5-2012

Outcomes and Presurgical Correlates of Lumbar Fusion in Utah Workers' Compensation Patients: A Replication Study

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OUTCOMES AND PRESURGICAL CORRELATES OF LUMBAR FUSION IN UTAH WORKERS' COMPENSATION PATIENTS: A REPLICATION STUDY

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Psychology

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UTAH STATE UNIVERSITY
Logan, Utah

2012

ABSTRACT

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by

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Utah State University, 2012

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Lumbar fusion performed among injured workers has dramatically increased over the past two decades, coinciding with the increased use of more advanced surgical technology. Despite recent changes in how this surgery is performed, few outcome studies have been conducted, particularly among workers compensation populations. In prior studies, several biopsychosocial risk factors were found to be predictors of functional outcomes of lumbar fusion. Considering the recent changes in lumbar fusion surgery, there is a need to identify how patient outcomes have changed among injured workers, and whether a biopsychosocial model continues to be predictive of outcomes. The current study aimed to address multidimensional patient outcomes associated with lumbar fusion and examine the relationship between presurgical biopsychosocial variables and outcomes by testing the predictive efficacy of a multiple variable model.

Injured workers ($N = 245$) who underwent their first lumbar fusion between 1998

and 2007 were included in a retrospective-cohort study performed in two phases that involved coding presurgical information documented in patient medical charts in the Worker's Compensation Fund of Utah computer database (Phase 1) and administering a telephone outcome survey with patients at least 2 years post-surgery (Phase 2). Of the total sample, 45% (n = 110) of patients were contacted and completed follow-up outcome surveys on several measures of patient satisfaction, quality of life, fusion status, dysfunction level, disability status, pain, and general physical and mental health functioning.

Results revealed injured workers reported a solid fusion rate of 89.0%, disability rate of 28.7%, and a poor outcome rate of 57.1%. Multiple linear regression analyses demonstrated an eight variable model was a statistically significant predictor of multiple patient outcomes. Involvement of a nurse case manger, vocational rehabilitation, and litigation at the time of fusion were the most prominent predictors across outcome measures, while age and depression history showed modest prediction of outcomes. Prior back operations, number of vertebral levels fused, and type of instrumentation showed no statistically significant prediction of outcomes. Results were evaluated and compared to prior lumber fusion studies on injured worker and fusion outcome literature, in general. Specific implications for our findings and limitations associated with this study were addressed.

(164 pages)

PUBLIC ABSTRACT

Outcomes and Presurgical Correlates of Lumbar Fusion in Utah Workers' Compensation Patients: A Replication Study

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Over the past 2 decades, lumbar fusion surgeries performed in the United States have increased dramatically, particularly for compensated workers. Costs for these procedures have also risen substantially in the past decade, primarily due to the use of more sophisticated surgical devices such as interbody fusion cages. While surgical instrumentation and technology may improve the rates of solid bony vertebral fusion, overall improvements in quality of life and pain outcomes related to this new technology are still inconclusive.

In collaboration with the Workers Compensation Fund of Utah (WCFU) and Utah State University (USU), a psychology professor, Dr. M. Scott DeBerard, and a USU doctoral student, Jessica Gundy, proposed a study examining multiple outcomes of lumbar fusion surgery in a sample of injured workers. The projects main purpose was to evaluate several biological, social, and, psychological outcomes among injured workers undergoing lumbar fusion in terms of quality of life, fusion rates, patient satisfaction, and

disability. Another important aim was to evaluate how outcomes have changed since the advent of new spine surgical fusion technology.

Findings from our project show that over the past decade, overall fusion rates have increased significantly. However, despite enhanced fusion rates, injured workers who have undergone lumbar fusion in Utah demonstrated somewhat worse outcomes than those documented a decade ago. Specifically, the present study demonstrated significant increases in disability rates and reported decreases in functional capacity and poor quality of life. While these findings do not support the position that compensated workers cannot benefit from lumbar fusion, they do highlight the importance of medical providers and surgeons to use more discretion when recommending lumbar fusion as a treatment option for injured workers. Further, there appear to be some strong incentives for surgeons to perform lumbar fusion with surgical devices that do not have adequate evidence to support their utility. These issues are imperative when considering both the financial costs associated with these surgeries, as well as the human costs such as pain, suffering, time away from family, job loss, and overall disability.

ACKNOWLEDGMENTS

The process of completing this project was a long journey and I had invaluable support, advice, and assistance along the way. I want to first express my overwhelming gratitude to my advisor and mentor, Dr. Scott DeBerard, who believed in my ability to take on this project. He taught me so much and I am grateful to have a mentor who will have an enduring impact throughout my future career as a psychologist. I would also like to thank my committee members, Drs. Michael Twohig, JoAnn Tschanz, Susan Crowley, and Edward Heath, who all gave important input and encouragement to make this project what it is. I also appreciate the Workers Compensation Fund of Utah for providing access to our population of interest.

My lab partner and friend, Anthony Wheeler, was a valuable collaborator and contributed to this project's integrity. Casey Nelson was also an asset who helped with data entry. Thanks to Tyler Christensen for guiding me through the dissertation process. I want to thank Kim Pratt and Michelle Woidneck for being my confidants over the last 4 years. I cannot imagine having this experience without you both. I will treasure going through this extraordinary journey together. I am incredibly grateful to my parents who continuously provided the love and support I needed to give me the strength to pursue a doctorate. Joe, I will be forever thankful for the encouragement and love you gave me throughout this journey. Finally, I thank the participants of this study for giving me their time and energy to help bring awareness to better serve future patients. Talking about pain and suffering is not easy and I am inspired by the courage of these individuals.

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Low back pain (LBP) represents one of the most complex and costly public health concerns for society. LBP is the most prevalent type of pain reported by adults (Deyo, Mirza, & Martin, 2006) and is the fifth most common reason for physician visits in the US (Hart, Deyo, & Cherkin, 1995). A recent national survey indicated that annually more than 50% of working-age adults experience LBP and 15% to 20% of those people seek medical help every year (Hurwitz & Shekelle, 2006). Further, a North American epidemiology review indicated point prevalence rates of LBP range from 13.7% to 28.7% (Loney & Stratford, 1999).

High LBP prevalence rates are particularly concerning for work-place populations. An estimated 5.6 million cases of work-related back pain were documented in 1995 (Murphy & Volinn, 1999), with projections that 60% to 80% of the adult population will experience at least one episode of LBP during their active work life (Nordin, Andersson, & Pope, 1997). Further, LBP represents approximately16% of all workplace compensation claims and is the most common reason for workers to file compensation claims in the US (Hadler, Carey, & Garrett, 1995). Such a high prevalence has had a dramatic influence on costs related to LBP for general and workplace populations.

The economic impact of LBP can be understood in terms of the total costs that the disease has incurred compared to the expense if the problem did not exist (Dagenais, Caro, & Haldeman, 2008). This incorporates both direct health care costs and indirect

tangential costs related to loss of employment and decreased productivity (Mantyselka, Kumpusalo, Ahonen, & Takala, 2002). The total cost of LBP in the US exceeds $100 billion per year with indirect expenses, such as lost wages and decreased productivity, accounting for almost two thirds of total costs (Katz, 2006). LBP has had a significant impact on the workers' compensation system, which covers approximately 127 million U.S. workers (Green-McKenzie, 2004). Workers' compensation is a system of state and federal laws that provides benefits for employees who are injured on the job. The compensation amount is based on any monetary loss associated with the specific injury that usually includes medical bills, hospital bills, wage replacement, rehabilitation, medications, and additional related expenses. In 1994, it was projected more than $11 billion was paid annually in the US for workers' compensation benefits for work-related LBP (Webster & Snook, 1994). For workers' compensation claims, LBP injury accounts for 33% to 41% of the total costs, but only accounts for 10% to 19% of all compensation claims filed (Hadler et al., 1995; Nachemson, 1992).

