detachment.

Physical impairment parameters: Includes glenohumeral flexion and internal rotation range of motion, shoulder flexion and external rotation isometric strength, scapular posture.

Physician-oriented outcome: Orthopaedic surgeon's perspective of patient outcome following standardized rehabilitation as assessed retrospectively. Physician completed the global rating of change scale for each patient after reviewing his initial and follow up notes.

Predictive factors: All recorded demographic, health history, self-reported function and physical impairment parameters that can be identified at baseline to predict the outcome at follow up.

Short term Outcome: Response to six weeks of standardized rehabilitation in patients with shoulder pain.

Standardized rehabilitation: Non-operative treatment for shoulder pain that includes strengthening and flexibility exercises targeting the rotator cuff and scapular musculature.

Therapist: Physical therapist, certified athletic trainer or occupational therapist who provides care for orthopaedic rehabilitation of musculoskeletal disorders

Therapist-oriented outcome: Physical impairment-based assessment determined by examination of demographic information, self-reported functional limitations and improvement in glenohumeral range of motion, strength and posture. Therapist completed the global rating of change scale for each patient after reviewing this information collected initial evaluation and follow up.

**Assumptions**

It will be assumed that:

1. Subjects understood all instructions and provided their best effort at answering patient reported outcome questionnaires.

**Delimitations**

1. Subjects were males and females between the ages of 16-60.
2. Subjects had no history of corticosteroid injection in the involved shoulder within one month prior to enrollment.
3. Subjects were free to seek therapy from the rehabilitation specialist of their choice, so treatment was not directly supervised or controlled.

**Limitations**

1. A large number of subjects were lost to follow up or have incomplete follow up data because they failed to see the physician for the 6 week follow up

appointment. Of 191 patients enrolled, 73 (38%) do not have follow up data available.

2. Physician-oriented and therapist-oriented outcomes will be obtained retrospectively, while patient-reported outcome was obtained prospectively.
3. Only one physician was involved in the study, limiting the external validity of the data.

# Chapter 2 Literature Review

## Purpose

The purpose of this literature review is to: 1) discuss current evidence regarding factors related to outcome in patients with shoulder pain, 2) discuss clinical prediction and its benefit to clinical decision making in orthopaedics, 3) discuss the literature describing differences in patient and clinician-oriented assessment of outcome and 4) discuss the International Classification of Health, Disability and Function (ICF) and its ability to serve as an existing classification system to which patient-nominated functional limitations can be "linked".

## Treatment decisions and prognostic factors for shoulder pain

### Diagnosis

Differential diagnosis is difficult in patients presenting with shoulder pain. A systematic review investigating the diagnostic accuracy of physical exam tests for the shoulder concluded there is a lack of quality studies and that existing evidence does not support the discriminatory ability of frequently used tests for diagnosis.[8] It has also been documented that agreement between clinicians is only moderate when classifying shoulder disorders, demonstrating the complicated nature of discriminating between various categories of shoulder disorders.[9] It may be that a cluster of physical exam tests along with other patient information may better determine potential outcome. Knowing the anatomical problems is not enough to predict outcome. For example, in rotator cuff tears, presence or severity of derangement does not predict outcome. Preliminary results from the Multi-Center Orthopaedic Outcome Network (MOON) Shoulder Group[11] indicate that no feature of a rotator cuff tear (size or amount of tendon retraction) was associated with outcome following non-operative management. Additionally, the

presence of an anatomic lesion doesn't necessarily even mean that the patient will experience any symptoms at all. For example, patients with asymptomatic rotator cuff tears did not demonstrate a clinically significant decrease in function compared to those with an intact rotator cuff.[12] In light of these findings, it seems that using diagnostic classification as a guide for treatment decisions may not lead to ideal treatment outcomes.

If the diagnosis is not driving the outcome, then it is important to examine other factors that may provide more meaningful information. The International Classification of Function model lends itself to this type of approach: the types of impairments and functional limitations experienced by the patient may be more informative than the diagnosis itself. Such an approach is now mandated by the Centers for Medicare and Medicaid Services (CMS).[13] The organization believes that the diagnosis provided on a medical claim is a "poor predictor for the type and duration of therapy services required".[26] Beginning in 2013, physical therapists are required to identify functional limitations as it is believed the identified limitations may be more indicative of likely outcome.

Common Treatment

Regardless of diagnosis, the standard of care for a patient seeking medical care for shoulder pain is conservative rehabilitation. The American Academy of Orthopaedic Surgeons clinical guidelines for shoulder pain[15] and management of rotator cuff problems[14] recommend therapeutic exercises as the first treatment option. Rehabilitation generally focuses on re-establishing range of motion, strength and function of the glenohumeral and scapular musculature.[17] The goal of these protocols is to restore joint stability in patients with shoulder pain, thereby reducing the need for surgical

intervention. A systematic review of exercise for the treatment of rotator cuff impingement concluded that exercise improves symptoms in this population.[17]

Across several shoulder diagnoses, rehabilitation is successful about 50-80% of the time.[16,18,19] This indicates there is a cohort of patients who do not improve following rehabilitation. In typical practice there is not a standard protocol prescribed and the individual therapist may take varying approaches to treating the patient. Kuhn[17] was the first to compile an evidence based exercise for patients with impingement syndrome.

Since diagnosis does not appear to provide enough information to predict treatment outcomes, other prognostic factors should be examined. These factors may include patient history, exam findings and functional limitations. Future studies investigating rehabilitation-related outcomes should use a standardized rehabilitation protocol. This will serve two purposes: control the intervention patients are receiving and enable clinicians to replicate the protocol in their own patients.

Prognostic Factors

A number of studies have been conducted with the purpose of investigating prognostic factors of shoulder pain. Unfortunately, these studies do not provide strong evidence for a certain factor or set of factors that can be applied clinically. Many of the studies available are not of high quality and a great deal of variation exists with respect to follow up time, the type of outcome assessed, population and statistical analyses employed (univariate versus multivariate).[21] A systematic review published in 2004 examined prognostic factors for shoulder disorders.[21] In a general medical population, there is strong evidence that high pain intensity predicts poorer outcome and moderate evidence exists that a longer duration of complaints and high disability score at baseline

predict a poorer outcome.[21] In an occupational population, strong evidence exists only to support that age (45-54 years) predicts poorer outcome.[21] However, it was identified that no studies of sufficient quality have been conducted in secondary care (e.g. orthopaedics). This identifies a substantial gap in the literature as many patients with persistent shoulder pain are referred to orthopaedic physicians for more specialized care.

One comprehensive multivariable model has been developed and validated for prognosis of shoulder pain.[24,25] In the derivation study, 103 general practitioners participated in enrolling 587 subjects. Potential subjects were patients who saw the primary care physician for a primary complaint of shoulder pain, which was defined as "pain in the deltoid and upper arm region".[24] The physical examination included passive and active ROM (estimated in degrees), Neer shoulder impingement sign, neck mobility and self-reported shoulder and neck pain during performance of the tests. Within 10 days of evaluation with the General Practitioner, patients completed a questionnaire to collect sociodemographic information, disease characteristics, physical activity and workload, and psychosocial factors.

Outcome was assessed at 6 weeks and 6 months via mailings. Information was obtained for 487 subjects at 6 week assessment and 538 subjects at 6 month assessment. Participants were asked to report "patient perceived recovery" on an 8-point scale. Outcome was dichotomized using this scale. Patients who reported "full recovery" or "very much improvement" were considered recovered; all others were identified as having "persistent symptoms". Unfortunately the full scale used was not provided by the authors, but it seems similar to a global rating of change scale.[43] Patients were prescribed standardized treatment according to the Dutch guidelines for shoulder complaints issued

by the Dutch College of General Practitioners. The course of treatment could include Non-Steroidal Anti-Inflammatory Drugs, corticosteroid injection or referral to physical therapy.

Overall, duration of symptoms and severity of symptoms were more important in predicting outcome than physical or psychological factors. At 6 weeks, longer duration of symptoms, gradual onset of pain, psychological complaints, report of repetitive movements at least 2 days per week, and high pain severity in the shoulder (0-10 scale) and in the neck (0-18 scale) at presentation were associated with persistent symptoms. Similar findings were observed at 6 months; duration of symptoms, gradual onset of pain, concomitant low back pain, shoulder pain (0-10) and shoulder pain experienced during physical examination (0-18) were associated with persistent symptoms. Neck pain was defined as the sum of pain scores reported during flexion and extension of the neck, rotation in a neutral, flexed and extended position, and lateral bending.

The generalizability, or external validity, of the prediction rule was examined in a follow up study by the authors.[25] This is an important step before a prediction model can be recommended for use in clinical practice.[44] The authors reported good generalizability of the 6 week prediction model, but not the 6 month model.[25] The area under the curve (AUC) of the Receiver Operator Characteristic curve provides a quantitative estimation of how well the model predicts outcome. The AUC of the 6 week model was 0.74 and 0.72 in the derivation and validation cohorts respectively, indicating reasonable performance. The AUC of the 6 month derivation model was 0.67, but dropped to 0.57 in the validation, indicating the model did not do much better than chance.

One major fact to consider in this set of studies by Kuijpers et al[24,25] is that the majority of patients were treated with a wait-and-see approach or injection; only 10% of patients in the study were referred to physical therapy.[24] This indicates that the model is examining the course of shoulder pain, not response to therapy, making the results of this study difficult to generalize to a population receiving rehabilitation. The population studied by Kuijpers et al[24,25] is different from the population of patients who report to orthopaedic surgeons in the US, as they are generally prescribed therapeutic exercises.[14,15] As such, it is reasonable that the factors that predict outcome following rehabilitation may be different from a population treated primarily with medication, injection or a wait-and-see approach. The first step is to investigate what combination of factors best predicts outcome in a population of patients who are prescribed standardized rehabilitation for shoulder pain. No comprehensive clinical prediction model has been developed for patients with shoulder pain treated with rehabilitation. CMS has recognized the need to develop a system for classifying clinical cohorts in order to determine what services will be needed.[13] This further supports the need to examine a multivariable approach to predicting outcome to develop a model or rule that can be directly applied to clinical practice related to the outcome of a rehabilitation intervention rather than clinical course of the disorder in patients with shoulder pain.

Preliminary results from the Multi-Center Orthopaedic Outcome Network (MOON) Shoulder Group[11] indicate that low patient expectation of therapy is the strongest predictor of going to surgery following standardized rehabilitation in patients with full thickness rotator cuff tears. Younger age, higher activity level, and not smoking were also predictors of having surgery.[11] This information, presented at the American

Society of Shoulder and Elbow Surgeons meeting in 2012, does not yet provide a comprehensive model for use clinically, but it is expected that the findings will be published in the near future. This will provide additional empirical evidence with respect to what multivariable collection of factors best predicts shoulder pain for a specific diagnosis (full thickness rotator cuff tears). The next step proposed above may still provide meaningful information as including patients with varied diagnoses will address whether diagnosis is related to clinical outcome.

Factors traditionally collected for consideration as potential predictors include patient history and physical exam findings. The data that has been collected for consideration in the analyses of this dissertation also includes quantitative assessments of impairments and both standardized and patient-nominated assessments of functional limitations. Inclusion of these additional factors into clinical prediction models may result in a more complete model, assisting clinicians in making the best and most efficient treatment decision for each patient.

**Clinical Prediction**

Clinical prediction is becoming more common in orthopaedics and rehabilitation.[45] Clinical prediction models serve as formal, evidence-based approaches to clinical decision making, providing estimates of probability using statistical models.[46,47] This provides clinicians with quantitative predictions of probability associated with a particular outcome, diagnosis or treatment success.[48] Types of prediction rules include prognostic, diagnostic and prescriptive. Prognostic models are intended to predict an outcome, often success or failure, while diagnostic models aim to

predict the presence of a specific disorder. Prescriptive models attempt to identify the most effective intervention for patients with certain clinical characteristics.[49,50]

Clinical prediction models may also be referred to as clinical prediction rules, prediction tools, prognostic models, risk scores or nomograms (graphical interpretations of a model). Clinical prediction rules are not, however, synonymous with clinical decision rules.[44] This is an important distinction for several reasons. Development of a clinical prediction rule involves three main phases: derivation, validation and impact analysis. Prediction models are developed to ultimately guide clinical care[46]. However, the validity and clinical impact of a prediction rule must be determined before the model is translated to a clinical decision rule intended to impact clinical decision making.[44] Reilly et al[44] define decision rules as being exclusively evidence-based, their predictions empirically validated and their benefits proven in clinical trials. As such, the term *clinical prediction model* was chosen for use in this paper, as it refers to a model regardless of phase of development.

In defining what a clinical prediction model is, it should also be described as what it is not. Studies that focus on determining outcomes following conservative or surgical treatment, or even those that identify risk factors or predictive factors of outcome do not qualify as clinical prediction models. While univariate or multivariable identification of risk factors related to outcome can be helpful to evidence-based medicine practitioners, a strong risk factor is not necessarily a good predictive factor[51]. Prediction models go one step further and develop a model believed to predict a specific outcome in patients. An outcome study may answer the question "do patients succeed", while a study of a prognostic model would addresses the question "which patients succeed".

While clinical prediction rules have become commonplace in medical literature, clinical prediction models have not yet become a fundamental part of patient care.[52] This is likely because most have not been appropriately validated.[44] Increasing clinicians' understanding of the interpretation and application of clinical prediction models may make evidence-based practitioners more willing to incorporate prognostic tools into their clinical practice. Some may perceive evidence-based medicine or clinical prediction models as a suppression of clinical freedom. On the contrary, these tools are designed to assist clinicians in finding a balance that integrates the best available evidence and patient values with individual clinical experience.[53,54]

Statistical Methods

The most common statistical analysis used to create prognostic prediction models is multivariable regression. Due to the multivariable nature of medicine, this analysis is ideal for several reasons. Use of a multivariable model has been demonstrated to be more accurate at prediction of outcome than a single variable.[55] Multivariable analysis considers the relationship between predictor variables as well as the relative contribution of each predictor variable to the outcome. Linear regression may be used when an outcome is continuous, while logistic regression requires a dichotomous outcome (e.g. yes/no or success/failure). Most often logistic regression is utilized because it can predict the probability of success or failure of a particular intervention (e.g. conservative treatment or surgical intervention). Variables included in a final logistic regression model should be influenced by clinical sensibility, as reliance on statistical significance alone can result in "overfitting", which results in the model being too specific to the original data set and then it may not be generalizable upon validation.[56,57]

As described previously, few investigations into prognostic factors for shoulder pain have resulted in a clinically applicable model or rule. As no comprehensive prediction models exist for outcome following rehabilitation in patients with shoulder pain, the next step is to establish an initial model. Development of a clinical prediction model will strengthen the utility of the available evidence in making clinical recommendations for these patients. This information will be intended to serve as an assistive prediction rule, which provides probabilities without recommending decisions, as opposed to a directive decision rule, which explicitly recommends a decision.

**Patient-clinician agreement in assessment of health status and change**

Patient-Oriented Outcome

In order to predict outcomes, we must be confident that we are predicting an appropriately defined outcome. There is no "gold standard" for the assessment of outcome in shoulder disorders.[58] However, patient-oriented outcomes are becoming more widely used throughout medicine. A recent report by the American Academy of Orthopaedic Surgeons identified patient-oriented outcomes as the best available evidence in the management of rotator cuff pathology.[14] The Strength of Recommendation Taxonomy (SORT) considers evidence based on patient-oriented outcomes as more informative than disease-oriented outcomes. While patient perceived improvement may certainly be the most important, identifying the perception of clinicians is also important since they are making recommendations for treatment. It is important to know if differences in perception lead to discordant assessment of outcomes between patients. If differences do exist, additional information may need to be considered when defining outcome.

Patient-Clinician Discordance

Perception of health-related assessments has been shown to vary between patients and clinicians, resulting in patient-clinician discordance. Discordance between patients and clinicians has been reported in assessments of disease severity[26-31], physical functioning,[30,32-35] pain[33,36] and quality of life[36] in a variety of acute and chronic pathologies. In general, patients tend to rate themselves as being more severely impacted compared to physician ratings.[26,27,31,33] However, there is some evidence that this may vary depending upon the pathology being examined.[30,34,36] The magnitude of disagreement and whether clinicians overestimate or underestimate impairments and disease severity appears to vary based on the disease.[30,34,36] This may reflect that clinicians tend to predetermine the effects a health condition will have on a patient based on the perceived generalized severity of the condition, rather than the individual patient's characteristics.

Discrepancies exist within health care professions between physician and therapists. One example from the musculoskeletal field is observed in the attempt to define subacromial impingement. Orthopaedic surgeons were more likely to consider tendinopathy as the most important etiology related to impingement, while physical therapists were more likely to consider motion abnormalities as a cause of impingement.[38] This difference may be a result of each professional's bias and thoughts on whether impingement is the primary or secondary issue at hand. Surgeons may view tendinopathy as the source of pain and tissue requiring treatment, while therapists may recognize that tendinopathy is a result of impingement.

These variations in perspectives, goals and biases may result in poor agreement in assessment of change or outcome between the three stakeholders. While discordance has

been examined in one time assessments of disease state or impairment, few have examined the effect these differences in perception may have on the assessment of change over time or outcome following an intervention.[28,39,40] Before outcome can be predicted, the best definition of outcome must be reached. Patient-reported outcomes are thought to be a true representation of outcome because they are representing areas meaningful to the patient. However, since clinicians make the recommendation for treatment, the patient-clinician agreement in cases of shoulder pain should be investigated to determine the amount of discordance, if any.

**International Classification of Functioning and Disability**

The ICF was developed by the World Health Organization (WHO) and approved in its current form in 2001. The ICF represents a paradigm shift in health care and rehabilitation medicine, placing focus on how various factors alter the level of dysfunction experienced by the patient. The primary domains of the ICF include impairments to body structures and functions, activity limitations and participation restrictions. The ICF model also accounts for contextual factors, which include environmental (physical, social and attitudinal) and personal factors to further assist in accounting for individual patient experiences.

The ICF was not designed as a theoretical model alone. The structure of the ICF is such that classifications are made based on the domain and subsequent subheadings. These classifications assist in specifically classifying impairments, limitations or restrictions experienced by the patient. The classification system allows clinicians to identify the impairments, limitations and restrictions of each patient. The ICF browser provides the full classification system in a searchable, online form. The browser contains

all items, as well as definitions for each classification level and terminal item. The existing terminal items contained within the ICF classification provide an existing framework for categorizing patient-oriented information. This is done through a process of "mapping" or "linking" each item from the outcome measure to a classification within the ICF.

Outcome measures can be mapped to the three domains (Impairments, Activity and Participation), or the full ICF classification terminal items. Several forms have been linked to the ICF, including the Disabilities of the Arm, Shoulder and Hand (DASH)[59,60] and Patient-Specific Functional Scale (PSFS).[61] Classification to the terminal level of the ICF also allows patient-nominated functional limitations to be reduced for further analysis. This will allow the large number of individual responses from each patient to be reduced to approximately 20 categories of functional limitations that can be used as predictors in a prediction model.

One limitation of the current ICF classifications is that activity and participation are listed together. This can be a challenge to the linking process. To improve the consistency of linking items to the ICF classification, Cieza et al published linking rules in 2002, and an updated version based on the authors' experience in 2005[62,63]. Even with the linking rules, reliability of the linking process can be problematic and needs to be considered. For this reason, at least two researchers familiar with the ICF should independently assess each item for its ICF classification. By using the ICF linking process, we can reduce the patient-nominated functional limitations into meaningful categories that can be utilized as potential predictor variables in a multivariable prediction model.

**Summary**

Based on previous literature, there is no clear set of factors that can be used clinically to predict the probability of a patient with shoulder pain demonstrating positive clinical outcome following standardized rehabilitation. Development of a clinical prediction model to identify a set of factors assessed at initial evaluation that predict outcome following rehabilitation would assist clinicians in making treatment decisions. Before a prediction model can be generated, patient-clinician agreement in orthopaedic shoulder disorders should be determined. Patient-oriented outcomes are advocated as a good assessment of outcome. If a large disparity in patient-clinician agreement exists, patient-reported outcomes may need to be supplemented by clinician-oriented outcomes.

# Chapter 3 Patient-clinician agreement on assessment of change following conservative rehabilitation for shoulder pain

In order to predict outcomes, the specific outcome measure(s) need to be determined. There are several perspectives that should be considered. This chapter investigates the agreement in perceived assessment of change between patient, physician, and independent physical therapists to determine if differences exist.

## Introduction

Perception of health-related assessments has been shown to vary between patients and clinicians, resulting in patient-clinician discordance. Discordance between patients and clinicians has been reported in assessments of disease severity[26-31], physical functioning,[30,32-35,41,42] pain[33,36,41] and quality of life[36] in a variety of acute and chronic pathologies and select musculoskeletal disorders. In general, patients tend to rate themselves as being more severely impacted compared to physician ratings.[26,27,31,33] However, there is some evidence that this may vary depending upon the pathology being examined.[30,34,36] The magnitude of disagreement and whether clinicians overestimate or underestimate impairments and disease severity appears to vary based on the disease.[30,34,36] This may reflect that clinicians tend to predetermine the effects a health condition will have on a patient based on the perceived generalized severity of the condition, rather than the individual patient's characteristics.

Determining the most "true" assessment of a patient can be challenging because physicians, therapists and patients are likely to factor different information into their judgment. Physicians are often thought to consider pain as a secondary result of a pathology or anatomic abnormality.[64] Evidence suggests physicians use their clinical

experience,[26,27] the patient's disease duration[65], and objective findings (e.g. clinical signs and symptoms and laboratory tests)[26,28,29,64-66] to determine their assessment. Patients, on the other hand, may not understand abnormalities explained by laboratory tests or diagnostic imaging[26], and judge severity of their injuries on their individual experience[67]. Patients also sense pain in a multifactorial manner that may be experienced even in the absence of pathology[64] and factor pain into their assessment[29,31]. A study of patients with lupus identified that patient-reported pain accounted for 20% of variance in patient-reported disease activity, but was not a significant predictor of physician reported disease activity.[29] Additionally, patients and physicians may have different expectations with regard to the outcome of the intervention, or what constitutes a good outcome.[39]

Despite this wealth of evidence, the impact of discordance on orthopaedics is relatively unknown. While discordance has been examined in one time assessments of disease state or impairment, few have examined the effect these differences in perception may have on the assessment of change over time or outcome following an intervention.[28,39,40] There is also little evidence to provide insight into whether discordance is present in an orthopaedic population. Two studies have reported fair to good patient-clinician agreement in patients with low back pain[41] and disorders of the neck-shoulder region[42]. Agreement on assessment of outcome has been examined relative to pain and overall satisfaction, but only in a cohort of post-operative patients following total hip arthroplasty.[39] No other studies in orthopedics have investigated these relationships related to change over time. This is not an issue of whose assessment is right or wrong; each perspective is equally valid. The patient's perspective should always be considered by the health care provider and is probably most important.

However, clinicians are making the recommendations for treatment and are therefore most influential in guiding the patients' course of treatment. Determining whether a patient has improved is an important factor in making treatment decisions. If these differences do exist in a population of patients experiencing musculoskeletal shoulder pain, they should be acknowledged in order to result in the most effective treatment. Therefore, the purpose of this study was to examine the agreement between patient-oriented, physician-oriented and therapist-oriented assessment of change using the Global Rating of Change (GROC) scale. We hypothesized that the three perspectives would demonstrate moderate agreement.

**Methods**

Subjects

Data from 59 subjects were used in this analysis. These data comes from a larger study in which patients were enrolled prospectively from December 2009 to November 2011. Patients reporting to the Lexington Clinic Orthopedics and Sports Medicine Center with shoulder pain were identified as potential subjects. Patients were eligible for enrollment if they presented with clinical history consistent with dysfunction due to musculoskeletal shoulder injury, reported pain with overhead activity and were between 15 and 60 years of age. Patients were excluded if they demonstrated signs and symptoms consistent with cervical radiculopathy[68], adhesive capsulitis[69], glenohumeral arthritis[70] or reported tingling/numbness in the upper extremity, surgery on the involved shoulder within the past year, or steroid injection within the last month. Patients who met the criteria and consented to participate underwent a full standardized examination by the physician and completed a battery of self-reported questionnaires including a numeric

pain rating scale (NPRS; 0=no pain, 10=worst pain) and the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH; 0 = no disability, 100 = severe disability). Subjects were prescribed physical therapy and provided with a standardized rehabilitation protocol to take to the therapist of their choosing.

Procedures

Patient-oriented assessment of change was collected prospectively at the time of physician follow up (6±1 weeks). Subjects completed a global rating of change (GROC) score to assess perceived improvement. The GROC is a 15 item scale ranging from "a very great deal worse" to "a very great deal better" (Appendix A).[43] Subjects were instructed to select the statement that best represented their perceived improvement since the initial evaluation.

Physician- and therapist-oriented assessments of change were done retrospectively in December 2012. The treating orthopaedic surgeon (WBK) was provided with the notes from initial evaluation and follow up visit for each patient. He was instructed to select the statement on the 15-point GROC scale to represent his opinion on patient improvement.

Three licensed physical therapists with varying duration of experience practicing in outpatient orthopaedic rehabilitation (low=2 years, mid=10 years, high = 37 years) evaluated improvements in impairment-based parameters in patients with shoulder pain. Each physical therapist was provided with a summary sheet including relevant patient history and physical impairment parameters from initial evaluation and follow up (Appendix C). The therapist was also instructed to select one statement on the GROC scale. The therapists had not treated the subjects in the study, rather they were acting as

blind assessors. Inter-rater agreement between the therapists was examined to verify that they were similar (Table 1); agreement was acceptable (ICC=0.838). Therefore, the most experienced PT was used as a representative in all further analysis to be similar to the experience of the physician.

Intra-rater reliability

Intra-rater reliability was established by having the physician and each therapist rate 10 subject data sheets at two different times, with a minimum of one week between ratings. Intra-class correlation coefficients (ICCs) were conducted to determine intra-rater reliability for each rater. Intra-rater reliability was excellent for all raters (ICC $\geq$0.928).

Data Reduction

The 15-point GROC was further reduced into a 3-point scale by collapsing response options into "better" (GROC score $\geq$+3), no change (-2 to +2), and "worse" (GROC score $\leq$ -3).[71] Providing patients (or clinicians) with too many options may be of concern as the individual may have difficulty attaching meaning to each separate response choice.[43] By treating the 15 point scale as continuous, ICC's and correlation coefficients can be performed, while the 3-point scale allowed for confirmation of the findings with weighted kappa and global percent agreement using a more simplified scale of better/no change/worse.

Statistical Analysis

ICCs were calculated for the overall three group comparison of patient-reported, physician-oriented and therapist-oriented assessment of change using the 15-point GROC scale. To compare the agreement between each pair, ICC's and Pearson correlation

coefficients were calculated using the responses on the 15-point GROC. Linear weighted kappa and global percent agreement, were calculated using the reduced 3-point scale (better, no change, worse). The strength of agreement for kappa was interpreted according to the following: <0.00 Poor, 0.00-0.20 Slight, 0.21-0.40 Fair, 0.41-0.60 Moderate, 0.61-0.80 Substantial, 0.81-0.99 Almost Perfect.[72] Maximum kappa values were calculated according to Sim and Wright.[73] These values provide a more meaningful reference value for interpretation because inadequate variation in the data can result in artificially low kappa values.[73] ICCs were interpreted according to Fleiss[74].

**Results**

The overall ICC for the three group agreement was 0.68. For paired analyses, each of the three comparisons demonstrated moderate to good agreement across all four methods of analysis (Table 3.2). ICCs ranged 0.61 to 0.75, Pearson's r ranged 0.61 to 0.77, weighted kappa ranged 0.48 to 0.54 and global percent agreement ranged 72% to 75%. Bivariate relationships are depicted using scatterplots (Figures 3.1-3.3).

**Table 3.1 Agreement between Physical Therapists of three experience levels**

| Experienced PT | Low Experience PT | | | Mid Experience PT | | |
|---|---|---|---|---|---|---|
| | "Worse" | "Same" | "Better" | "Worse" | "Same" | "Better" |
| "Worse" | 1 | 2 | 0 | 2 | 1 | 0 |
| "Same" | 0 | 32 | 3 | 1 | 26 | 8 |
| "Better" | 0 | 5 | 16 | 0 | 3 | 18 |

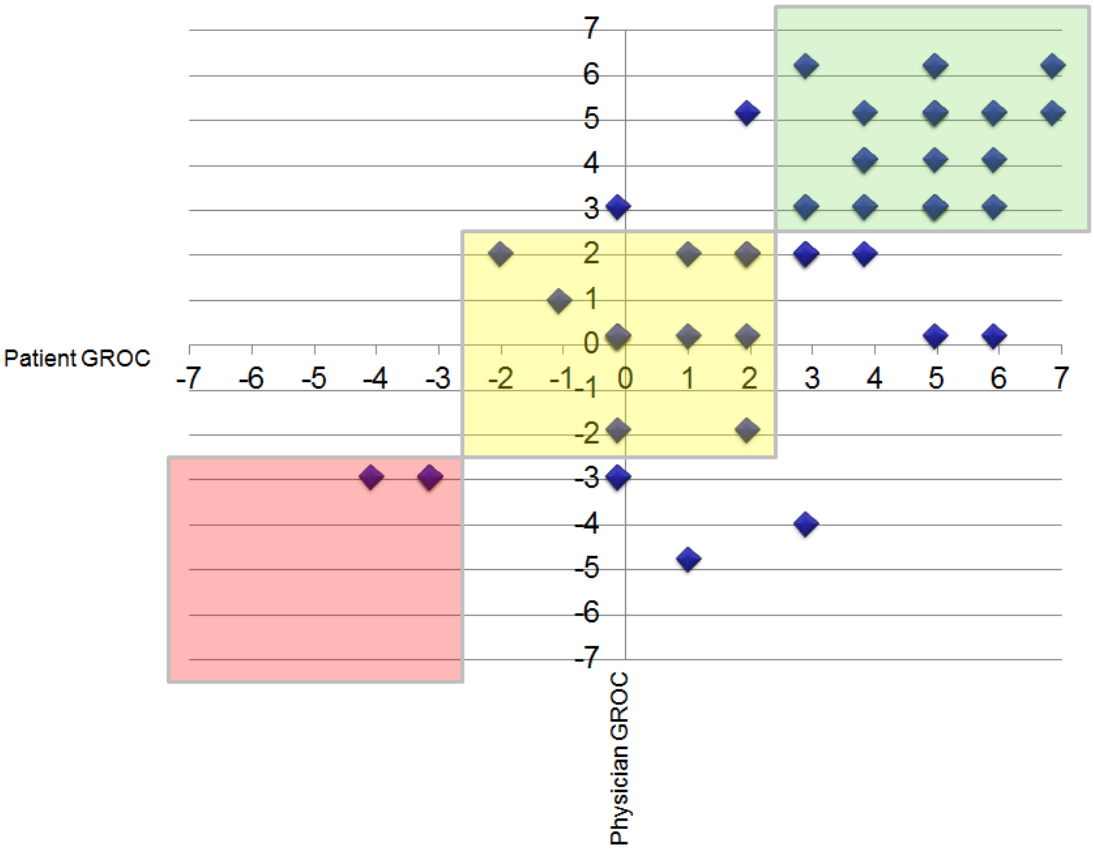
PT, physical therapist; "worse", Global Rating of Change score ≤-3; "same", Global Rating of Change score -2 to +2; "better", Global Rating of Change score ≤3.