In 1994, the U.S. Department of Health and Human Services implemented evidence-based guidelines for the treatment of lumbar and thoracic pain (Bigos et al., 1994). The guidelines stressed the need to shift attention away from focusing care exclusively on conventional treatments to address acute and chronic LBP and move toward helping patients improve activity tolerance. Acute LBP is typically defined as pain that persist less than 6 weeks with symptoms often ranging from muscle ache and limited flexibility (Kinkade, 2007). However, some acute pain syndromes can become more serious. LBP is often considered chronic if it persists for more than 7-12 weeks

(Andersson, 1999). Recently, The American College of Physicians (ACP) and the American Pain Society (APS) issued a comprehensive joint clinical practice guideline for the diagnosis and treatment of acute and chronic LBP (Chou et al., 2007). These guidelines offer recommendations related to how to categorize the type of LBP patients experience, when and what type of diagnostic imaging tests to perform, what medications to prescribe based on patients pain and functional impairment, and the usefulness of nonpharmacological therapy. Although these guidelines are intended to assist clinicians with patient management and to promote the use of conservative treatments, there has been little done to translate these guidelines for managing workplace LBP. Further, despite most of these guidelines advocating conservative nonsurgical care as first line approaches, increasing numbers of patients are having spine surgery.

Internationally, the US has the highest rate of back surgery (Ehrlich, 2003). There are many types of LBP surgery used today (discectomy, foraminotomy, laminectomy, fusion, fusion). Typically, a first line spine surgery will involve a less invasive procedure. For example, discectomy is considered a less invasive surgical treatment for herniated discs of the lumbar spine that involves removing part of the damaged disc to relieve the pressure on the nerve tissue causing the pain (Spangler, 1982). While this procedure is often effective in reducing pain, long-term follow-up studies suggest that a significant number of patients have poor outcomes (DeBerard, LaCaille, Spielmans, Colledge, & Parlin, 2009; Loupasis et al., 1999). Such patients, particularly those with spinal instability, will turn to lumbar fusion surgery as a next possible solution.

The underlying principle for lumbar fusion surgery assumes that instability of

vertebral bodies is causing pressure on spinal nerves, which, in turn, causes LBP and associated neurological symptoms (e.g., sciatica, reflex changes, muscle weakness) (Herkowitz, 1995). Thus, by fusing the unstable vertebral bodies, and limiting their movement, it is presumed the fusion will reduce pain, increase function, and quality of life (An et al., 2003). Surgical implants (also known as instrumentation) are often used for lumbar fusion surgeries to provide additional spinal stability while helping the fusion solidify, thus improving the rates of successful spinal fusion. Examples of such implants include pedicle screws and rods and interbody fusion cages (Deyo, Gray, Kreuter, Mirza, & Martin, 2005).

Since 1992, lumbar fusion surgeries performed in the US have dramatically increased when compared to other less invasive procedures such as lumbar discectomy and laminectomy (Weinstein, Lurie, Olson, Bronner, & Fisher, 2006). Rates of lumbar fusion surgery in the US have risen more than 250% over the past decade (Deyo & Mirza, 2006), with more than 200,000 spinal fusion surgeries performed annually to relieve discogenic back pain and instability (Starkweather, 2006). The prevalence of fusion surgeries performed is even more concerning for compensated workers. In one study, patients with work-place LBP injuries covered by workers' compensation were 1.37 times more likely to undergo surgery involving fusion than other patients with LBP and almost twice as likely to have a subsequent reoperation within 3 years of the index surgery (Taylor, Deyo, Ciol, & Kreuter, 1996).

In the past decade, overall costs for spinal fusion are estimated to have increased more than 500%, from $75 million to $482 million. In 1992, lumbar fusion represented

14% of total spending for back surgery; by 2003, the number increased to 47% (Weinstein et al., 2006). A recent study comparing current medical costs for compensated lumbar fusion patients in Utah to costs identified in a prior similar study in the 1990s revealed medical costs have risen approximately 174% (Wheeler, Gundy, & DeBerard, in press). The high prevalence and cost increase is likely due, in part, to an introduction and use of more sophisticated surgical devices in the early 1990s (e.g., interbody fusion cages; Deyo et al., 2005).

However, while such surgical instrumentation and technology may improve the rate of solid fusion, overall improvements in quality of life and pain outcomes related to this new technology are still inconclusive (DeFrances & Hall, 2007; Deyo & Mirza, 2006). In fact, a recent study demonstrated no benefit in outcomes for patients who underwent more complex and expensive fusion surgeries (Wilson-MacDonald et al., 2008). Further, there is evidence that patients with LBP who receive workers' compensation have even poorer clinical fusion outcomes than other patients with back problems (DeBerard, Masters, Colledge, & Holmes, 2003; Taylor et al., 1996). In Utah, a study on lumbar fusion outcomes for compensated workers at 2-year postsurgical follow-up found that 36.1% of fusion patients reported worse pain with 35.4% demonstrating their overall quality of life was no better than before surgery (DeBerard, Masters, Colledge, Schleusener, & Schlegel, 2001). Additional research has indicated that the use of surgical implantation is associated with increased risk of complications and showed no improvements in disability or reoperation rates versus noninstrumented fusion (Maghout-Juratli, Franklin, Mirza, Wickizer, & Fulton-Kehoe, 2006). Although such studies have

started to address outcomes related to new surgical technology, research has been limited to surgeries performed before 2001 when the use of interbody fusion cages was just starting to climb.

Due to these considerable cost increases, amplified use of lumbar fusion surgery, and poor clinical outcomes, there is an impetus to examine presurgical patient characteristics that might predispose patients to differential outcomes. Presurgical psychosocial predictors have been shown to be important in predicting surgical outcomes for LBP patients (DeBerard et al., 2001; Keeley et al., 2008). DeBerard and colleagues (2001) identified several presurgical psychosocial variables as correlates related to the surgical outcomes of Utah workers who received lumbar fusion surgery. The study showed that older age, lawyer involvement, increased number of prior low back surgeries, low income, compensation, increased time of work disability, and depression were all predictive of lumbar fusion outcomes. The study also found that a diagnostic severity index based upon presurgical imaging studies (MRI, CT) did not predict fusion outcomes indicating that presurgical psychosocial factors are more consistently predictive of patient outcomes. In terms of work-related and compensation variables, another Utah study showed that workers compensation claims involving a nurse case manager and vocational rehabilitation prior to lumbar discectomy were more likely to have poorer outcomes (DeBerard et al., 2009). However, no known studies to date have addressed how these particular variables might impact lumbar fusion outcomes. Additionally, research on LBP patients has shown that that anxiety, depression, fear avoidance beliefs relating to work, and back-pain related stresses predicted impairment in subsequent

physical health-related quality of life and healthcare utilization (Keeley et al., 2008). While such studies have had a significant impact on influencing evidence based guidelines for surgical decisions regarding lumbar fusion, screening for psychosocial variables that may identify LBP patients at risk for poorer outcomes is still not a common procedure in clinics for work-place injury patients.

There is evidence of substantial increases in the prevalence and costs associated with lumbar fusion surgery. Development of new surgical implant technology to facilitate solid fusion is clearly associated with these increases. Despite advances in surgery technology, it is unclear if outcomes associated with lumbar fusion have improved significantly over time. Recent studies suggest a significant number of patients still experience poor clinical outcomes following lumbar fusion. Lumbar fusion has been studied less in workers' compensation patients, and while preliminary studies suggest a substantial percent of poor outcomes in this population, additional outcome studies are clearly needed, particularly given the increase in cost as a result of increased surgical technology. There is also a clear need to further investigate how presurgical factors influence lumbar fusion outcomes among worker's compensation patients. The current study has three primary purposes: (a) to examine patient presurgical variables and understand the interrelationships between such variables; (b) to characterize multiple outcomes associated with lumbar spinal fusion surgery patients in terms of quality of life, function, and health status variables, as well as fusion rates, patient satisfaction, and disability; and (c) to explore the relationship of presurgical variables to outcomes and test the predictive efficacy of a multiple variable predictive model.

CHAPTER II

REVIEW OF LITERATURE

The following literature review describes studies related to LBP, lumbar fusion outcomes, workers compensation populations, and back pain related disability. The primary purposes of this review were to: (a) describe estimated prevalence and costs of LBP and lumbar fusion; (b) characterize contemporary indications and surgical procedures for lumbar fusion; (c) describe patient outcomes associated with lumbar fusion, particularly among injured workers; and (d) identify potential presurgical biopsychosocial correlates of outcomes. Articles were primarily identified through the Medline and PsychINFO computer databases using the following search terms: lumbar fusion; patient outcomes; biopsychosocial; prediction, workers compensation. Based upon this review, a comprehensive list of relevant presurgical biopsychosocial patient variables and outcomes were proposed for purposes of this study. The study produced a specific multivariate predictive model of surgical outcomes based on the number of presurgical variables reviewed and analyzed.

Low Back Pain: General Prevalence and Workplace Prevalence

LBP is among the most significant socioeconomic and medical problems in our society. In the US, LBP is known as one of the most common symptom for which people seek medical care (Deyo et al., 2006) with point prevalence rates ranging from 14% to 28% (Loney & Stratford, 1999). A recent survey by (Deyo et al., 2006) showed approximately one quarter of U.S. adults reported back pain during a 3-month period.

Hurwitz and Shekelle (2006) reported similar finding indicating, annually, more than 50% of working age adults experience LBP and 15% to 20% of those people seek medical help.

LBP is shown to be responsible for approximately 16% of all workplace compensation claims and is the most common reason for workers to file compensation claims in the US (Hadler et al., 1995). In 1995, an estimated 5.6 million cases were documented for work-related back-pain (Murphy & Volinn, 1999), with projections suggesting 60% to 80% of the adult population will experience at least one episode of LBP during their active work life (Nordin et al., 1997).

Low Back Pain: Costs

The expenditures associated with spinal problems and LBP remain a significant economic burden as direct health care cost and indirect tangential costs continue to be on the rise (Dagenais et al., 2008; Mantyselka et al., 2002; Martin et al., 2008). Direct costs comprise expenditures related to physician services, medical devices, imaging and diagnostic testing, medications, and hospital stay. To examine associated trends related to back and neck pain, a recent study estimated health care expenditures in the US comparing national data from 1997 to 2005 (Martin et al., 2008). The study found inflation-adjusted health care expenditures for spine problems increased from $4,695 in 1997 per person to $6,096 in 2005 yielding an estimated $85.9 billion in total direct costs in 2005. While outpatient visits accounted for the largest proportion of total cost ($30.8 billion), the greatest increase was observed for medications expenditures ($7.3 billion in

1997 to $19.8 billion in 2005). The authors concluded other increases may be related to imaging and diagnostic tests, spinal injections, and increased use of spinal fusion surgery and instrumentation.

Indirect tangential costs associated with LBP are also largely responsible for the significant increases in expenditures (Dagenais et al., 2008; Mantyselka et al., 2002). Indirect costs are related to estimated loss of productivity and wage replacement benefits that are often provided by the workers compensation system. Annually, approximately 149 million lost work days resulted from work related LBP injuries with annual productivity losses estimated at $28 billion (Maetzel & Li, 2002). Workers' compensation is a system of state and federal laws that provides benefits for employees who are injured on the job and covers approximately 127 million U.S. workers (Green-McKenzie, 2004). In addition to compensation costs, workers' compensation is often responsible for medical related costs. Compensation costs typically include all wage replacement and the final impairment settlement related to the work-place injury. In 1994, it was projected that more than $11 billion was paid annually in the U.S. for workers' compensation benefits for work-related LBP (Webster & Snook, 1994). For workers' compensation claims, LBP injury accounts for 33% to 41% of the total costs, but only accounts for 10% to 19% of all compensation claims filed (Hadler et al., 1995; Nachemson, 1992).

Low Back Pain: Progression of Treatments Used

Over the past two decades, there is significant progress in the development of

treatment guidelines for health care professionals concerning the progression, indications, and interventions for LBP (Bigos et al., 1994; Chou et al., 2007; van Tulder et al., 2006). Most recently, the ACP and the APS established evidence-based guidelines for the management of LBP with recommendations regarding diagnostic testing, patient education, and pharmacological interventions (Chou et al., 2007). Typically, acute, nonspecific LBP has no serious underlying pathology and there is evidence to suggest that conservative care, such as acetaminophen, nonsteroidal anti-inflammatory drugs, skeletal muscle relaxants, physical activity, heat therapy, physical therapy, and patient education, are considered appropriate lines of treatment (Kinkade, 2007**)**. However, if specific "red flags" or indicators of latent spinal pathology are present, a more thorough evaluation will be deemed necessary. Imaging studies (i.e., MRI, x-ray, CT) and various subjective physical tests and indicators (i.e., supine straight leg raising, reflexes, back pain with radiation, focal weakness) are often utilized to determine lumbar instability and the extent of "mechanical" LBP (Jarvik & Deyo, 2002; Jensen et al., 1994). Typically, surgery is not considered until LBP is recognized as chronic, which is indicated by pain that persists for more than 7 to 12 weeks (Andersson, 1999). If conservative care has failed, a first line surgery (i.e., discectomy, foraminotomy, and laminectomy) will likely be considered before lumbar fusion (Esses & Huler, 1992; Hestbaek, Leboeuf-Yde, & Manniche, 2003).

Lumbar Fusion: Indications and Procedure

Indications for using lumbar fusion are influenced by the reality that some

patients do not achieve adequate relief of their LBP after conservative care or first-line surgeries (Esses & Huler, 1992; Hestbaek et al., 2003). If pain persists and there is evidence of instability of spinal segments, then lumbar fusion is often a next surgical option. Spinal fusion was first described by Hibbs (1911) as an operation that involves fusing the "spinous processes, laminae and intervertebral articulations" to prevent further progression of curvature of the spine in a patient with spinal tuberculosis. In later years, spinal fusion was adopted in the treatment of additional spinal conditions, such as LBP with sciatica pain and other conditions caused by lumbar instability due to structural defects or to regressive degeneration of the lumbar spine (Herkowitz, 1995). The rationale behind lumbar fusion is to prevent motion between unstable vertebral bodies by fusing and limiting their movement, thus, decreasing or eliminating the back pain created by the motion (An et al., 2003). Lumbar spinal conditions that are currently associated with lumbar fusion include, but are not limited to, degenerative disk disease, herniated lumbar disc, spondylolisthesis, spinal stenosis, deformity, distal extension of previous fusions, fracture, and trauma (Waddell & Turk, 2001). There is criticism that the diagnostic indications for lumbar fusion surgery are poorly defined and outcomes vary with different underlying pathologies (Glassman et al., 2009). Due to the high variability in patient selection for lumbar fusion, there is a lack of consensus regarding well-defined indications for the procedure.