**Table 3.2 Agreement between patients and clinicians**

| Group | ICC | Pearson's r | Kappa | Maximum weighted Kappa | Global percent agreement |
|---|---|---|---|---|---|
| Patient & MD | 0.75 | 0.77 | 0.54 | 0.76 | 75 |
| Patient & PT | 0.61 | 0.61 | 0.51 | 0.81 | 75 |
| MD & PT | 0.62 | 0.62 | 0.48 | 0.86 | 72 |

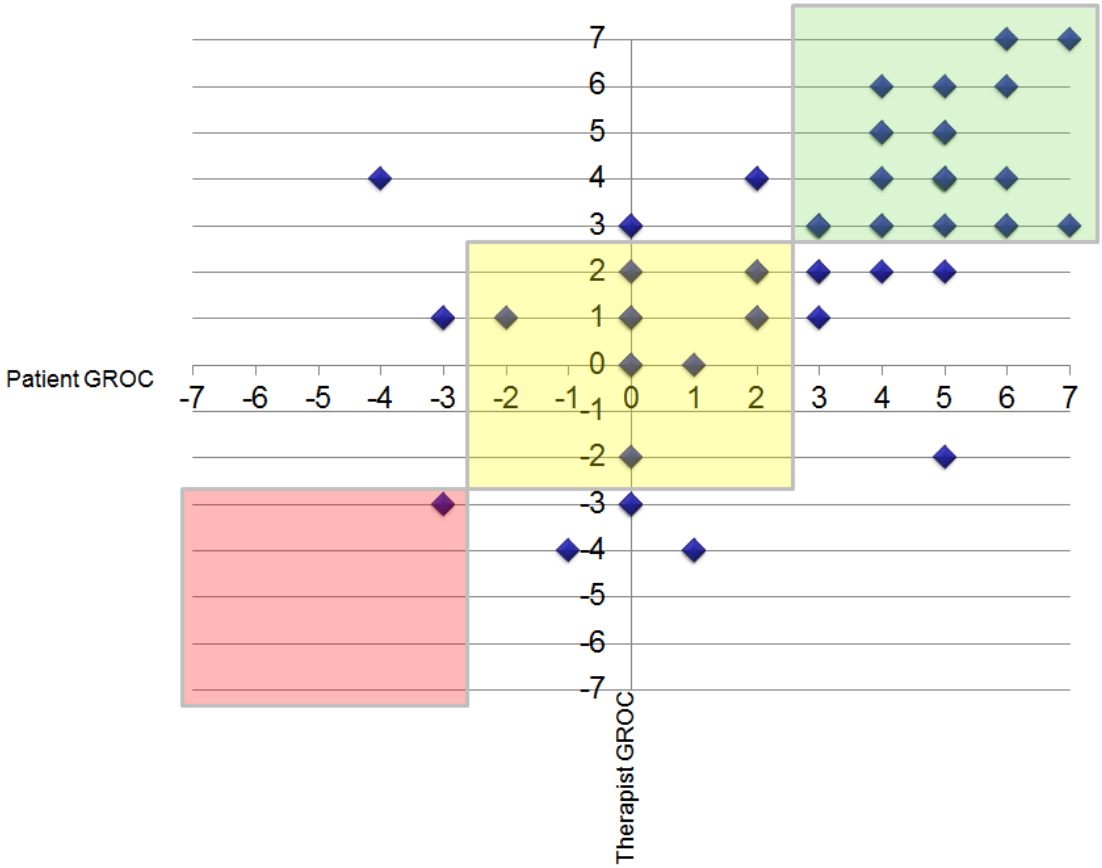
ICC = intraclass correlation coefficient, MD = physician, PT = physical therapist

Figure 3.1 Patient and physician agreement



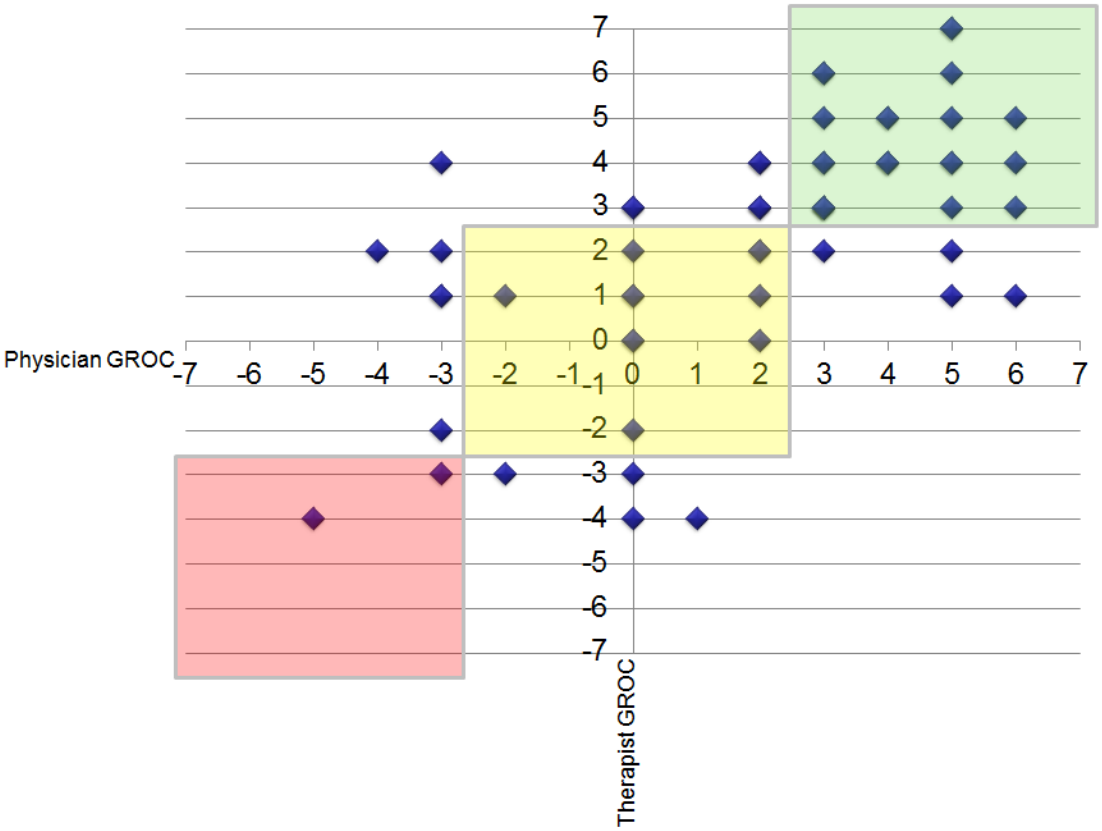

Points that fall within the green ("better"), yellow ("no change") and red ("worse") boxes represent that the patient and physician both rated the patient in the same category (agreement). Points that fall outside of the boxes represent disagreement between the patient and physician.

Figure 3.2 Patient and therapist agreement




Points that fall within the green ("better"), yellow ("no change") and red ("worse") boxes represent that the patient and therapist both rated the patient in the same category. Points that fall outside of the boxes represent disagreement between the patient and therapist.

Figure 3.3 Physician and therapist agreement




Points that fall within the green ("better"), yellow ("no change") and red ("worse") boxes represent that the physician and therapist both rated the patient in the same category. Points that fall outside of the boxes represent disagreement between the physician and therapist.

**Discussion**

The purpose of this study was to examine the agreement between patient, physician and therapist assessment of change following rehabilitation for patients with shoulder pain. Our hypothesis of moderate agreement was supported. Overall, we observed moderate to good agreement across all three comparisons. Our findings indicate similar patient-clinician agreement compared to previous research. Patient-physician agreement reported in the literature ranges from 58-77%.[26,29,31,32,35,66,75] Our findings of 72-75% are consistent with these reports, though on the higher end of the range. Our

assessments of weighted kappa statistics (range 0.48 to 0.54) are better than previous reports (range 0.09 to 0.39).[28,35,42]

Our findings of higher agreement than previous literature may be because our patients did not report high pain severity or disability. Discordance between patients and physicians is known to be greater and more common in patients with more severe ratings of disease activity, impairment or pain.[27,29,35,39] The mean rating of current pain on the NPRS was 4±2 at initial evaluation and 3±2 at follow up. The mean QuickDASH at initial exam was 37±19 indicating our patients were approximately 40% disabled at initial evaluation. At follow up, patients improved by an average of 12±14 points on the QuickDASH. Our sample seems to represent the typical population of shoulder pain patients as our findings are similar to previously reported scores for the NPRS and QuickDASH.[76-78] It is possible that agreement may be lower in a population of more disabled orthopaedic patients.

Substantial evidence has been generated to demonstrate the existence of patient-clinician discordance in ratings of current health status. However, with regard to assessment of change over time or outcome, only three studies have been identified. In one study of patients with rheumatoid arthritis, patients and physicians each rated change in global function over approximately 3 months.[40] A patient-physician relationship similar to our findings was observed (ICC = 0.64, r = 0.63).[40] In another study of patients with heart disease, a 7-point "transition index scale" similar to the GROC was used to assess change in health-related quality of life in patients with heart disease.[28] The authors identified poor agreement (k=0.09 to 0.23) between patients and physicians. The low agreement may be due to the type of data collected and compared. A single global

assessment made by the physician was compared to multiple domains assessed by the patient[28]. In our study the same global assessment was performed by both the patient and physician which may explain why we observed better agreement. In the final study, patient reported assessment of pain and overall satisfaction following total hip arthroplasty was compared to the physician assessment using a VAS scale.[39] Differences in patient and physician ratings of pain were statistically significantly different, but the difference was only 0.6cm. Reports of overall satisfaction between patient and physician were not significant, differing by 0.4cm. The authors did note that patient-physician agreement was notably worse (difference of 2.7 to 3.2cm) among the patients with high pain (>4cm) or low satisfaction (<7cm). While Lieberman et al.[39] did investigate outcome in orthopaedics, their cohort was post-surgical and the authors did not provide an assessment of agreement (e.g. kappa, ICC, global percent agreement) making it difficult to draw comparisons to the current study. Our data provides the first examination of assessment of change following conservative rehabilitation in an orthopaedic population.

The relationship of the therapist with the patient has not been widely investigated. We felt it was important to examine this relationship for several reasons. Therapists are carrying out the rehabilitation prescribed to the patient, so it would be important to know if their perception of the patient's improvement or lack thereof is consistent with the patient's self assessment. Self-report measures and physical impairment parameters of strength and range of motion have been found to demonstrate low agreement in post-operative patients following total shoulder arthroplasty.[37] This suggests that patient-reported assessments may not coincide with therapist assessments.

Three studies have examined patient-therapist agreement. The first study has examined patient-therapist agreement on assessments of functional limitations and pain in patients with low back pain.[41] The authors reported an ICC of 0.55 on ratings of pain intensity and ICCs varying between 0.22 and 0.74 on functional limitations. In the only identified study to assess patients with upper extremity dysfunction, a physical examination of the neck and shoulder region was compared to a patient-reported questionnaire assessing presence, duration and severity of symptoms.[42] The authors noted a global percent agreement of 72% with a kappa of 0.44 between patients and therapists. In line with these previous findings, we observed 75% agreement and a weighted kappa of 0.51 . Clinical observations of functional disability performed by both occupational therapists and medical advisors with expertise in assessing functional disability were compared to patient-reported disability in patients with fibromyalgia.[34] Patients rated themselves as significantly more disabled compared to the clinicians. The discrepancy was an average of 2.4cm on a 10mm visual analog scale (VAS) of functional disability. There was some concern that our patient-therapist agreement may be lower because the GROC was performed by a blinded therapist who had not treated the patient. However, in a population of patients with shoulder pain we observed an ICC of 0.61, kappa of 0.51 and 75% global percent agreement between patients and therapists, indicating our findings are in line with with previous literature.

Discrepancies exist within health care professions between physicians and therapists. One example from the musculoskeletal field is observed in the attempt to define subacromial impingement. Orthopaedic surgeons were more likely to consider tendinopathy as the most important etiology related to impingement, while physical

therapists were more likely to consider motion abnormalities as a cause of impingement.[38] In rating assessment of change of patients with shoulder pain, we observed 75% agreement between physicians and therapists. This suggests that, while physicians and therapists may utilize different criteria in assessing change, these judgments seem to be in relatively good agreement.

We used a 15-point GROC to assess perceived change. The "global", less specific nature of the GROC allows the patient to base their response on what is most important to them.[43] This was ideal for addressing the purpose of the present study in that we wanted to identify if differences existed between perceptions of patients and clinicians. Test-retest reliability of the GROC within 24 hours was excellent in patients with musculoskeletal disorders (ICC range 0.90 to 0.99).[79] One limitation of a global rating of change assessment is that it requires the patient to recall their previous condition with respect to their current status.[43] It has been suggested that GROC scores may be influenced by current status as follow up time increases.[79]

Limitations

A few limitations of this study should be noted. First, patients completed the GROC at the time of their visit, while the physician completed the GROC retrospectively. Additionally, the therapists who participated in this study were not the therapists who treated the patients during rehabilitation. The physician had his own notes to refer to when completing the GROC but the therapists only had select information provided to them. While this reduces bias, it may have inaccurately reduced the patient-therapist and physician-therapist agreement. Finally, our assessments looked at change over time from baseline to follow up. While all patients were prescribed a standardized

physical therapy intervention, several variables could have factored into the results including expectation of treatment success, patient satisfaction with outcome or physician services[39] and adherence to therapy. Future studies should account for those variables to further explain the patient-clinician relationship with regard to agreement on health-related assessment.

## Clinical Implications

It has been suggested that multiple constructs should be assessed to provide a comprehensive evaluation of outcome.[37] Based on previous work and our current findings, we suggest assessments of outcome include patient-reported assessment along with impairment parameters (e.g. pain, strength, range of motion) to better approximate "true" change or outcome. This is also in line with the Outcome Measures in Rheumatology Clinical Trials and Osteoarthritis Research Society International joint recommendation for assessing outcome.[80] The consensus reached by the societies was to include three assessment criteria: pain, function and patient's global assessment. Meeting specified thresholds for improvement in two of these three criteria are necessary to be considered a responder to prescribed treatment.