There are a variety of different surgical techniques, which can be used to achieve lumbar fusion; however, all methods involve adding a bone graft to an area of the spine to encourage a biological response, which causes a bony fusion graft to grow between the

two vertebral bodies (Cotler & Cotler, 1990). Lumbar fusion surgeries are typically performed using either posterior lumbar interbody fusion (PLIF), or anterior lumbar interbody fusion (ALIF). However, more recently there is a trend to combine surgeries from both the posterior and the anterior approach thus creating a "circumferential" or "360 degree fusion," which purportedly maximizes spinal stability immediately following surgery and ultimately increases the chance of solid fusion (Fritzell, Hagg, Wessberg, & Nordwall, 2001). Surgeons often rely on the addition of surgical implants (also known as instrumentation), such as pedicle rods and screws and interbody fusion cages, which are used in addition to the bone graft to further stabilize the spine. Such methods have been introduced at a rapid rate. While recent reviews conclude these devices improve fusion success rates (Burkus, Gornet, Schuler, Kleeman, &. Zdeblick, 2009), outcome data regarding pain, disability and psychosocial functioning remains unclear (Maghout-Juratli et al., 2006).

Lumbar Fusion: Prevalence and Cost

Lumbar fusions performed in the US have dramatically increased since 1992 (Deyo & Mirza, 2006; Starkweather, 2006; Weinstein et al., 2006). In 1991, the total number of lumbar fusions performed annually was estimated to be 46,500 (Taylor, Deyo, & Cherkin, 1994). One decade later, a study reported there were 200,000 fusion surgeries performed annually to relieve discogenic low back pain and instability (Starkweather, 2006). Deyo and Mirza (2006) estimated that the rates of lumbar fusion surgery in the US have climbed more than 250% over the past decade with rates rising most rapidly among

patients over age 60. Such dramatic increases in lumbar fusion rates have been linked to technological advances in fusion techniques (i.e., new spinal implantation devices; Maghout-Juratli et al., 2006). High prevalence rates of lumbar fusion surgeries performed are even more substantial for workers compensation patients. Taylor and colleagues (1996) reported that patients with work-place LBP injuries covered by workers' compensation were 1.37 times more likely to undergo surgery involving fusion than other patients with LBP and almost twice as likely to have a subsequent reoperation within 3 years of the index surgery. In the 1990s, DeBerard and colleagues (2003) found average compensation and medical costs for compensated lumbar fusion patients in Utah to be $30,103 and $27,218, respectively. Recently, this study was replicated in a similar cohort of Utah workers and found that medical costs increased 174%, while compensation costs increased relative to the pace of inflation (Wheeler et al., in press). When considering the drastic increase in lumbar fusions and associated costs, particularly among injured workers, there is a clear need to examine patient outcomes associated with these procedures.

Lumbar Fusion: Review of Outcome Measures

Treatment outcomes are often difficult to assess due to the subjective nature of an individual's experience of LBP. Recently, an emphasis has been placed on how exactly to measure a "successful" surgical outcome (Mannion & Elfering, 2006). In the past, outcomes for lumbar spinal fusion surgery have typically been determined based on radiographic evidence (e.g., X rays) to assess whether or not the patient achieves a solid

fusion. Other common surgical outcomes include post-operative complications (e.g., pseudarthrosis or nonfusion, infection, bone donor site pain) and reoperation rates (Champain, Mazel, Skalli, & Mitulescu, 2007). However, over the last decade, researchers have demonstrated quite modest correlations of these common surgical outcomes with patient-oriented outcomes such as pain levels, quality of life, and disability. Thus, most current spine researchers would agree that it is prudent to utilize a multidimensional approach to assess patient outcome based not only on fusion success but also patient-health status and quality of life (Glassman et al., 2009). This is consistent with the World Health Organization (WHO) definition of health acknowledged in 1948 as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 1948, p. 100). In 1998, a standardized set of measures for assessing LBP outcome data was recommended to allow for improved comparisons between studies and produce quality systematic reviews (Deyo et al., 1998). This review was revised in 2000 to include five domains specific to the assessment of self-reported LBP including pain, back specific function, work disability, generic health status, and patient satisfaction (Bombardier, 2000). In the treatment of degenerative spine disorders, the Short Form Health Survey (SF-36v2; Ware, Snow, Kosinski, & Gandek, 2000) and the Oswestry Disability Index (ODI; Fairbank & Pynsent, 2000) are the most commonly used self-report measures (Glassman et al., 2009). Other commonly used measures identified in the literature include the Roland and Morris Disability Scale (RMDS; Roland & Morris, 1983a, 1983b), and Visual Analog Scale or Verbal Numeric Rating Scale (VAS/VNRS; Von Korff, Jensen, & Karoly, 2000).

Lumbar Fusion: Review of Outcomes Studies

In 1992, Turner and colleagues published a review that included 47 published lumbar fusion studies from 1966 to 1991. The review indicated that patients undergoing lumbar fusion had satisfactory outcomes ranging from 16% to 95%, with a mean of 68%. The study also indicated high complication rates associated with lumbar fusion surgery and confirmed there were no randomized control trials comparing lumbar spinal fusion with any other technique. The variability in reported success rates in this review was indicative of the need for more outcome research addressing the effectiveness of lumbar fusion for LBP when compared to surgery without fusion and nonsurgical treatments. To date, lumbar fusion is shown to be very beneficial for fractures, infections, progressive deformity, and instability with spondylolisthesis (Carragee, Lincoln, Parmar, & Alamin, 2006; Moller & Hedlund, 2000; Swan et al., 2006). For example, Moller and Hedlund conducted a prospective randomized study comparing spinal fusion surgery and an exercise program for patients with spondylolisthesis (a condition where one vertebral segment slips forward on another). The ODI was used as a responsive outcome measure that addresses the impact of back pain on daily functioning and disability. The patients who underwent surgery reported greater benefits at two years in terms of ODI scores compared with those who engaged in the exercise program. While lumbar fusion shows encouraging results for specific diagnoses indicative of LBP (e.g., spondylolisthesis, vertebral fracture), there is inconclusive evidence that fusion surgery effectively alleviates pain for persistent nonradicular LBP with common degenerative changes (e.g., degenerative disc disease; Chou et al., 2009; Nguyen, Randolph, Talmage, Succop, &

Travis, 2011).

There is criticism the majority of randomized control trials on surgery for less specific diagnostic categories for LBP compare surgical techniques (e.g., instrumentation vs. noninstrumentation; PLIF vs. 360 degree fusion) rather than comparing lumbar fusion to nonoperative care (Don & Carragee, 2008). The few studies focused on this issue have found little, if any, supportive evidence in favor of lumbar fusion for broad diagnoses of LBP. Four known randomized studies looked at differences between nonoperative treatments versus lumbar fusion for chronic LBP (Brox et al., 2006; Brox et al., 2003; Fairbank et al., 2005; Fritzell et al., 2001). Fritzell and colleauges published a rigorous trial for LBP, which concluded lumbar fusion in patients with severe chronic LBP is more effective in reducing pain and disability than "usual" nonoperative treatment. While the study supported the indication for using lumbar fusion over nonoperative care, the control group was given an unstructured, heterogeneous therapy that was mostly physical therapy, however was also supplemented with other forms of treatment, including education, treatment aimed at pain relief (i.e., acupuncture, injections), cognitive and functional training, and/or coping strategies. To address this concern, Fairbank and colleagues compared lumbar fusion surgery (n = 176) with an intensive rehabilitation program (n = 173) for patients with chronic LBP. The difference between the treatment groups for outcomes related to functional disability was only marginally statistically significant with the surgery group demonstrating only modest improvements in functional disability. However, this study was limited due to high dropout rates for both the surgical group (22%) and the nonsurgical group (16%). In another study, Brox and colleagues

(2003) published a randomized control trial comparing lumbar fusion to cognitive intervention/exercise for treatment of 64 patients with chronic LBP. At 1 year follow-up, no differences were found for pain improvement or functional disability between the two groups. Further, both the surgical and nonoperative treatment groups improved significantly compared to pretreatment conditions. A later study found similar results, in a sample of 60 patients with low back pain lasting longer than one year after previous surgery for disc herniation who were randomized to either lumbar fusion or cognitive intervention with exercise group (Brox et al., 2006). Results indicated no differences were found in functional disability between the two interventions indicating a success rate of 50% in the fusion group and 48% in the cognitive intervention/exercise group. While the Brox and colleagues (2003, 2006) studies suggest that fusion may not be more effective than a structured cognitive and exercise rehabilitation program, it is important to interpret their findings with caution based on small sample sizes.

In addition to comprehensive evidence with regards to general LBP populations, there is evidence that fusion patients who receive workers' compensation have even poorer clinical outcomes than uncompensated patients (Carreon, Glassman, Kantamneni, Mugavin, & Djurasovic, 2010; DeBerard et al., 2003; Maghout-Juratli et al., 2006; Taylor et al., 1996). For example, in a retrospective population-based cohort study on lumbar fusion outcomes for compensated workers in Utah, DeBerard and colleagues (2001) found that 36% of fusion patients reported worse pain, with 35% demonstrating their overall quality of life was no better than before surgery at 2-year postsurgical follow-up. A recent retrospective population-based cohort study found between 1994 and 2001,

1,950 compensated workers who underwent lumbar fusion had an overall disability rate of 63.9 %, a reoperation rate of 22.1%, and a complication rate of 11.8 % at 2 years post-surgery. While the literature review identified convincing evidence of positive fusion outcomes for specific, well-defined diagnoses indicative of LBP, convincing evidence is lacking for positive outcomes in the absence of conclusive diagnoses and a limited amount of research has compared surgical versus nonsurgical treatment of LBP.

Lumbar Fusion: Review of Variables Predictive of Outcomes

Based on the previous review, there are a considerable number of patients who do not do well following lumbar fusion, particularly for workers compensation populations. Previous research has attempted to identify specific presurgical characteristics that may account for some of the variability in surgical outcomes. The following section will review several low back and lumbar fusion studies that have identified a number of presurgical variables shown to have some correlations with LBP and surgical outcome.

Demographic Variables

Despite the potential benefits of lumbar fusion surgery, age is often indicated as a strong risk factor for surgical outcomes. While there is a small body of research suggesting older age is related to poor lumbar fusion outcomes (Chen, Baba, Kamitani, Furusawa, & Immure, 1994; DeBerard et al., 2001, 2003; Kim, Lenke, Bridwell, Kim & Steger-May, 2005), the majority of the literature regarding lumbar surgeries in older patients focuses on the risk of perioperative (during the procedure) complications (Benz, Ibrahim, Afshar, & Garfin, 2001; Deyo, Cherkin, Loeser, Bigos, & Ciol, 1992;

Kalbarczyk, Lukes, & Seiler, 1998;). For example, Deyo and colleagues found in a sample of 27,111 Medicare patients, the rates of complications and mortality rates doubled in patients who had spinal fusion surgery when compared to other surgeries. In another study, results showed that older age was associated with a higher rate of pseudoarthrosis (also known as nonfusion), with 46% of patients over age 55 and only 12% under age 55 demonstrating pseudoarthrosis (Kim et al., 2005). Additionally, DeBerard and colleagues (2001) found that after age 25, each 5-year increase in age resulted in a 119% increase in postfusion disability. While most of these studies indicate age as a predictive factor for poor outcomes, there is criticism that the literature regarding lumbar fusion in older patients focuses more on the prevalence of complications rather than differences in clinical outcomes between older and younger patients (Glassman, Polly, Bono, Burkus, & Dimar, 2008). To address the need for more evidence for older populations, Glassman and colleagues recently compared instrumented lumbar fusion outcomes of 50 patients older than 65 and 174 patients younger than 65 in a randomized control study. For both groups, results showed statistically significant improvements from baseline in all health-related quality of life measures used at 6-month, 1-year, and 2-year postoperative follow-up. Further, older patients' back and leg pain related symptoms improved more than younger patients at all-time intervals (reaching significance at 6-months follow-up). Results also showed that 94.7% of older patients indicated fusion compared to 87.7% of younger patients. Such findings indicate older patients undergoing lumbar fusion with instrumentation may show symptomatic improvement at rates similar to those in younger patients.

Although the literature remains mixed on the issue of gender, studies have shown a relationship between gender and patient outcome and satisfaction after spinal surgery (Airaksinen, Herno, Turunen, Saari, & Suomlainen, 1997; Iversen, Daltroy, Fossel, & Katz, 1998; Katz et al., 1994; Shabat et al., 2005). One study found gender influences the satisfaction rate of lumbar surgery with 57% of women reporting satisfactory results compared to 77% of men (Shabat et al., 2005). In another outcome study for lumbar surgery, participants who were younger and male reported more improvements in physical functioning and ability to walk after surgery (Iversen et al., 1998). One possible explanation for such differences may be women have a greater ability to discriminate among pain intensities, report lower pain thresholds, and higher pain ratings when compared to men (Bush, Harkins, Harrington, & Price, 1993; Ellermeier & Westphal, 1995; Feine, Bushnell, Miron, & Duncun, 1991). This is supported by laboratory research indicating a clear sex-linked biological element in pain perception (Berkley, 1997).

Several studies have indicated that chronic LBP is associated with education level. Evidence suggests that patients with higher levels of education tend to have a decreased risk of developing low back pain (Barnes, Smith, Gatchel, & Mayer, 1989; Bigos et al., 1991; Kwon et al., 2006). This relationship is, at least in part, due to the fact that people with less education tend to have more physically intensive jobs that are related to higher incidences of chronic LBP (Damkot, Pope, Lord, & Frymoyer, 1984). In 2001, the National Research Council published a review that indicated a positive relationship between low back disorders and heavy physical work. However, there is contradictory evidence regarding the relationship between the physical demands of work

and low back pain by evidence suggesting sedentary workers may also suffer from low-back pain. Such findings have caused some to question whether physical demands cause low back pain, or whether they worsen an underlying condition (Snook, 2004).

Compensation and Litigation Variables

The LBP literature has extensive research identifying specific work related factors including compensation and litigation, as predictor variables for future pain and disability. There is evidence that filing worker's compensation claims is strongly linked with a poor prognosis of chronic pain and disability in patients with back related injuries (Damkot et al., 1984; Rasmussen, Leboeuf-Yde, Hestbæk, & Manniche, 2008). Other studies have found more than two thirds of workers who filed compensation claims for back pain and returned to work experienced subsequent episodes of back-pain-related sick leave (Baldwin, Johnson, & Butler, 1996). In a recent study, 1,831 U.S. workers who filed workers' compensation claims for back pain between 1999 and 2002 found that 30% of workers experienced multiple episodes of sick leave at 1-year follow-up (Cote, Baldwin, Johnson, Frank, & Butler, 2008). In addition, workers who did not go on sick-leave and/or return to work in a short amount of time reported significantly better health outcomes than workers who experienced multiple episodes of sick leave or no return to work.