## Conclusion

Our results indicate that patient reported assessment of change displayed moderate to good agreement with physicians and therapists. This supports use of patient reported outcomes as an appropriate gauge of outcome.

## Chapter 4 Linking Methods and Results

The purpose of Chapter 4 is to describe the methods used to link patient responses on the Patient Specific Function Scale to the International Classification of Function. The results presented here indicate which categories identified through this linking process will be used in the predictive model in Chapter 5. Discussion of the findings and implications for clinical practice will be included in Chapter 5. The final categories identified in Table 4.2 will serve as potential predictors in the prediction model analysis conducted in Chapter 5.

### Background

The Patient Specific Function Scale (PSFS) was developed to identify functional limitations specific to the individual patient (Appendix B).[81] The PSFS asks patients to identify 3 functional limitations they are experiencing. We collected the patient-nominated functional limitations provided by patients experiencing shoulder pain. The International Classification of Functioning, Disability and Health (ICF) provides researchers and clinicians with a framework to which the patient-nominated functional limitations can be "linked". The ICF taxonomy consists of over 1400 categories, which are designated by alphanumeric codes. The ICF classifies functioning within the domains of *body functions* (b), *body structures* (s), *activities & participation* (d) and *environmental* (e). An additional domain, *personal factors*, has not yet been classified. The ICF uses a system arrangement of hierarchical alphanumeric coding to classify categories of functioning and environmental factors. The initial letter refers to the domain. This letter is followed by a numeric code that starts with a chapter number (e.g. *Mobility*, d4), this is followed by a two digit second level (e.g. *Hand and arm use*, d445),

and then followed by a one digit third level (e.g. *Throwing*, d4454). By using the existing ICF classification system to categorize patient-nominated functional limitations, we can reduce them into a manageable number of factors to examine their relationship to clinical outcome. Most predictive models focus on impairment parameters such as clinical tests and body function measures of strength or mobility. By linking the functional limitations to an existing classification system, we are able to organize these self-nominated functional limitations into specific categories. The ability to collapse individual response into a pre-existing categorical system better affords us the ability to use these important individual limitations which may be critical in a predictive model. Therefore, the purpose of this analysis was to categorize the patient-nominated functional limitations reported by patients with shoulder pain. This was done by linking the meaningful concept(s) of each self-nominated functional limitation with the ICF classification.

**Methods**

Data were obtained for this secondary analysis from a prospective clinical trial investigating predictive factors of outcome following rehabilitation. Data from 185 subjects were included in this analysis (age 40±13 years, 130 (70%) males, duration of symptoms 18±41 months). As a part of this study patients completed the PSFS, which asks patients to provide a minimum of three functional limitations they were experiencing as a result of their shoulder pain. Patients also rated their ability to do the functional limitation from 0 (unable to perform) to 10 (can perform at pre-injury level).

The functional limitations obtained from the PSFS were linked to the International Classification of Function (ICF) by three raters; one Registered

Occupational Therapist and Certified Hand Therapist (ESF), one Certified Athletic Trainer (SDM), and one Licensed Physical Therapist and Certified Athletic Trainer (TLU). Each rater was familiar with the ICF classification system and followed the linking rules established by Cieza et al[63]. In order to establish that each rater had requisite knowledge of the ICF, each rater completed three required readings[60,63,82] and demonstrate the ability to appropriately link a sample of 15 functional limitations randomly selected from the full list. Following independent review, the researchers met as a team to identify discrepancies and reach a consensus on how to evaluate each functional limitation. Following this initial training session, each researcher independently linked the self-nominated PSFS functional limitations to the ICF classification system. A final consensus meeting was then held to resolve conflicts between reviewers on each functional limitation. Raters were blinded to the outcome of the patient who reported each functional demand. In order to link a functional limitation to the ICF, the meaningful concept(s) must be identified. Each meaningful concept was linked to the most appropriate ICF classification. It was common that one functional limitation was linked to more than one ICF code. For example, the functional limitation "baseball pitching" was linked to both "throwing" d4454 and "sport" d9201.

Statistical Analysis

Percent agreement prior to the final consensus meeting was calculated for each pair of raters. After the consensus meeting frequencies were determined for meaningful concepts within each domain and chapter. Any chapters that contained a large number of responses were further stratified to the second level (e.g. d445, hand and arm use) or third level (e.g. 45540, pulling) as appropriate.

**Results**

As expected, percentage agreement was best when examining the chapter level (69-71%) and declined slightly as classification became more specific (Table 4.1). It should be noted that a considerable number of non-agreement cases (24-27%) occurred when one rater assigned additional meaningful concepts to a functional limitation that the other did not, resulting in a comparison of one rater's response to another rater's lack of response. When these instances are excluded, agreement at the chapter level improves to 94-97%. All data are being used at the chapter level with the exception of chapter d4 which is being further subdivided due to the high number of responses within the chapter

**Table 4.1 Percent agreement between three raters**

| Comparison | Chapter | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|
| AT & PT/AT | 71% | 66% | 62% | 45% |
| AT & OT/CHT | 69% | 64% | 61% | 55% |
| PT/AT & OT/CHT | 70% | 67% | 60% | 41% |

AT, athletic trainer; PT, physical therapist; OT, occupational therapist; CHT, certified hand therapist

A total of 590 functional limitations were provided by the 185 patients, resulting in the identification of 806 meaningful concepts (Figure 4.1& 4.2). 21 meaningful concepts were excluded because the patient failed to provide the rating of impairment, leaving 785 for analysis. None of the meaningful concepts represented the body structures domain (s). 132 (17%) were from the body function domain (b), representing three of the eight chapters in domain b. 651 (83%) were from the activities and participation domain (d). All nine chapters of domain d were represented, although chapters 1, 2, 3 and 7 negligibly so ($n \leq 3$). Chapter d4 (Mobility) was most represented ($n=447$), containing over 50% of the total meaningful concepts. Due to this, Chapter d4 was further stratified into second level classifications. The second level classification of

d445 (hand and arm use) represented 244/447 (55%) of all self-nominated limitations within Chapter d4 and therefore was further stratified into third level classifications. (Figure 4.2) This ultimately resulted in 22 distinct ICF categories.

**Figure 4.1 Functional limitations by ICF domain**

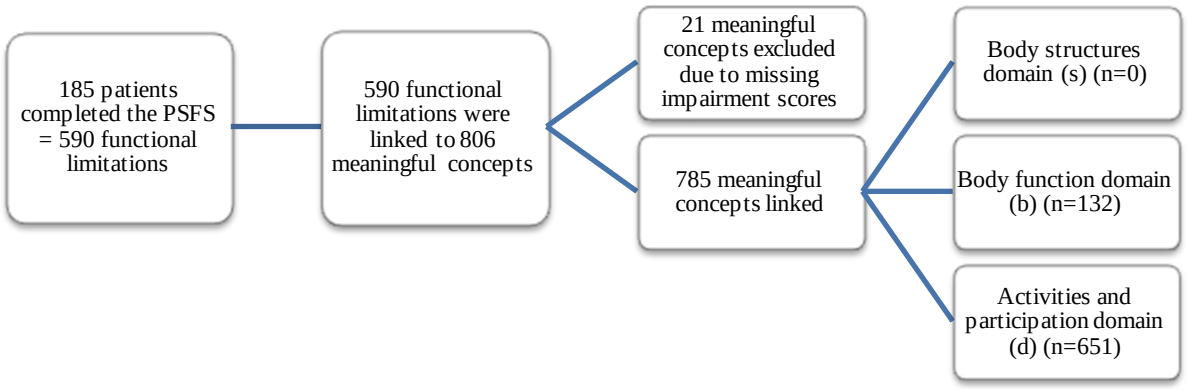
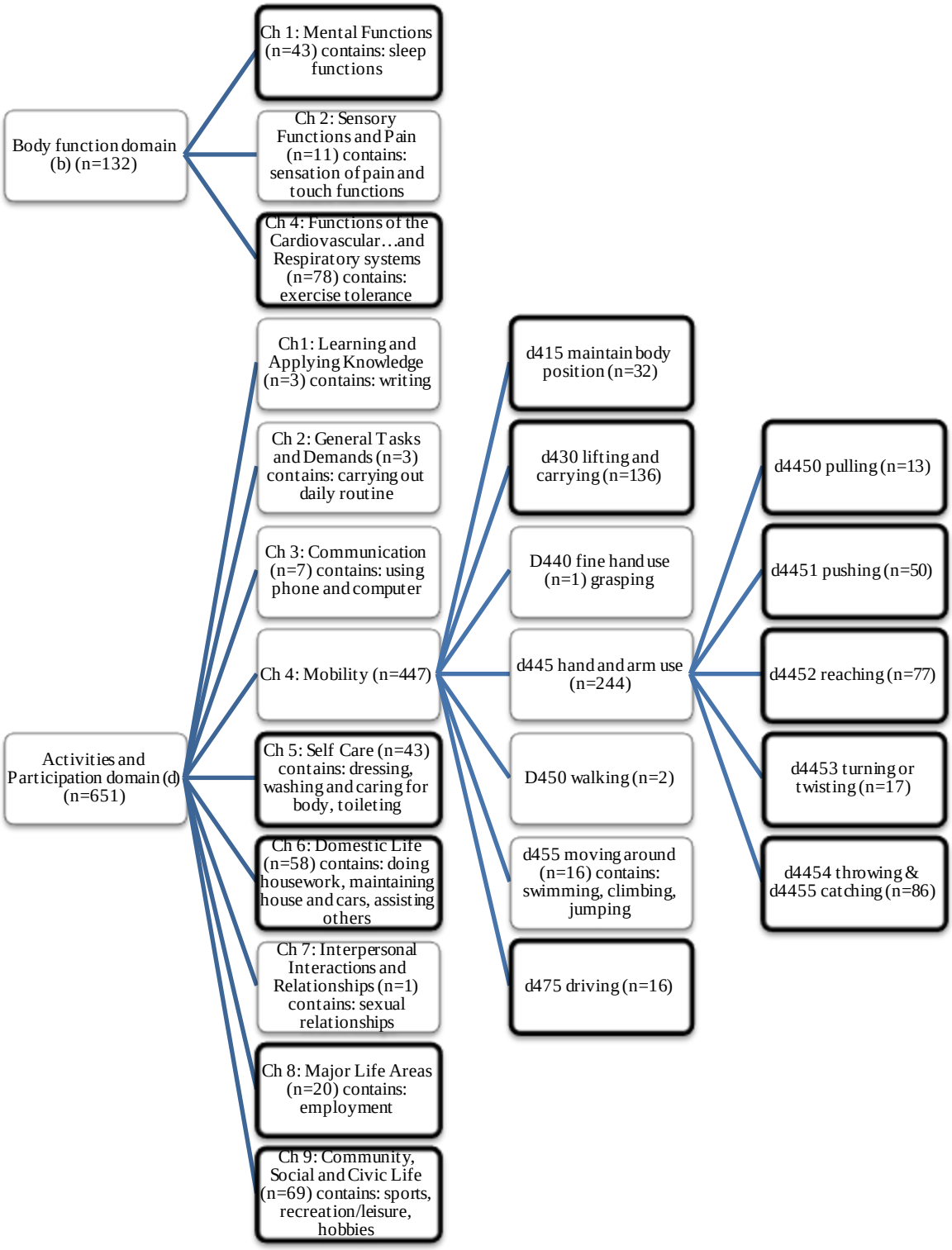


**Figure 4.2 Functional limitations by ICF chapter**




*Bolded black boxes denote the 14 classifications that were selected for consideration.

**Summary**

The majority (83%) of functional limitations reported by the patients in this sample were from the activities and participation domain. In fact, over half (57%) of all functional limitations reported were related to mobility. This gives us clear insight into the types of functional problems patients with shoulder pain are experiencing. This is logical as the primary functional role of the shoulder is to provide mobility for the upper extremity.[83] By completing the linking process we were able to reduce the widely varied self-reported functional limitations into 22 categories to be considered as potential predictors in the prediction model. Of the 22 categories identified, 14 were selected as potential predictors in the model (Table 4.2). This selection was based on having enough responses in that category to warrant further examination.

This process reduced 785 individual meaningful concepts of patient self-nominated functional limitations to 14 variables, which is a 98% reduction in identified limitations. These variables will be added to the other factors of patient history, clinical findings, standardized functional questionaires, and measures of strength and range of motion impairments. These factors will be considered in the final step of this project to identify factors that predict outcomes in patients with shoulder pain.

**Table 4.2 Categories selected for consideration in the predictive model**

| Code | Title | Includes |
|---|---|---|
| b134 | Sleep functions | |
| b455 | Exercise tolerance | |
| d415 | Maintain body position | maintain lying position |
| d430 | Lifting and carrying | |
| d4450 | Pulling | |
| d4451 | Pushing | |
| d4452 | Reaching | |
| d4453 | Twisting or turning | |
| d4454 & d4455 | Throwing & catching | |
| d475 | Driving | |
| d5 | Self-care | washing and caring for body and hair, dressing, toileting |
| d6 | Domestic life | housework, maintaining home and cars, caring for plants or animals, assisting others |
| d850 | Employment | |
| d9 | Community, social and civic life | sports, recreation & leisure, hobbies, play |

# Chapter 5 Predicting Patient-Reported Outcome following Six Weeks of Standardized Rehabilitation in Patients with Shoulder Pain

This chapter incorporates the findings from Chapters 3 and 4 to determine what combination of factors is most predictive of positive clinical outcome for patients undergoing standardized rehabilitation for shoulder pain. The results from Chapter 3 indicated that patient and physician were in moderate agreement when assessing change following rehabilitation. Therefore, patient reported outcomes will be used as the primary indicator of outcome in this study. The results from Chapter 4 provided 14 functional limitation variables that will be added to the other variables to be considered as candidate predictors in the multivariable analysis.

## Introduction

Shoulder injury is a common problem facing orthopaedic and rehabilitation specialists. Shoulder pain accounts for approximately 15% of all musculoskeletal complaints.[1,2] In the US alone, 8.9 million office visits were made to physicians for the primary complaint of shoulder symptoms in 2006.[3] Differential diagnosis of specific shoulder pathology is difficult to make[8] and is not highly reliable[9]. This difficulty is further confounded by the fact that patients with shoulder injury often have concomitant injury.[10] Furthermore, knowledge of a specific diagnosis alone is not enough information to predict outcome. For example, preliminary results from a multi-center trial identified that no feature of a rotator cuff tear (size or amount of tendon retraction) was associated with outcome following non-operative management.[11]

A health condition or diagnosis may describe the anatomy involved, but it does not explain how the anatomical injury affects the individual patient's life or dictates the type or extent of dysfunction a patient may experience. The Centers for Medicare and

Medicaid Services (CMS) states that diagnosis is a poor predictor for the type and duration of therapy services that may be required and has mandated that functional limitations be assessed and reported by therapists.[13] Functional limitations consider issues beyond tissue pathology and structure to include activity and participation implications of the disease state. The CMS is starting a process to better track outcome by requiring treating health care providers to indicate current level of functional limitation and expected level of function at end of care when submitting claims. The intent of this is to facilitate a better understanding of what activity or participation limitation may affect final outcome of patients with musculoskeletal disorders.

One item that is consistent across nearly every shoulder diagnosis is that a patient is recommended conservative intervention including physical therapy to initially address shoulder pain.[14-16] A systematic review of the evidence supports that therapeutic exercise reduces symptoms in patients with rotator cuff pathology.[17] The level of success across several shoulder disorders, including rotator cuff impingement, labral lesions and instability, varies from 50-80%. [16,18,19] Providing clinicians with a clinical tool to help determine which patients are more likely to have a positive outcome with non-operative rehabilitation for shoulder pain would help direct treatment decisions, make treatment more efficient and improve patient care. In fact, the call for such information has been recently stated by the federal government. The CMS has recognized the need to develop a system for classifying clinical cohorts in order to determine what services will be needed since diagnosis does not provide enough information.[13]

Current clinical prediction models for shoulder pain are limited.[21] One model for shoulder pain has been derived and subsequently validated by Kuijpers et al.[24,25] The

model is designed to predict the risk of persistent symptoms at 6 weeks among patients with shoulder pain seen in general medical practice. The majority of patients were treated with medication or a wait-and-see approach instead of physical therapy. The clinical guideline on shoulder pain statement put forth by the American Academy of Orthopaedic Surgeons indicates that therapeutic rehabilitation is often prescribed for patients with shoulder pain. A systematic review on prognostic factors for shoulder pain identified that no studies of sufficient quality exist in orthopaedics.[21] Therefore, the purpose of the present study was to identify what combination of factors best predicts outcome following 6 weeks of standardized rehabilitation in patients seeking medical care for shoulder pain from an orthopaedic surgeon at a sports medicine clinic. We hypothesized that diagnosis would not be predictive of positive clinical outcome, rather that body function impairments and self-nominated functional limitations will be predictive of positive clinical outcome.

**Methods**

Subjects

Potential subjects were identified as new shoulder evaluation patients at the Lexington Clinic Orthopedics and Sports Medicine Center between December 2009 and November 2011. Patients were excluded from the study if they demonstrated numbness or tingling in the upper extremity; signs and symptoms consistent with cervical radiculopathy[68], adhesive capsulitis[69], glenohumeral arthritis[70], steroid injection in the involved shoulder within the previous month or surgery on the involved shoulder within the last year. Of 191 subjects enrolled in the study, follow up data was available from 118 subjects who are included in this analysis (age=41±12 years, mass=85±19 kg, height=175±9 cm, 67 males). The study was approved by the Institutional Review

Boards. All patients read and signed an approved informed consent form prior to enrollment in the study.

Procedures

Subjects completed a standard history form and underwent standard examination by the orthopaedic physician. Clinical exam findings and physician diagnosis were recorded. The information collected during the exam was used to categorize patients independent of the physician to examine diagnosis in a subjective manner. Patients were categorized as having findings consistent with either labral pathology or rotator cuff tendinopathy based on specific criteria. Patients who did not meet either of these classifications were categorized as shoulder pain of unknown etiology (SPUE). Patients classified as having findings consistent with labral pathology (n=38) met at least 3/4 clinical criteria: positive modified dynamic labral shear, positive O'Brien's test, positive anterior slide test and self-report of popping and catching (modified from Walsworth et al[84]). Patients classified as having rotator cuff tendinopathy (n=38) met at least3/4 clinical criteria: positive Neer impingement sign, positive Hawkins-Kennedy test, positive painful arc test and pain with resisted abduction (modified from Park et al[85] and Michener et al[86]). Patients who did not meet either of these classifications (n=42) were classified as SPUE. Seven patients met criteria for both the labral and rotator cuff classifications. The physician reported diagnosis was consulted and all 7 patients were given a diagnosis of labral injury without notation of concomitant rotator cuff involvement, therefore all 7 were classified into the labral group for the purposes of this analysis.

Subjects completed additional questionnaires and functional testing, including an injury-specific history questionnaire, pain and function self-report questionnaires. A numeric pain rating scale (NPRS; 0=no pain, 10=worst pain) was utilized to collect current pain, worst pain in the last week and least pain in the last week.[87] The three responses of current, worst and best pain were collected and analyzed separately. The Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH; 0 = no disability, 100 = severe disability), American Shoulder and Elbow Surgeons Shoulder Assessment Form (ASES; 0 = poor function, 100 = normal function)[78,88,89] and Patient Specific Functional Scale (PSFS) were administered. With use of the PSFS the patient lists 3-5 functional limitations they are experiencing because of their shoulder problem, and rate each item on a 10 point scale (0 = unable to perform activity at all, 10 = can perform activity at the same level as prior to the injury). The self-reported functional limitations provided by patients in the PSFS were linked to the International Classification of Function classification system using standardized procedures.[62,63] This process allowed the large number of individual responses to be reduced to a more reasonable number of categories that could be considered as potential predictive factors. The linking process, detailed in Chapter 4, resulted in 14 variables to be considered in this prediction model.

Bilateral glenohumeral range of motion (ROM), strength and posture were assessed. Active shoulder flexion ROM and passive glenohumeral internal rotation, external rotation and horizontal adduction ROM were measured with a digital inclinometer (Dualer, JTech Medical, Salt Lake City, UT) as previously described. [90-93] All passive ROM measures were recorded at the end range (perceived increased resistance to motion by the examiner or if pain was reported as intolerable by the

subject). Isometric muscle strength was measured in forward flexion and external rotation with a hand-held dynamometer (Model 01163, Lafayette Instruments, Lafayette, IN) as previously described.[94,95] Arms were tested in alternating fashion to allow for approximately 30 seconds of rest between trials. For each strength measure, the dynamometer was placed just proximal to the wrist and two 5-second maximum effort trials were performed and averaged for analysis. Shoulder posture was assessed using a double square instrument. Subjects were asked to assume a normal posture after taking a cleansing breath to relax. The double square instrument was aligned with the wall and the anterior aspect of the acromion; this distance was measured and recorded bilaterally.[96,97]

All subjects were prescribed physical therapy and provided with a standardized rehabilitation protocol consisting of stretching exercises for muscular tightness and strengthening exercises for shoulder musculature (Appendix D). The rehabilitation protocol consisted of four phases. The program was developed to address mobility deficits of the glenohumeral joint. The phased program started with scapular orientation exercises, short lever arm shoulder strengthening, progressing to long lever arm exercises and incorporating ballistic exercises in the final phase. The program was to be individualized for each patient by the treating therapist based on the level of pain and dysfunction with which the patient presents.

At a follow up visit with the orthopaedic surgeon 6±2 weeks after the initial visit, the QuickDASH and numeric pain rating scale were re-assessed and the global rating of change (GROC) score was obtained. The GROC is a 15-point scale ranging from -7 (a great deal worse) to zero (no change) to +7 (a great deal better).[43,98] The change from

baseline to follow-up scores was determined for the quickDASH and NPRS to evaluate patient's self-report of function and pain.

Criteria used for categorizing patients were based on meaningful improvements determined by the patients' reported function, pain, and overall change between physician appointments. Meaningful improvements were considered a change of at least 11 points on the quickDASH and at least 2 points on the NPRS.[99-101] A score of +3 ("somewhat better") or better was considered meaningful improvement on the GROC, as previous studies have used this value for minimally clinical important differences in patients with shoulder pain.[101] Patients were divided into two groups based on change scores. Responders (positive clinical outcome) were determined by demonstrating improvement in at least 2/3 criteria. Non-responders (negative clinical outcome) were defined as patients who met 1 or none of the 3 criteria. These responder criteria were modeled after the Osteoarthritis Research Society International-Outcome Measures in Rheumatology (OMERACT-OARSI) set of responder criteria used to determine response to treatment in osteoarthritis patients, which recommends assessment of three symptomatic domains: pain, function and patient's global assessment.[80]

## Statistical Analysis

### Diagnosis as a prognostic factor

To address whether diagnosis was predictive of outcome, a chi-square test was performed to examine the relationship of criterion-based diagnosis with clinical outcome.

### Variable selection and multivariable logistic regression

To determine what set of variables best predict outcome, a total of 76 variables (28 continuous and 48 categorical) were obtained from subject demographics, injury history, self-reported function questionnaires, orthopaedic exam, impairment parameters

and functional limitations collected at the initial visit. Each variable was assessed individually for a bivariate relationship with positive clinical outcome using simple statistics (independent t-tests and chi square tests for continuous and categorical variables respectively). Normality of continuous variables was assessed using a one-sample Kolmogorov-Smirnov test. A non-parametric statistic (Mann-Whitney U) was used in place of the independent t-test for any variables found not to be normally distributed. Variables were assessed for multicollinearity using Spearman's rho rank correlation coefficient ($r_s$) so as not to include highly correlated variables in the model. Once a reduced set of variables had been selected following these procedures, logistic regression was performed (forward stepwise selection of variables; $P_{in}$ <0.15, $P_{out}$ <0.2). Data analysis was performed using SPSS with the exception of area under the curve (AUC) of the receiver operator characteristic curve which was calculated using SAS.

**Results**

51 patients were classified as responders (2/3 criteria = 29, 3/3 criteria = 22). 67 patients were classified as non-responders (0/3 criteria = 42, 1/3 criteria = 25).

Hypothesis 1: Diagnosis as a prognostic factor

In this sample there is no evidence to support that diagnosis is related to clinical outcome or has an impact on positive clinical outcome (p=0.543). This indicates that diagnosis is not predictive of outcome in patients with shoulder pain. This is further supported by the fact that the observed percentages in outcome across the three diagnoses were very similar (Table 5.1).

Table 5.1 Contingency table - Diagnosis and positive clinical outcome

| Diagnosis | Non-Responder (n=67) | Responder (n=51) | Total (N=118) |
|---|---|---|---|
| Labral pathology | 23 (60%) | 15 (40%) | 38 |
| Rotator cuff tendinopathy | 23 (60%) | 15 (40%) | 38 |
| SPUE | 21 (50%) | 21 (50%) | 42 |

SPUE, shoulder pain of unknown etiology
Chi-square test p=0.543

Hypothesis 2: Multivariable logistic regression model

Variable Selection

The results of the 76 bivariate simple statistical analyses are presented in Appendix E. Twenty variables demonstrated a significant bivariate relationship with the outcome ($p \leq 0.2$). One variable was eliminated because of missing a large number of cases (horizontal adduction range of motion). Spearman rho correlations calculated for the remaining 19 variables are presented in Appendix F. After eliminating four variables because of multicollinearity, ($r_s \geq 0.50$; Neer impingement test, previous treatment, previous physician consultation and the functional limitation 'maintaining body position') (Appendix F), 15 remaining variables were entered into the logistic regression model (Table 5.2).

Table 5.2 Fifteen candidate variables used in forward stepwise logistic regression

| Variable | Type of variable |
|---|---|
| Duration of symptoms | continuous (months) |
| NPRS - Best pain | continuous (0-10) |
| External rotation ROM | continuous (degrees) |
| Neck pain | dichotomous (yes/no) |
| Numbness/tingling | dichotomous (yes/no) |
| pain around shoulder blade | dichotomous (yes/no) |
| previous PT | dichotomous (yes/no) |
| painful arc | dichotomous (negative/positive) |
| hawkins kennedy | dichotomous (negative/positive) |
| scapular dyskinesis | dichotomous (negative/positive) |
| Crepitus | dichotomous (negative/positive) |
| single leg balance | dichotomous (negative/positive) |
| b1 sleeping | dichotomous (yes/no) |
| b4 exercise | dichotomous (yes/no) |
| d6 domestic life (e.g. household work) | dichotomous (yes/no) |

Multivariable Logistic Regression

To address hypothesis 2, a multivariable logistic regression (forward stepwise selection of variables; $P_{in}$ <0.15, $P_{out}$ <0.2) was performed. The analysis identified three variables as being related to the outcome (Table 5.3). The final model included 109 subjects. Absence of neck pain (self-reported on the injury-specific history questionnaire), longer duration of symptoms and reporting exercise as a functional limitation were related to increased odds of positive clinical outcome following rehabilitation. The overall model was significant (p=0.003) and all three variables were significant at p≤ 0.1 level; only neck pain was significant at p≤0.05 level. The model AUC was 0.68, indicating the model better predicts outcome compared to neck pain (AUC=0.61), exercise (AUC=0.58) or duration of symptoms (AUC=0.63) independently . The model correctly predicted 62% of patients in this derivation cohort. The model was better able to correctly classify non-responders (71%). The model was not better

than chance at classifying the patients who had a positive clinical outcome (49%). Predicted probability (P) of positive clinical outcome at 6 weeks can be determined by the equation below.

**Equation:**

$$\boldsymbol{P = 1/[1 + exp - (0.092 - 0.022 \times duration\ of\ symptoms - 0.857 \times neck\ pain + 0.750 \times exercise)\ ]}$$

Table 5.3 Results of Logistic Regression

| Variable | Regression coefficient | *p* value | OR (95% CI) |
|---|---|---|---|
| Duration of symptoms* | -0.022 | 0.090 | 0.98 (0.95, 1.00) |
| Neck pain | -0.857 | 0.054 | 0.42 (0.18, 1.01) |
| Exercise functional limitation | 0.750 | 0.109 | 2.12 (0.85, 5.30) |
| Constant | 0.092 | | |

* in months

OR = adjusted odds ratio

**Discussion**

The purpose of this study was to investigate factors thought to be related to outcome in patients with shoulder pain and to develop a preliminary comprehensive prediction model to be easily implemented in clinical practice. We hypothesized that diagnosis would not be a predictor of outcome. While we cannot reject the null hypothesis because our sample size is not large enough to detect differences for a categorical variable, there is no evidence to support that diagnosis plays a role in outcome in this sample. We also suspected that body function parameters (e.g. range of motion, strength, posture) and self-reported functional limitations (e.g. self-care, throwing, etc.) would be related to outcome. This hypothesis was partially supported in that the self-

reported functional limitation of exercise was included in the final model but no range of motion, clinical tests, strength or posture variables were included.

This is the second study to present a model for predicting outcome of non-operative shoulder pain, and the first to incorporate rehabilitation. Our multivariable analysis identified the combination of three factors, shorter duration of symptoms, absence of concomitant neck pain and report of exercise as a functional limitation as being predictive of positive clinical outcome. The adjusted odds ratios can be interpreted as follows: for every 1 month increase in duration of symptoms the odds of positive clinical outcome decrease by 2%, patients with an absence of neck pain have 58% greater odds of positive clinical outcome compared to those who report neck pain, and patients who report exercise as a functional limitation have 2 times (200%) greater odds of positive clinical outcome compared to those who did not report exercise when controlling the other variables in the model. The prediction equation generated from the model allows the model to be applied clinically. For example, the estimated probability of positive clinical outcome for a patient with a duration of symptoms of 3 months, no neck pain and reports exercise as a functional limitation would be 68%. Alternatively, a patient with duration of symptoms of 6 months, history of neck pain and no report of exercise as a functional limitation would have a predicted probability of positive clinical outcome of 29%.