Work-related factors, such as worker's compensation, disability claims, work status, and the duration of sick leave, have also been identified as predictors of surgical outcome (DeBerard et al., 2001; Hodges, Humphreys, Eck, Covington, & Harrom, 2001; Mannion & Elfering, 2006). A meta-analysis including data from more than 20,000

patients found that compensated patients were four times more likely to have unsatisfactory outcome after surgery when compared to noncompensated patients (Harris, Mulford, Solomon, van Gelder, & Young, 2005). In another study, Greenough, Peterson, Hadlow, and Fraser (1998) found that workers' compensation patients who underwent lumbar fusion surgery had significant increases in pain and psychological disturbances, as well as, lower rates of returning to work when compared to noncompensated patients. Further, no differences were found in fusion rates, frequency of physician consultations, or level of functioning.

The role of the legal system also plays an important role in back surgery outcomes. Several studies demonstrate the relationship between compensation claims involving litigation and increased rate of disability and pain (Bernard, 1993; Greenough et al., 1998; Greenough, Taylor, & Fraser, 1994; Junge, Dvorak, & Ahrens, 1995). For lumbar fusion specifically, retrospective studies show involvement of a lawyer in compensation claims is a predictor of a various negative outcomes after lumbar fusion (DeBerard et al., 2001, 2003; LaCaille, DeBerard, Masters, Colledge, & Bacon, 2005). One study indicated compensation claims involving a lawyer revealed a 376% increase in the probability patients would remain disabled two years following lumbar fusion compared to claims not involving a lawyer (DeBerard et al., 2001). Specific mechanism related to the association between compensation and poor outcome are proposed to include, but are not limited to, the effect of patients blaming others for their injury, secondary gain (i.e., medication and/or money), and the role of exposure to a complex and adversarial system (i.e., legal and insurance systems; Harris, 2007).

Perceived higher-risk surgery cases are often referred to nurse case managers and or vocational rehabilitation to help manage patient's medical treatments and facilitate return to work. Despite such proactive measures, studies have shown an association of assigning nurse case managers and vocational rehabilitation with worse patient outcomes for discectomy patients (DeBerard et al., 2009); however, the association of referral to nurse case manager and utilization of vocational rehabilitation on fusion outcomes remains unknown. While these findings seem counterintuitive, as the intention of providing nurse case managers and vocational rehabilitation are to reduce risk and lower costs, patients referred to such services are often at higher risk from the outset. These findings lend support for further evaluation of these services in terms of lumbar fusion patient outcomes in workers compensation populations.

Health-Related Variables

While studies have indicated individuals with LBP have an increased risk of relying on substances for pain relief such as alcohol or pain medication (e.g., Frymoyer, 1992; Stevenson, Weber, Smith, Dumas, & Albert, 2001), there is still a lack of evidence suggesting their impact on back surgery outcomes (Block & Callewart, 1999; Turner et al., 1992). Conversely, the literature indicates nicotine use is responsible for significant increases in LBP (Battie et al., 1990; Bigos et al., 1991, 1994), as well as negatively impacting fusion rates (An, Simpson, Glover, & Stephany, 1995; Silcox et al., 1995; Wing, Fisher, O'Connell & Wing, 2000). Evidence supports smoking may potentially act as a bone toxin by disrupting the ability for normal bone formation and growth, thus, inhibiting fusion to take place (Andersen et al., 2001). One study indicated smokers who

underwent spinal fusion showed an increased rate of pseudoarthrosis (fusion failure) by 47% when compared to nonsmokers (An et al., 1995). More recently, a study compared the clinical outcomes and fusion status at 2-year post surgical follow-up of 188 cigarette smokers and 169 nonsmokers who underwent lumbar fusion. Rates for nonunion were 14% for nonsmoking patients and 27% for smoking patients; however, patients that quit smoking between 1 and 6 months after surgery had a nonunion rate of 18% (Glassman et al., 2000). Such findings indicate smoking may be both a predictor variable, as well as a mediating variable for fusion outcomes. In addition to increased pseudoarthrosis risk, there is empirical support that smoking also affects clinical outcomes independent of fusion success. In one study, nonsmoking patients with successful fusion had superior physical pain scores (significant at 12- and 24-months postoperative) and mental ability scores (significant at 6- and 12- months postoperative) when compared to smoking patients with successful fusion (Harvinder, Thomas, Foley, Safdar, & Fengyu, 2001). Such results question whether the negative effect on fusion rate is related to smoking itself or to others factors associated with smoking.

Obesity is well documented as an independent predictor for low back pain (Deyo & Bass, 1989). While a few studies have addressed the effect of obesity on clinical outcomes of a variety of spine surgeries (Andreshak, An, Hall, & Stein, 1997; Gepstein et al., 2004), most of the emphasis was on perioperative complications with little outcome data on patient-based, health-related quality of life measures. Recently, one study looked at clinical outcomes and complication rates of patients undergoing lumbar spinal fusion by comparing health related outcome measures and numerical rating scales of back and

leg pain of obese patients to nonobese patients (Djurasovic, Bratcher, Glassman, Dimar, & Carreon, 2008). Despite the fact that overall complication rates were lower in the nonobese group (17.4%) compared to the obese group (28.4%), improvement levels did not differ significantly with both groups showing significant improvement in back and leg pain after surgery. Similarly, quality of life and disability scores showed significant improvement after surgery in both obese and nonobese groups. Such findings suggest that obese patients who meet acceptable criteria and indications for lumbar fusion may achieve similar benefits as nonobese patients.

Research on LBP patients has shown that psychological factors such as anxiety, depression, fear avoidance relating to work, and back-pain-related stresses predict impairment in subsequent physical health-related quality of life and healthcare utilization (Keeley et al., 2008). While some studies demonstrate psychological distress is not predictive of post-operative improvement in patients who underwent lumbar fusion (Tandon, Campbell, & Ross, 1999), the majority of the literature suggests presurgical psychological characteristics do play an important role in surgical outcome (DeBerard et al., 2001; LaCaille et al., 2005). One study examined whether three aspects of psychological distress (depression, anxiety, and hostility) predict several surgical outcomes (employment status, subjective pain change ratings, and changes in functional abilities; Trief, Grant, & Fredrickson, 2000). Results indicated inability to return to work and failure to report improvement in pain and functional abilities were significantly predicted by presurgical anxiety and depression. Due to the probable impact psychological variables may have on fusion outcomes, there are additional concerns that

patients who are clinically depressed preoperatively will likely have an increase in depressive symptoms postoperatively leading to continued negative effects on surgery outcomes (Block, Gatchel, Deardorff, & Guyer, 2003). Thus, by screening patients prior to surgery, patients have the option to treat their depression prior to surgery.

Back-Related Physiological and Surgical Procedural Variables

Although there are advances with regards to proper diagnosis, there is criticism about the frequency of nonspecific and subjective diagnoses used in outcome studies evaluating the effectiveness of lumbar fusion (Franklin, Haug, Heyer, McKeefrey & Picciano, 1994; Glassman et al., 2009; Turner et al., 1992). Diagnoses are often grouped into broad categories such as chronic LBP (Fairbank et al., 2005; Fritzell et al., 2001) or degenerative disc disease (Dimar, Glassman, Burkus, & Carreon, 2006; Sasso, Kitchel, & Dawson, 2004). Such a lack in specificity for diagnosis limits the ability to compare effectively the benefit of surgical versus nonsurgical treatment, one surgical technique versus another, or the potential added benefit of a surgical implant. In a recent study, Glassman and colleagues found fusion outcome improvements are not equal among diagnostic subgroups. Specifically, the study indicated the most substantial improvement in fusion outcomes were for patients with spondylolisthesis and scoliosis, followed by the diagnosis of disc pathology, postdiscectomy revision, instability, stenosis, and adjacent level degeneration. The least improvement for patients after surgery was seen in patients with pseudoarthrosis of a prior fusion.

Recent evidence based guidelines suggest patients with LBP should undergo

diagnostic imaging such as x-ray, magnetic resonance imaging (MRI), or computed tomography (CT), only if there is a strong indication nerve damage or a specific cause of the low back pain would show up on the test and that positive results would potentially lead to surgery or epidural steroid injection for suspected (Chou et al., 2007). There is criticism the identification of abnormalities with early MRI leads to increase costs of care and increased number of spine operations without any predictive value for outcomes. For example, studies have indicated MRIs or CT for individual without low back pain commonly present with images of disk herniations, disk bulges, and disk degeneration (Boden, Davis, Dina, Patronas, & Wiesel, 1990; Jarvik, Hollingworth, Heagerty, Haynor, & Deyo, 2001). These findings are often nonspecific and there is no compelling evidence routine imaging affects treatment decisions or improves outcomes (Chou et al., 2007). Some evidence exists combining various diagnostic criteria with results of objective imaging studies (MRI, CT, discography) is a more reliable predictor of surgical outcome than diagnosis alone (Boos, Marchesi, & Aebi, 1991; Hasenbring, Marienfeld, Kuhlendahl, & Soyka, 1994; Lacroix et al., 1990). However, more recent finding suggest that, for patients undergoing lumbar fusion, a surgical diagnostic severity score based on presurgical imaging indicated no predictive power for either disability status, global outcome, or physical or social functioning (DeBerard et al., 2001).

A considerable amount of research has been directed toward examining different aspects of surgical history and procedural variables in relation to predicting lumbar fusion outcomes. Multiple-levels spinal fusion is shown to be predictive of clinical outcomes (Franklin et al., 1994; Glassman et al., 1998; Narayan, Haid, Subach, & Rodts, 2002;

Turner et al., 1992). In one study, successful fusion rates in 457 patients were correlated with the number of fusion levels indicating fusion rates declined significantly in relation to each additional level fused. However, recently, Glassman and colleagues (2006) compared patients who underwent either a single-level fusion (n = 324) or a two-level fusions indicating no significant differences between the two groups with both groups revealing significant improvement from preoperative to postoperative outcome at 1- and 2-year follow-up. Several studies also shown a history of prior back surgeries is a predictor of poorer outcomes (DeBerard et al., 2001; Franklin et al., 1994).

Recently, research has started to address the influence new surgical implants (i.e., interbody fusion cages) have on lumbar fusion outcomes (Maghout-Juratli et al., 2006). Interbody fusion cages were developed and introduced to provide better mechanical strength in addition to bone on bone fusion. However, whether interbody fusion cages provide better functional outcomes than bone only fusion or pedicle screw and rod fixation remains unclear. For example, a recent study examining interbody fusion cage outcomes reported poor quality of life and continued functional impairment, with 38% of patients totally disabled at approximately 2-years follow-up (LaCaille et al., 2005). These findings are similar to previous outcome research on surgeries that did not use such sophisticated technology (DeBerard et al., 2001; Turner et al., 1994). Further, the use of interbody fusion cages have also been associated with increased post-operative complication risk compared to bone-only fusions (Maghout-Juratli et al., 2007).

Conclusions from the Literature Review

Despite the several demographic, occupational, health, psychological, and surgical variables associated with lumbar fusion outcomes, only a few studies have addressed the predictive nature of multiple variables on lumbar fusion outcomes. The biopsychosocial model suggests biological, psychological, and social factors are interrelated in their role of human functioning for any given state of health or illness (Gatchel & Bell, 2000; Taylor, 1999). This model remains distinct from the biomedical approach that suggests illness has a single underlying pathophysiological cause that is independent from psychological and social factors (Wright, 2005). Such a model could only be supported if the removal of the pathology resulted in a return to health. For LBP, this is clearly not the case. There is evidence that lumbar spine pathology is often present in people who experience no symptoms associated with the pathology (Boden et al., 1990; Jarvik et al., 2001). Conversely, lumbar fusion patients who do have pathology often have limited functional recovery after surgical repair of the pathology (DeBerard et al., 2001; Franklin et al., 2004). Further, there is evidence to suggest presurgical diagnosis and the severity of lumbar spinal pathology are not predictive of lumbar fusion outcomes (DeBerard et al., 2001; Turner et al., 1992). Such evidence supports the justification for viewing low back pain from a perspective that combines physical, mental, and social well-being, as well as broadens the focus not to simply "cure" disease, but also to promote health. The current study will use the biopsychosocial model as a foundation when considering multiple types of predictors for outcomes as well as conceptualize and assess outcomes in a multidimensional fashion.

The current study replicates the methods of DeBerard and colleagues (2001) and LaCaille and colleagues (2005) studies that examined predictors of lumbar fusion surgery outcomes and expands on these early finding by including additional variables affiliated with more recent lumbar fusion literature and advancements in surgical technology. The factors to be used in the model were identified from the variables currently reviewed and include: age at the time of the procedure, gender, level of education, BMI, litigation status, time between injury and surgery, previous history of depression, presurgical psychological evaluation, smoking history, prior history of back surgery, pain medication use, pain severity (1-10), diagnosis, type of surgery, instrumentation use, and number of levels fused (see Figure 1).

Research Purpose and Study Objectives

The current study has three primary objectives: (a) to examine patient presurgical variables and understand the interrelationships between such variables; (b) to characterize multiple outcomes associated with lumbar fusion patients in terms of quality of life, function, and health status variables, as well as fusion rates, patient satisfaction, and disability; and (c) to explore the relationship of presurgical variables to outcomes and test the predictive efficacy of a multiple variable predictive model.

Research Questions

This study addressed the following research questions related to objective 1.