One existing model has been developed and externally validated[24,25] to predict persistent symptoms at 6 weeks in patients with shoulder pain seen in primary care. One fundamental difference between the existing model and our current analysis is that our patients were prescribed a standardized rehabilitation protocol while the existing model

was developed for patients treated primarily with medication, corticosteroid injection or a "wait-and-see" approach. Because rehabilitation is often prescribed to patients seen by orthopaedic physicians in the US, we wanted to investigate a model for such a population. Despite this difference, both models identified a shorter duration of symptoms and the absence or lower severity of neck pain to be related to positive outcome. Our assessment of neck pain was self-reported via a yes/no question, "do you have neck pain?", while neck pain was defined by Kuijpers et al[24] as the sum of self-reported pain (0-4) experienced during cervical ROM. It should be noted that we did not include a physical examination of the neck, or obtain further information from the patient as to how they defined or described their neck pain. Kuijpers et al[24] also observed that gradual onset of pain, psychological complaints, report of repetitive movements (at least 2 days per week) and high pain severity in the shoulder were related to persistent symptoms.

Our finding that duration of symptoms was predictive of outcome is consistent with existing literature.[4,6,7,102-104] Duration of symptoms is one of the most commonly reported prognostic factors related to outcome in shoulder pain.[21] Moreover, a systematic review established that there is moderate evidence to support that longer duration of symptoms predicts poorer outcome.[21] We are also not the first to identify concomitant neck pain as a predictor of outcome. van der Windt et al[6] noted that concomitant neck pain was associated with poorer outcome at 12 months along with higher pain in patients with shoulder pain.

Our model indicated that the self-report of exercise as a functional limitation was predictive of positive clinical outcome. We are the first to investigate the prognostic

value of self-reported functional limitations. One limitation to the Patient Specific Function Scale, from which the self-nominated functional limitations were obtained, is that each patient's response is slightly different resulting in a large number of varying responses. We reduced the responses to manageable categories by linking them to the ICF classification system using standardized procedures.[63] Of the 109 subjects in the final model, 29 (27%) reported at least one functional limitation related to exercise. The most common specific responses from the exercise classification included "weight lifting" or the description of a specific exercise (e.g. kettle bells, pushups, bench or overhead press). One explanation for its relationship to outcome may be that patients who are reporting exercise as a functional limitation are more likely to set aside time for their rehabilitation. In a study of 218 patients enrolled in physical therapy, non-compliant patients were more likely to report problems such as lack of time to exercise (73% versus 13% of compliant patients), forgetting to exercise (47% versus 3% of compliant patients) and lack of motivation to exercise (35% versus 5% of compliant patients).[105]

In a general medical population, there is strong evidence that high pain intensity predicts poorer outcome and moderate evidence that high disability score at baseline predict a poorer outcome.[21] We did not observe either of these factors to be predictive of outcome in our cohort. This could be because the average pain and functional disability reported by our patients was not extremely high and were not significantly different between responders and non-responders. Mean NPRS scores were 4/10 for current pain and 6/10 for worst pain in the past week. The mean score on the QuickDASH was 36

and the mean score on the ASES was 61, indicating that the average patient in the present study were approximately 40% disabled.

Preliminary findings from a multi-center trial indicate that patient expectation of physical therapy was the strongest predictor of surgical intervention in patients with full thickness rotator cuff tears.[11] There is growing evidence in the orthopaedic literature that patient expectation plays a role in outcome, particularly in post-operative patients.[106-108] It has also been shown in patients with chronic pain that higher expectation of alternative therapies such as acupuncture and massage are related to better improvement.[109-111] Kuijpers et al[24] did not assess expectation of therapy for their prediction model, but patients did complete the Fear-Avoidance Beliefs Questionnaire[112] and the Tampa Scale for Kinesiophobia[113], as well as assessments of coping, anxiety, depression and distress and a general one-item question (yes/no) as to the presence of any psychological complaints. Their final model included the simple yes/no question as it did as well at representing that data as the more involved questionnaires. We did not assess expectation of therapy or other psychosocial factors. Based on the long duration of symptoms experienced by the non-responder group (mean of 2 years), these patients may fit the characteristics of chronic pain. Assessment of expectation of therapy, the Fear-Avoidance Beliefs Questionnaire[112] and the Tampa Scale for Kinesiophobia[113] should be assessed and considered in future models to determine if these may in fact be related to outcome in patients with shoulder pain.

Limitations

There are several limitations of this study that limit the generalization of our results, the first being inadequate sample size. It is generally accepted that a minimum of

100 events are necessary to approach an appropriate sample size. Based on our positive clinical outcome rate of 43% and accounting for 30% attrition, a minimum of 325 patients would need to be enrolled. We enrolled 191 patients, but were only able to obtain follow up data from 118, resulting in a 38% loss to follow up. Our data were collected by one physician with extensive experience and training who is often referred patients who haven't responded to previous treatments or are more challenging cases to manage. In this sample, 61/118 (52%) of patients reported having previously seen another physician for this episode of shoulder pain. Interestingly though, the pain and disability of the subjects was relatively low. It is possible that the model may not hold true in other settings with less experienced or a more disabled sample. Finally, we did not investigate psychosocial factors such as expectation of physical therapy or fear avoidance, which may be important given the long duration of symptoms experienced by the patients in our sample.

## Conclusion

In our sample of shoulder pain patients prescribed a standardized rehabilitation protocol, the combination of shorter duration of symptoms, absence of neck pain and report of exercise as a functional limitation were predictive of positive clinical outcome. This is the first comprehensive model to predict outcome patients with shoulder pain treated non-operatively with standardized rehabilitation. Additionally, we found no evidence to support that diagnosis was predictive of outcome in this sample of patients with shoulder pain. However, these results should be interpreted with caution due to our small sample size. Further development of the model in a larger sample, along with

validation of the model with a separate cohort are required before the model can be used to influence clinical practice.

## Chapter 6 Summary

The purposes of this dissertation were to assess patient-clinician agreement on a measure of assessment of change and to identify what combination of factors collected at initial evaluation best predicts patient-reported response to 6 weeks of standardized rehabilitation in patients with shoulder pain. Specifically, the following aims and hypotheses were examined:

**Specific Aim #1:** Determine the agreement in assessment of change following 6 weeks of standardized rehabilitation in patients with shoulder pain by examining the agreement of a global rating of change assessment between:

1) patient-reported assessment of change
2) physician-oriented assessment of change
3) therapist-oriented assessment of change

*Hypothesis:* The three perspectives will demonstrate moderate agreement (ICC and $r \approx 0.6$).

**Specific Aim #2:** Determine what combination of factors collected at initial evaluation best predicts response to non-operative treatment at 6 weeks in patients with shoulder pain.

*Hypothesis:* We hypothesize that diagnosis will not be predictive of outcome, but that a combination body function impairments and functional limitations will be predictive of positive patient-reported outcome.

**Patient-clinician agreement on assessment of change**

The overall purpose of this dissertation at formation was to determine what set of factors best predicts outcome of conservative rehabilitation in patients with shoulder pain.

In order to do this, it became clear that the most "true" assessment of outcome must first be determined to ensure that we are predicting an appropriate outcome. This can be challenging because the judgment of patients, physicians and therapists may be influenced by different perceptions and biases. Patient-clinician discordance has been widely reported in assessments of disease status in a number of chronic illnesses.[26,27,29,30,33,36] However, we found that this disparity is relatively unknown with respect to assessment of change over time or in an orthopaedic population.

Overall, patient-physician and patient-therapist agreement were moderate to good in a population of patients with shoulder pain, supporting our hypothesis. Our findings were similar to or better than to patient-clinician agreement reported in previous research. The higher agreement observed may be because our patients were only approximately 40% disabled, typical of this patient population at initial evaluation[76-78]. Patient-physician discordance is known to be amplified in patients with more severe ratings of disease activity, impairment or pain.[27,29,35,39]

The current findings support the use of patient-reported information as an appropriate assessment of "true" outcome. Also taking into consideration previous work, it is recommended that assessments of outcome also incorporate impairment parameters (e.g. pain, strength, range of motion) to provide an inclusive assessment of outcome. While no recommendations currently exist for upper extremity musculoskeletal conditions, the Outcome Measures in Rheumatology Clinical Trials and Osteoarthritis Research Society International joint recommendation for assessing outcome calls for a similar assessment in knee osteoarthritis.[80] The consensus reached by the societies was to include three assessment criteria: pain, function and patient's global assessment. For a

patient to be considered a responder to prescribed treatment, minimal improvement must be demonstrated in two of the three criteria. Based on the results of the first study and that all of these are patient reported measures we chose to adopt these criteria to determine outcome in the prediction model investigated.

**Functional limitations linked to the International Classification of Function, Disability and Health**

In order to examine patient-nominated functional limitations as potential predictors in Aim 2, the multitude of varied patient responses needed to be reduced into a reasonable number. This reduction was achieved by "linking" each functional limitation to an existing framework, the International Classification of Function, Disability and Health (ICF). Linking the functional limitations to the ICF resulted in a 98% reduction in the responses, reducing 785 meaningful concepts into 14 variables to be included as potential predictors for the model derived in Chapter 5. These results also provided insight into the types of functional limitations patients with shoulder pain are experiencing. The majority (57%) of functional limitations reported were related to mobility (e.g. lifting, reaching, throwing). Other major categories included sleeping, exercise, self care, household tasks, employment and sport.

**Clinical prediction model for shoulder pain**

Currently clinicians often rely on diagnosis to make treatment decisions when treating musculoskeletal injuries. However, differential diagnosis of shoulder injuries can be difficult to make[8,9] and diagnosis does not provide enough information to predict outcome[13]. In the US, nearly every shoulder diagnosis a patient is recommended conservative intervention including physical therapy to initially address shoulder pain.[14-16] Therefore, we wanted to determine what combination of factors evaluated at initial

evaluation best predicted patient-reported outcome following conservative standardized rehabilitation for patients with shoulder pain.

As we hypothesized, there was no evidence to support that diagnosis was related to outcome in this sample of patients (p=0.543). This was further supported by the fact that the percentage of responders was similar across all diagnoses (labral pathology = 40%, rotator cuff tendinopathy = 40%, shoulder pain of unknown etiology = 50%). A larger sample is necessary to confirm these findings and generalize the results to other samples. The combination of absence of neck pain, shorter duration of symptoms and report of exercise as a functional limitation provided the best predictive model for positive clinical outcome to a rehabilitation program. The model indicates that for every 1 month a patient has shoulder pain the odds of positive clinical outcome decrease by 2%, patients with an absence of neck pain have 58% greater odds of positive clinical outcome compared to those who report neck pain, and patients who report exercise as a functional limitation have 2 times (200%) greater odds of positive clinical outcome compared to those who did not report exercise when controlling the other variables in the model. These findings can be made useful to clinicians by utilizing the prediction equation generated from the model:

**Equation:**

$$\boldsymbol{P = 1/[1 + exp - (0.092 - 0.022 \times duration\ of\ symptoms - 0.857 \times neck\ pain + 0.750 \times exercise)\ ]}$$

This model estimates the predicted probability of positive patient-reported outcome following 6 weeks of rehabilitation for shoulder pain using the three variables identified. This is the first comprehensive model to predict outcome patients with

shoulder pain treated non-operatively with standardized rehabilitation. The sample size in the final model was 109 patients. Because of this low sample size, these results should be interpreted with caution and cannot yet be generalized to other samples. Further development of the model in a larger sample (approximately 325 patients) is necessary to confirm the findings. Validation of the model with a separate cohort is also required before the model can be used to influence clinical practice.

**Conclusion**

Overall, agreement between the patient, physician and therapist was good with respect to change over time in patients with musculoskeletal shoulder pain. This leads us to conclude that using patient-reported information as a representation of outcome is appropriate in these patients. A combination of absence of neck pain, shorter duration of symptoms and report of exercise as a functional limitation best predicted patient-reported outcome at 6 weeks in this sample of patients with shoulder pain treated with conservative rehabilitation. Diagnosis was not found to be related to patient-reported outcome in this sample of patients. Future confirmation and validation of the model in a larger sample is necessary to generalize these findings to other samples.

Appendices

**Appendix A - Global Rating of Change Scale**

*Overall, has there been any change in your symptoms since you started rehabilitation exercises? Please indicate if there has been any change in your symptoms by checking one of the following options.*

*Are your symptoms:*

| | | |
|---|---|---|
| | ___About the same (0) | |
| ___Almost the same, hardly any worse at all (-1) | | ___Almost the same, hardly any better at all (+1) |
| ___A little worse (-2) | | ___A little better (+2) |
| ___Somewhat worse (-3) | | ___Somewhat better (+3) |
| ___Moderately worse (-4) | | ___Moderately better (+4) |
| ___A good deal worse (-5) | | ___A good deal better (+5) |
| ___A great deal worse (-6) | | ___A great deal better (+6) |
| ___A very great deal worse (-7) | | ___A very great deal better (+7) |

**Appendix B - Patient-Specific Function Scale**[81]

Initial Assesment:
I am going to ask you to identify up to three important activities that you are unable to do or are having difficulty with as a result of your shoulder problem. Today, are there any activities that you are unable to do or having difficulty with because of your shoulder problem?

Patient-specific activity scoring scheme (Point to one number):

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Unable to perform activity | | | | | | | | | | Able to perform activity at the same level as before |

| Activity | Score |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |

Follow up:
At your initial appointment on _____, you identified important activities that you had difficulty with as a results of your shoulder problem. These activities are listed below. Using the scale provided, please score your ability to perform these activities today.

**Appendix C – Therapist evaluation of assessment of change**

Patient #

____ hand dominant with ____ side shoulder pain

Age:

Duration of symptoms:

Previous physical therapy? Yes/No

Functional demands (Patient Specific Function Scale):

| Impairment parameters | BASELINE | | Follow up at ____ weeks | |
|---|---|---|---|---|
| | Involved | Uninvolved | Involved | Uninvolved |
| Passive IR ROM | | | | |
| Passive ER ROM | | | | |
| Active Flexion ROM | | | | |
| ER Strength | | | | |
| Flexion Strength | | | | |
| PSFS score | | ---- | | ---- |

**For this patient, please select one of the options below:**

| | ___About the same | |
|---|---|---|
| ___Almost the same, hardly any worse at all | | ___Almost the same, hardly any better at all |
| ___A little worse | | ___A little better |
| ___Somewhat worse | | ___Somewhat better |
| ___Moderately worse | | ___Moderately better |
| ___A good deal worse | | ___A good deal better |
| ____A great deal worse | | ___A great deal better |
| ____A very great deal worse | | ___A very great deal better |

**Appendix D - Standardized Treatment Protocol**

A warm-up of choice on a bicycle or treadmill for approximately 10 minutes could precede these exercises

Stretching*

Phase 1:

1. Cross body stretch
2. External rotation stretch
3. Supine scapular retraction
4. Table slides for shoulder elevation, 10x5 sec
5. Walk aways for shoulder elevation,10x5 sec
6. Soft tissue massage

Phase 2:

1. Cross body stretch
2. Doorway pectoralis stretch
3. Flexion stretch, supine with stick or seated rope and pulley
4. Supine scapular retraction with elevation of spine or overpressure
5. Wall washes, 2x12 reps
6. Soft tissue massage or joint mobilization

Phase 3:

1. Sleeper stretch at 45º
2. All 4's lat stretch

Phase 4:

1. Sleeper stretch at 90º
2. Wall active external rotation stretch
3. All 4's lat stretch

Strengthening†

Phase 1:‡

1. Sternal lift
2. Low row
3. Inferior glide (Isometric adduction)
4. Scapular clock

Phase 2:

1. Dynamic low row
2. Lawnmower pull
3. Scapular retraction with external rotation
4. Supine/wedge press up with resistance
5. Hip abduction and extension with resistance

Phase 3:

1. Rows
2. Fencing
3. Shoulder dump, single or double handed
4. Standing lat pull down with elbows extended
5. Scapular retraction with external rotation for elevation with progression to overhead press
6. Standing punches
7. Push up plus on incline

Phase 4:

1. Prone horizontal abduction "T" with scapular retraction
2. Prone flexion at 135º "Y" with scapular retraction
3. Internal/external rotation at 90 º abduction
4. Shoulder flexion and scaption
5. Upper cut
6. Push up plus
7. Plyometric deceleration supine, sidelying and prone§
8. Power position for throwers

Modalities

Not specified, at discretion of therapist

*Flexibility exercises: All exercises were to be performed to the point of stretch but not elevating current level of pain by more than 2 points. A warm-up of your choice on a

bicycle or treadmill for approximately 10 minutes can precede these exercises. 3x30 seconds, 2x per day unless otherwise noted.
[†]Strengthening exercises: All exercises were to be performed to a moderate level of fatigue but not elevating current level of pain by more than 2 points. Level of resistance varied depending upon the subject's strength and was determined by the treating therapist. 3x10 3 second holds, 1x per day unless otherwise noted. Add step to encourage more trunk activation if needed.

[‡] 10x3-5 second holds
[§]3x15 to 20 second bouts

**Appendix E – Candidate variables for multivariable model**

Table E.1 Continuous variables at baseline – data are presented as mean ± SD

| Variable | All (N=118) | Non-responder (n= 67) | Responder (n=51 ) | p value |
|---|---|---|---|---|
| Height (cm) | 175.3 ± 9.4 | 175.3 ± 9.5 | 175.5 ± 9.4 | 0.916 |
| Weight (kg) | 85.0 ± 19.3 | 85.8 ± 19.2 | 83.7 ± 19.7 | 0.570 |
| Age (years) | 40.9 ± 12.0 | 41.1 ± 10.8 | 40.7 ± 13.5 | 0.865 |
| Duration of symptoms (months) | 17.2 ± 40.3 | 23.8 ± 51.2 | 8.5 ± 13.8 | 0.017 |
| QuickDASH | 36.1 ± 17.9 | 36.9 ± 18.3 | 35.0 ± 17.6 | 0.570 |
| Current pain | 3.7 ± 2.3 | 3.8 ± 2.5 | 3.6 ± 2.0 | 0.556 |
| Worst pain | 6.5 ± 2.3 | 6.6 ± 2.4 | 6.3 ± 2.3 | 0.458 |
| Best pain | 2.2 ± 2.2 | 2.5 ± 2.3 | 1.9 ± 1.9 | 0.201 |
| ASES | 60.5 ± 18.3 | 59.7 ± 20.1 | 61.6 ± 15.7 | 0.571 |
| PSFS | 3.4 ± 1.9 | 3.5 ± 2.0 | 3.4 ± 1.9 | 0.843 |
| Scapular posture of injured side (cm) | 14.8 ± 2.3 | 14.9 ± 2.3 | 14.6 ± 2.3 | 0.625 |
| Flexion ROM of injured side | 144.8 ± 21.9 | 142.7 ± 22.2 | 147.6 ± 21.4 | 0.238 |
| ER ROM of injured side | 75.0 ± 23.0 | 72.7 ± 25.2 | 78.2 ± 19.4 | 0.187 |
| IR ROM of injured side | 60.6 ± 18.4 | 59.6 ± 19.2 | 61.9 ± 17.4 | 0.498 |
| HA ROM of injured side | 80.6 ± 12.4 | 82.7 ± 11.7 | 77.5 ± 13.0 | 0.057 |
| Flexion ROM of healthy side | 156.3 ± 15.4 | 154.7 ± 16.6 | 158.4 ± 13.5 | 0.205 |
| ER ROM of healthy side | 86.3 ± 15.8 | 85.8 ± 15.6 | 86.8 ± 16.4 | 0.736 |
| IR ROM of healthy side | 67.0 ± 15.5 | 68.0 ± 16.8 | 65.8 ± 13.7 | 0.448 |
| HA ROM of healthy side | 86.2 ± 11.3 | 86.8 ± 9.5 | 85.4 ± 13.5 | 0.562 |
| ER strength of injured side | 9.1 ± 4.8 | 8.9 ± 4.8 | 9.4 ± 4.8 | 0.548 |
| Flexion strength of injured side | 7.0 ± 3.1 | 7.0 ± 3.4 | 7.0 ± 2.8 | 0.997 |
| ER strength of healthy side | 13.3 ± 5.0 | 13.1 ± 5.0 | 13.5 ± 5.0 | 0.669 |
| Flexion | 9.1 ± 3.3 | 8.9 ± 3.3 | 9.3 ± 3.3 | 0.513 |

strength of healthy side

Table E.1, cont.

| Variable | All (N=118) | Non-responder (n= 67) | Responder (n=51 ) | p value |
|---|---|---|---|---|
| ER strength deficit | -4.1 ± 4.1 | -4.1 ± 4.5 | -4.1 ± 3.4 | 0.955 |
| ER ROM deficit | -11.0 ± 25.2 | -12.6 ± 24.4 | -8.7 ± 26.1 | 0.405 |
| IR ROM deficit | -5.9 ± 19.7 | -7.5 ± 20.2 | -3.8 ± 18.8 | 0.328 |
| Flexion ROM deficit | -11.1 ± 18.4 | -11.2 ± 18.8 | -10.8 ± 17.9 | 0.909 |
| Flexion strength deficit | -2.0 ± 2.7 | -1.8 ± 3.0 | -2.3 ± 2.4 | 0.375 |

All values presented as mean ± SD

QuickDASH, Quick Disabilities of the Arm, Shoulder and Hand; ASES, American Society of Shoulder and Elbow Surgeons questionnaire; PSFS, patient-specific functional scale; ROM, range of motion; ER, external rotation; IR, internal rotation; HA, horizontal adduction.

Table E.2 Categorical variables at baseline – data are presented as count (percentage)

| Variable | All (N=118) | Non-responder (n= 67) | Responder (n=51 ) | p value |
|---|---|---|---|---|
| Sex (N=118) | | | | 0.302 |
| Male | 82 (69%) | 44 (66%) | 38 (75%) | |
| Female | 36 (31%) | 23 (34%) | 13 (25%) | |
| Criterion diagnosis (N=118) | | | | 0.543 |
| Labral pathology | 38 (32%) | 23 (34%) | 15 (29%) | |
| Rotator cuff tendinopathy | 38 (32%) | 23 (34%) | 15 (29%) | |
| SPUE | 42 (36%) | 21 (31%) | 21 (41%) | |
| Neck pain (N=118) | | | | 0.02 |
| No | 77 (65%) | 37 (55%) | 40 (78%) | |
| Yes | 41 (35%) | 30 (45%) | 11 (22%) | |
| Numbness/tingling (N=117) | | | | 0.115 |
| No | 58 (50%) | 29 (43%) | 29 (58%) | |
| Yes | 59 (50%) | 38 (57%) | 21 (42%) | |
| Pop/grind/click (N=118) | | | | 0.214 |
| No | 39 (33%) | 19 (28%) | 20 (39%) | |
| Yes | 79 (67%) | 48 (72%) | 31 (61%) | |
| Pain around shoulder blade (N=117) | | | | 0.042 |

| | | | | |
|---|---|---|---|---|
| No | 43 (37%) | 19 (29%) | 24 (47%) | |
| Yes | 74 (63%) | 47 (71%) | 27 (53%) | |

Table E.2, cont

| Variable | All (N=118) | Non-responder (n= 67) | Responder (n=51 ) | p value |
|---|---|---|---|---|
| Previous subluxation (N=117) | | | | 0.575 |
| No | 96 (82%) | 53 (80%) | 43 (84%) | |
| Yes | 21 (18%) | 13 (20%) | 8 (16%) | |
| Shoulder pain began gradually (N=116) | | | | 0.751 |
| No | 53 (46%) | 31 (47%) | 22 (44%) | |
| Yes | 63 (54%) | 35 (53%) | 28 (56%) | |
| One event caused shoulder pain (N=111) | | | | 0.508 |
| No | 47 (42%) | 26 (41%) | 21 (45%) | |
| Yes | 64 (58%) | 38 (59%) | 26 (55%) | |
| Elbow pain (N=117) | | | | 0.811 |
| No | 90 (77%) | 51 (76%) | 39 (78%) | |
| Yes | 27 (23%) | 16 (24%) | 11 (22%) | |
| Previous physician consultation (N=117) | | | | 0.128 |
| No | 56 (48%) | 28 (42%) | 28 (56%) | |
| Yes | 22 (19%) | 39 (58%) | 22 (44%) | |
| Previous treatment (N=115) | | | | 0.147 |
| No | 51 (44%) | 25 (38%) | 26 (52%) | |
| Yes | 64 (56%) | 40 (62%) | 24 (48%) | |
| Previous PT (N=116) | | | | 0.07 |
| No | 68 (59%) | 35 (52%) | 33 (67%) | |
| Yes | 48 (41%) | 32 (48%) | 16 (33%) | |
| Apprehension test (N=116) | | | | 0.683 |
| No | 108 (93%) | 62 (94%) | 46 (92%) | |
| Yes | 8 (7%) | 4 (6%) | 4 (8%) | |
| Belly press (N=116) | | | | 0.74 |
| No | 108 (93%) | 61 (92%) | 47 (94%) | |
| Yes | 8 (7%) | 5 (8%) | 3 (6%) | |
| Liftoff (N=116) | | | | 0.814 |
| No | 103 (89%) | 59 (89%) | 44 (88%) | |
| Yes | 13 (11%) | 7 (11%) | 6 (12%) | |
| Bearhug (N=116) | | | | 0.976 |
| No | 88 (76%) | 50 (76%) | 38 (76%) | |

| | | | |
|---|---|---|---|
| Yes | 28 (24%) | 16 (24%) | 12 (24%) |

Table E.2, cont

| Variable | All (N=118) | Non-responder (n= 67) | Responder (n=51 ) | p value |
|---|---|---|---|---|
| Uppercut (N=116) | | | | 0.409 |
| No | 79 (68%) | 47 (71%) | 32 (64%) | |
| Yes | 37 (32%) | 19 (29%) | 18 (36%) | |
| Speeds (N=116) | | | | 0.851 |
| No | 96 (83%) | 55 (83%) | 41 (82%) | |
| Yes | 20 (17%) | 11 (17%) | 9 (18%) | |
| Modified dynamic labral shear (N=116) | | | | 0.825 |
| No | 52 (45%) | 29 (44%) | 23 (46%) | |
| Yes | 64 (55%) | 37 (56%) | 27 (54%) | |
| O'Brien's active compression (N=116) | | | | 0.539 |
| No | 80 (69%) | 44 (67%) | 36 (72%) | |
| Yes | 36 (31%) | 22 (33%) | 14 (28%) | |
| Anterior slide (N=116) | | | | 0.837 |
| No | 82 (71%) | 47 (71%) | 35 (70%) | |
| Yes | 34 (29%) | 19 (29%) | 15 (30%) | |
| Point tender pain )N=116) | | | | 0.311 |
| No | 91 (78%) | 54 (82%) | 37 (74%) | |
| Yes | 25 (22%) | 12 (18%) | 13 (26%) | |
| SICK position (N=115) | | | | 0.566 |
| No | 54 (47%) | 29 (45%) | 25 (50%) | |
| Yes | 61 (53%) | 36 (55%) | 25 (50%) | |
| Scapular assistance test (N=116) | | | | 0.989 |
| No | 44 (38%) | 25 (38%) | 19 (38%) | |
| Yes | 72 (62%) | 41 (62%) | 31 (62%) | |
| Scapular retraction test (N=115) | | | | 0.906 |
| No | 43 (37%) | 24 (37%) | 19 (38%) | |
| Yes | 72 (63%) | 41 (63%) | 31 (62%) | |
| Painful arc (N=116) | | | | 0.047 |
| No | 33 (28%) | 14 (21%) | 19 (38%) | |
| Yes | 83 (72%) | 52 (79%) | 31 (62%) | |
| Hawkins kennedy (N=116) | | | | 0.16 |
| No | 68 (59%) | 35 (53%) | 33 (66%) | |

| | | | | |
|---|---|---|---|---|
| Yes | 48 (41%) | 31 (47%) | 17 (34%) | |
| Neer impingement (N=116) | | | | 0.17 |
| No | 73 (63%) | 38 (58%) | 35 (70%) | |
| Yes | 43 (37%) | 28 (42%) | 15 (30%) | |

Table E.2, cont

| Variable | All (N=118) | Non-responder (n= 67) | Responder (n=51 ) | p value |
|---|---|---|---|---|
| Dyskinesis (N=116) | | | | 0.153 |
| No | 18 (16%) | 13 (20%) | 5 (10%) | |
| Yes | 98 (84%) | 53 (80%) | 45 (90%) | |
| Crepitus (N=116) | | | | 0.181 |
| No | 104 (90%) | 57 (86%) | 47 (94%) | |
| Yes | 12 (10%) | 9 (14%) | 3 (6%) | |
| Single leg balance (N=113) | | | | 0.076 |
| No | 74 (65%) | 47 (72%) | 27 (56%) | |
| Yes | 39 (35%) | 18 (28%) | 21 (44%) | |
| Single leg squat (N=113) | | | | 0.231 |
| No | 73 (65%) | 45 (69%) | 28 (58%) | |
| Yes | 40 (35%) | 20 (31%) | 20 (42%) | |
| Pain with resisted abduction (N=116) | | | | 0.432 |
| No | 9 (8%) | 4 (6%) | 5 (10%) | |
| Yes | 107 (92%) | 62 (94%) | 45 (90%) | |
| b1 sleeping (N=114) | | | | 0.064 |
| No | 85 (75%) | 52 (81%) | 33 (66%) | |
| Yes | 29 (25%) | 12 (19%) | 17 (34%) | |
| b4 exercise (N=114) | | | | 0.062 |
| No | 83 (73%) | 51 (80%) | 32 (64%) | |
| Yes | 31 (27%) | 13 (20%) | 18 (36%) | |
| d5 self care (N=114) | | | | 0.368 |
| No | 91 (80%) | 53 (83%) | 38 (76%) | |
| Yes | 23 (20%) | 11 (17%) | 12 (24%) | |
| d8 work (N=114) | | | | 0.859 |
| No | 101 (89%) | 57 (89%) | 44 (88%) | |
| Yes | 13 (11%) | 7 (11%) | 6 (12%) | |
| d9 rec and leisure (N=114) | | | | 0.393 |
| No | 82 (72%) | 44 (69%) | 38 (76%) | |
| Yes | 32 (28%) | 20 (31%) | 12 (24%) | |
| d6 domestic life (N=114) | | | | 0.048 |
| No | 88 (77%) | 45 (70%) | 43 (86%) | |
| Yes | 26 (23%) | 19 (30%) | 7 (14%) | |

| | | | | |
|---|---|---|---|---|
| d415 maintain body position (N=114) | | | | 0.063 |
| No | 95 (83%) | 57 (89%) | 38 (76%) | |
| Yes | 19 (7%) | 7 (11%) | 12 (24%) | |

Table E.2, cont

| Variable | All (N=118) | Non-responder (n= 67) | Responder (n=51 ) | p value |
|---|---|---|---|---|
| d430 lifting and carrying (N=114) | | | | 0.724 |
| No | 50 (44%) | 29 (45%) | 21 (42%) | |
| Yes | 64 (56%) | 35 (55%) | 29 (58%) | |
| d4450 pulling (N=114) | | | | 0.971 |
| No | 105 (92%) | 59 (92%) | 46 (92%) | |
| Yes | 9 (8%) | 5 (8%) | 4 (8%) | |
| d4451 pushing (N=114) | | | | 0.437 |
| No | 88 (77%) | 51 (80%) | 37 (74%) | |
| Yes | 26 (23%) | 13 (20%) | 13 (26%) | |
| d4452 reaching (N=114) | | | | 0.565 |
| No | 74 (65%) | 43 (67%) | 31 (62%) | |
| Yes | 40 (35%) | 21 (33%) | 19 (38%) | |
| d4453 turning and twisting (N=114) | | | | 0.677 |
| No | 101 (89%) | 56 (88%) | 45 (90%) | |
| Yes | 13 (11%) | 8 (12%) | 5 (10%) | |
| d4454 throwing (N=114) | | | | 0.217 |
| No | 75 (66%) | 39 (61%) | 36 (72%) | |
| Yes | 39 (34%) | 25 (39%) | 14 (28%) | |
| d475 driving (N=114) | | | | 0.871 |
| No | 102 (89%) | 57 (89%) | 45 (90%) | |
| Yes | 12 (11%) | 7 (11%) | 5 (10%) | |

Data are presented as count (percentage)

PT, physical therapy; SICK, **S**capular malposition, **I**nferior medial border prominence, **C**oracoid pain and malposition, and dys**K**inesis of scapular movement.

## Appendix F – Spearman rho correlations for 19 candidate variables

| | Duration of symptoms (months) | Best pain | Injured arm ER ROM | Neck pain | Numbness /tingling | Pain around shoulder blade | Previous physician consultation | Previous treatment | Previous physical therapy | Painful arc (forward flexion) | Hawkins |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Duration of symptoms (months) | | | | | | | | | | | |
| Best pain | -0.120 | | | | | | | | | | |
| Injured arm ER ROM | 0.086 | -.294** | | | | | | | | | |
| Neck pain | 0.167 | .226* | 0.044 | | | | | | | | |
| Numbness/tingling | 0.181 | .215* | -0.027 | .477** | | | | | | | |
| Pain around shoulder blade | .258** | .301** | 0.105 | .257** | .372** | | | | | | |
| Previous physician consultation | .191* | 0.016 | -0.108 | 0.065 | 0.138 | .187* | | | | | |
| Previous treatment | .229* | 0.060 | -0.050 | 0.107 | 0.088 | 0.171 | **.703**** | | | | |
| Previous physical therapy | 0.183 | 0.172 | -0.151 | 0.106 | 0.063 | .188* | .408** | **.644**** | | | |
| Painful arc (forward flexion) | -0.054 | .229* | 0.130 | .250** | .199* | .304** | 0.008 | -0.063 | -0.032 | | |
| Hawkins | -0.084 | .198* | -0.012 | .196* | 0.098 | .277** | 0.088 | 0.122 | 0.095 | .491** | |
| Neer Impingement | -0.060 | 0.177 | -0.084 | .190* | 0.119 | .250** | 0.112 | 0.153 | 0.062 | .444** | **.913**** |
| Scapular dyskinesis | 0.040 | -0.141 | .185* | 0.063 | 0.004 | 0.162 | 0.067 | 0.024 | 0.050 | -0.059 | -0.075 |

Appendix F, cont.

| | Duration of symptoms (months) | Best pain | Injured arm ER ROM | Neck pain | Numbness /tingling | Pain around shoulder blade | Previous physician consultation | Previous treatment | Previous physical therapy | Painful arc (forward flexion) | Hawkins |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crepitus | -0.032 | -0.057 | -0.031 | -0.010 | -0.060 | -0.054 | 0.042 | -0.008 | -0.171 | .214* | 0.117 |
| Single leg balance | -0.073 | -0.019 | -0.069 | 0.096 | 0.125 | 0.011 | -0.001 | 0.057 | 0.062 | -0.138 | -0.159 |
| Functional limitation of sleeping | -0.047 | -0.025 | 0.072 | -0.128 | -0.096 | -0.051 | -0.168 | -.226* | -0.126 | -0.058 | -0.083 |
| Functional limitation of exercise | -0.093 | -.194* | 0.110 | -.196* | -0.173 | -.243** | -0.087 | -0.146 | -0.141 | -0.108 | -0.012 |
| Functional limitation of domestic life (e.g. housework) | 0.035 | -0.053 | 0.030 | 0.134 | 0.131 | 0.116 | 0.060 | 0.035 | 0.093 | 0.080 | -0.013 |
| Functional limitation of body position | -0.161 | -0.175 | 0.099 | -.227* | -0.067 | -0.144 | -0.138 | -.231* | -0.122 | 0.108 | 0.014 |

**. Correlation is significant at the 0.01 level

*. Correlation is significant at the 0.05 level

Bolded values indicate $r_s \geq 0.50$ of which one of the variables was excluded

Appendix F, cont.

| | Neer Impingement | Scapular dyskinesis | Crepitus | Single leg balance | Functional limitation of sleeping | Functional limitation of exercise | Functional limitation of domestic life | Functional limitation of body position |
|---|---|---|---|---|---|---|---|---|
| Neer Impingement | | | | | | | | |
| Scapular dyskinesis | -0.065 | | | | | | | |
| Crepitus | 0.032 | -0.167 | | | | | | |
| Single leg balance | -0.135 | .305** | 0.052 | | | | | |
| Functional limitation of sleeping | -0.074 | 0.072 | 0.067 | -0.078 | | | | |
| Functional limitation of exercise | 0.045 | 0.039 | 0.108 | -0.106 | 0.141 | | | |
| Functional limitation of domestic life (e.g. housework) | -0.054 | 0.039 | 0.030 | 0.046 | -0.125 | -.238* | | |
| Functional limitation of body position | 0.054 | -0.018 | 0.006 | -0.170 | **.495**** | 0.097 | -.187* | |

**. Correlation is significant at the 0.01 level

*. Correlation is significant at the 0.05 level

Bolded values indicate $r_s \geq 0.50$ of which one of the variables was excluded

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# Vita

Stephanie D. Moore, MS, ATC

Certificate or Specialty Board Licensure:
National Athletic Trainers' Association Board of Certification #070702068 (since 2007)

**I. Education**

2009-present University of Kentucky, Lexington, KY
Doctor of Philosophy, Rehabilitation Science
Expected Completion: May 2013
*Dissertation:* Predictors of Outcome following Standardized Rehabilitation in Patients with Shoulder Pain
*Advisor:* Tim L. Uhl, PhD, PT, ATC, FNATA

2007-2009 Illinois State University, Normal, IL
Master of Science, Kinesiology and Recreation, emphasis in Athletic Training*
*Thesis:* A Randomized, Controlled Study of the Acute Effects of Muscle Energy Techniques on Posterior Shoulder Tightness
*Advisor:* Kevin Laudner, PhD, ATC, FACSM
***NATA Accredited Post-Certification Graduate Athletic Training Education Program*

2003-2007 University of Central Missouri, Warrensburg, MO
Bachelor of Science, Athletic Training
Graduate of the Honors College, Summa cum Laude

**II. Professional Experiences**

2009-present Research Assistant
The Shoulder Center of Kentucky, Lexington, KY

2009-2010 PRN Athletic Trainer
Lexington Clinic Sports Medicine, Lexington, KY

2007-2009 Graduate Assistant Athletic Trainer
University High School, Normal, IL

**III. Honors**

2010 Rehabilitation Sciences Internal Research Award, University of Kentucky
2009 Outstanding Graduate Student Researcher Award, College of Applied Science & Technology, Illinois State University
2009 Dr. L. Marlene Mawson Graduate Research Potential Award, Department of Kinesiology and Recreation, Illinois State University
2009 Free Communications Master's Oral Award Finalist, National Athletic Trainers'

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| | Association Research and Education Foundation |
| 2008 | Phebe M. Scott Endowment Fund Recipient, Illinois State University |
| 2008 | Student-Mentor Award (Mentor: Dr. Kevin Laudner), Illinois Association for Health, Physical Education, Recreation and Dance |
| 2006 | Outstanding Student Major – Athletic Training, Missouri Association for Health, Physical Education, Recreation and Dance |
| 2006 | Outstanding Student Leadership Award, University of Central Missouri |
| 2005 | University of Central Missouri Board of Governors Student Representative Finalist |

## IV. Speaking Engagements/Presentations

### Invited

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| November 2012 | Kentucky Athletic Trainers' Association Society Town Hall Meeting<br>Edgewood, KY<br>*Assessment and Treatment of Posterior Shoulder Tightness in the Overhead Athlete* |
| June 2012 | Kentucky Athletic Trainers' Society Annual Meeting and Symposium<br>Louisville, KY<br>*Posterior Shoulder Tightness in Overhead Athletes: Assessment and Intervention* |
| March 2012 | Southeast Athletic Trainers' Association Clinical Symposium<br>Atlanta, GA<br>*Assessment and Treatment of Posterior Shoulder Tightness* |
| July 2011 | Disabled Throwing Shoulder Summit: 10 Year Update<br>Lexington, KY<br>*Quantifying a Baseball-Specific Strengthening Program in Adolescent Athletes* |
| May 2011 | University of Kentucky Sports Medicine Symposium<br>Lexington, KY<br>*Stretching and Strengthening Interventions for the Posterior Shoulder: An Evidence-Based Approach* |

### Peer Reviewed

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| May 2013 | American College of Sports Medicine Annual Meeting<br>Indianapolis, IN<br>-Thematic Poster- *ED2 Macrophage Number is Dependent upon Loading Conditions in Aged Muscle.* **Moore SD**, Waters-Banker C, Butterfield T, Dupont-Versteegden E. |

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| January 2013 | Combined Sections Meeting of the American Physical Therapy Association<br>San Diego, CA<br>-Poster- *Odds of Being Recommended for Surgery following Physical Therapy with a Superior Labral Lesion.* Uhl TL, **Moore SD**, Sciascia AD, Kibler WB. |
| October 2012 | University of Kentucky Center for Muscle Biology Annual Retreat<br>Lexington, KY<br>-Poster- *ED2 Macrophage Number is Dependent upon Loading Conditions in Aged Muscle.* **Moore SD**, Waters-Banker C, Butterfield T,Dupont-Versteegden E. |
| October 2012 | American Society of Shoulder and Elbow Therapists<br>Sea Island, GA<br>-Oral- *Odds of Being Recommended for Surgery following Physical Therapy with a Superior Labral Lesion.* Uhl TL, **Moore SD**, Sciascia AD, Kibler WB. |
| June 2012 | National Athletic Trainers' Association Annual Meeting and Symposium<br>St. Louis, MO<br>-Oral - *Compliance to a Standardized Exercise Protocol in Patients with Superior Labral Lesions.* Seekins KA, **Moore SD**, Sciascia AD, Uhl TL, Kibler WB<br><br>-Poster - *Improvements in Muscular Endurance following a Baseball Specific Strengthening Program in High School Baseball Players*. **Moore SD**, Uhl TL, Haegele L, Kibler WB |
| March 2012 | Center for Clinical and Translational Science Annual Conference<br>Lexington, KY<br>-Poster - *Improvements in Muscular Endurance following a Baseball Specific Strengthening Program in High School Baseball Players*. **Moore SD,** Uhl TL, Haegele LE, Kibler WB<br><br>-Poster - *Compliance to a Standardized Exercise Protocol in Patients with Superior Labral Lesions.* Seekins KA, **Moore SD**, Sciascia AD, Uhl TL, Kibler WB |
| March 2012 | Southeast Athletic Trainers' Association Clinical Symposia<br>Atlanta, GA<br>-Poster - *Improvements in Muscular Endurance following a Baseball Specific Strengthening Program in High School Baseball Players*. **Moore SD,** Uhl TL, Haegele LE, Kibler WB |

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| | -Poster - *Compliance to a Standardized Exercise Protocol in Patients with Superior Labral Lesions.* Seekins KA, **Moore SD**, Sciascia AD, Uhl TL, Kibler WB. |
| October 2009 | University of Kentucky Center for Muscle Biology Annual Retreat Lexington, KY<br>-Poster- *A Randomized, Controlled Study of the Acute Effects of Muscle Energy Techniques on Posterior Shoulder Tightness.* **Moore SD**, Laudner KG, McLoda TA, Shaffer M, Somers AK |
| June 2009 | National Athletic Trainers' Association Annual Meeting and Symposia<br>San Antonio, TX<br>-Oral - *A Randomized, Controlled Study of the Acute Effects of Muscle Energy Techniques on Posterior Shoulder Tightness.* **Moore SD**, Laudner KG, McLoda TA, Shaffer M, Somers AK |
| November 2008 | Illinois Association of Health, Physical Education, Recreation and Dance<br>St. Charles, IL<br>-Oral - *Differences in Functional Hip Characteristics between Baseball Pitchers and Position Players.* **Moore SD**, Laudner KG, Meister K |

**V. Research and Creative Productivity**

**Refereed Journal Publications**

Kerins CM, **Moore SD**, Butterfield TA, McKeon PO, Uhl TL. *Reliability of the Myotonometer for Assessment of Posterior Shoulder Tissue Compliance.* International Journal of Sports Physical Therapy 2013; In Press.

**Moore SD**, Uhl TL, Kibler WB. *Improvements in Shoulder Endurance Following a Baseball Specific Strengthening Program in High School Baseball Players.* Sports Health: A Multidisciplinary Approach 2013; 5:233-237.

Kibler WB, Kuhn JE, Wilk K, Sciascia A, **Moore SD**, Laudner KG, Ellenbecker T, Thigpen C, Uhl T. *The Disabled Throwing Shoulder: Spectrum of Pathology - 10 Year Update*. Arthroscopy 2013; 29(1):141-161.

Kibler WB, Sciascia AD, **Moore SD**. *An Acute Throwing Episode Decreases Shoulder Internal Rotation*. Clinical Orthopaedics and Related Research 2012; 470:1545-1551.

**Moore SD**, Laudner KG, McLoda TA, Shaffer M. *The Immediate Effects of Muscle Energy Technique on Posterior Tightness: A Randomized Controlled Trial.* Journal of Orthopaedic and Sports Physical Therapy June 2011; 41(6):400-407.

Laudner KG, **Moore SD,** Sipes RC, Meister K. *Functional Hip Characteristics of Baseball Pitchers and Position Players.* American Journal of Sports Medicine 2010;38(2):383-387.