1. What are the patient characteristics of this sample in terms of the presurgical

PREDICTIVE VARIABLES	PATIENT OUTCOME VARIABLES
DEMOGRAPHIC VARIABLES *Age at injury Income Level *Education Level Gender Ethnicity Marital Status Child Care Responsibility PHYSIOLOGICAL VARIABLES *Obesity Status Diagnosis Physical Exam Data Pain Severity (1-10) TREATMENT VARIABLES *Number of Levels Fused Diagnosis *Number of Prior Back Operations Type of Procedure *Instrumentation Type HEALTH VARIABLES *Smoking at Time of Fusion General Health Problems Alcohol Use *Amount of Pain Before Fusion Use of Pain Meds Prior to Fusion WORK/COMPENSATION VARIABLES *Lawyer Involvement Total Compensation Costs *History of Prior Claims Time Between Date of Injury and Fusion Employed at Time of Fusion Occupation Title *Case Manager Assigned *Vocational Rehabilitation Assigned PSYCHOLOGICAL VARIABLES *History of Depression *Presurgical Psychological Evaluation	FUSION RATE % based on chart and self-report DISABILITY Current Work/Disability Status Roland-Morris Disability Scale STAUFFER-COVENTRY INDEX Good, Fair, and Poor Outcome Categories PATIENT SATISFACITON Global Perceived Effect Current Pain Level on 11-Point Scale (VNRS) Back Pain Following Surgery Quality of Life Following Fusion Have Fusion Again Pain Better or Worse than Expected How Satisfied if Back Condition Continued ROLAND-MORRIS DISABILITY QUESTIONNAIRE Level of Dysfunction Score HEALTH & MENTAL HEALTH Back Procedures 2 years post-Fusion (from med chart and survey) Pain Catastrophizing Scale Total Score Rumination Magnification Helplessness Short-Form Health Survey Physical Health Component Score Mental Health Component Score Physical Functioning Role Functioning Social Functioning General Mental Health Current Health Perceptions Pain

*Identifies variables considered for prediction analyses.

Figure 1. A summary of patient and outcome variables.

psychosocial variables of interest?

2. What are the intercorrelations among presurgical predictor variables of interest?

This study addressed the following research question related to objective 2.

3. What is the percentage of solid fusion in the population sample of interest?
4. What percentage of the subject sample is still work-disabled following surgery?
5. What is the level of postsurgical back pain disability among participants and is it consistent with existing back pain patient norms and previous workers compensation populations?
6. What is the percentage breakdown for patient satisfaction variables?
7. What is the percentage breakdown of good, fair, and poor outcomes (i.e., based upon pain reduction, return to work, physical functioning, medication usage) for the patient sample?
8. What is the subjective pain level reported my fusion patients?
9. What are the mean values for mental health and overall health indices (i.e., physical functioning, role functioning, social functioning, general mental health, current health perceptions, and pain perception) and are these consistent with existing patient, nonpatient, and worker's compensation population norms?
10. What are the interrelationships among the outcome variables?

This study addressed the following research question related to objective 3.

11. What are the intercorrelations among presurgical predictor variables of interest and outcomes?
12. Is a multiple-variable presurgical model predictive of determined patient outcomes?

CHAPTER III

METHODS

Population and Sample

All adults insured through Workers' Compensation Fund of Utah (WCFU) who were at least 2 years post lumbar fusion surgery were eligible for inclusion in this study. The 2-year follow-up was used in accordance with the suggested minimum follow-up period indicated by editors of *Spine*, a major medical subspecialty journal (Nachemson & LaRocca, 1987). Participants were excluded if their condition was related to a fracture of the spine at the time of the surgery. WCFU gave signed authorization to review patient files and initiate telephone contact. The WCFU computer database was used to identify all patients who had undergone lumbar fusion surgery from 1998 to 2007. The final sample size was determined based on the original sample extracted from the database and number of participants contacted at follow-up for gathering outcome data.

Figure 2 identifies the process of patient selection and follow-up participation. A total of 286 medical charts of patients who had undergone lumbar fusion were available for review via the WCFU database. However, due to inclusion criteria, several patients were ineligible for participation, yielding a total sample of 245 injured workers who were included for medical chart review (see Phase 1 below). Patient's primary diagnosis given by the operating surgeon according to the operative report included disc herniation (39.2%), degenerative disc disease (30.2%), spondylolisthesis (13.5%), spinal stenosis (7.8%), radiculopathy (3.3%), and other (5.7%). While previous retrospective studies

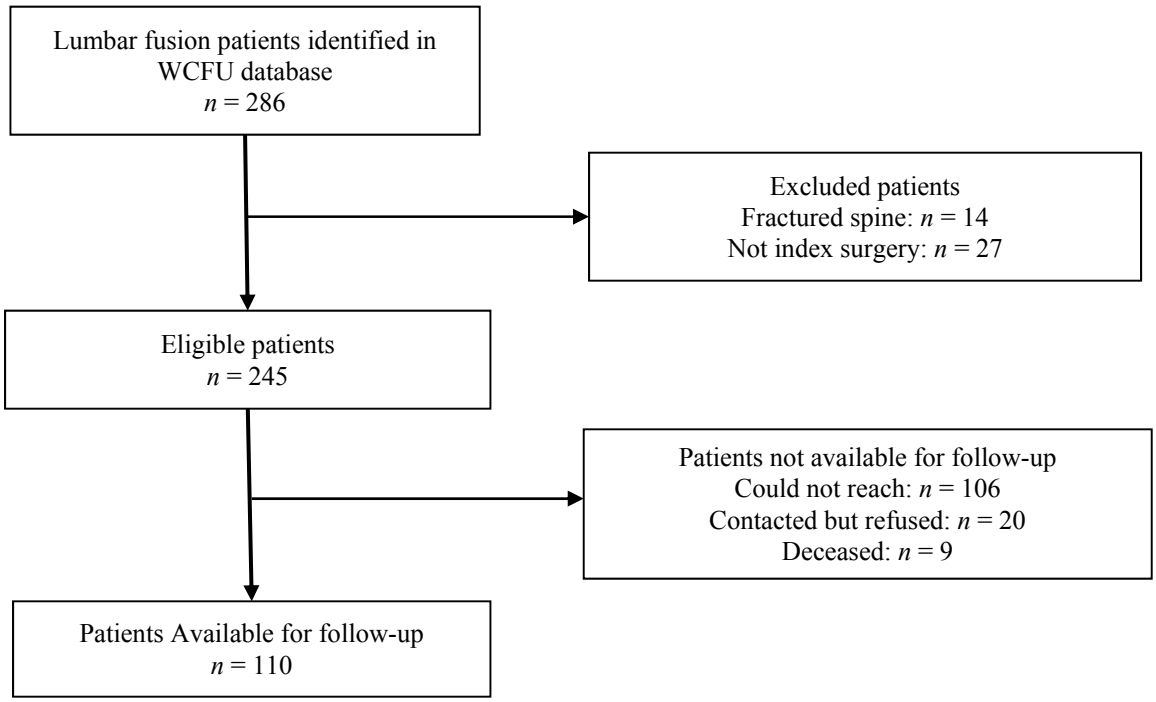

Figure 2. Process of patient selection and follow-up participation.

indicate an approximate outcome follow-up rate for back surgery patients of 50% (DeBerard et al., 2001; LaCaille et al., 2005), our sample obtained outcome data for 110 patients who were contacted by telephone and agreed to participate in the telephone interview portion of the study (see Phase 2 below), yielding an overall response rate of 45%. The author and one other graduate student conducted all 110 of the interviews. Of the remaining 135 patients who did not participate, 20 were contacted but declined to participate, 7 were deceased, and the remaining 108 were unavailable or relocated to an unknown destination.

Due to the nature of the statistical analyses related to presurgical patient characteristics and procedural variables, these will be thoroughly addressed in the results section. The specific differences between patients available for follow-up and patients

lost to follow-up will also be addressed. Because the target population for the current study is specifically injured workers receiving compensation from WCF, it is intended the findings from the current review will generalize to similar populations of injured workers across the US.

Study Design

This study was a retrospective-cohort design. Phase 1 involved gathering presurgical information documented in patient medical charts and in the WCFU computer database. Phase 1 was followed by mailing participants a letter describing the study and notification that they would be contacted for a 20-minute telephone survey. Phase 2 consisted of a telephone survey.

Procedure

Phase 1

Phase 1 began with identifying the specific number of participants that met researcher established inclusion/exclusion criteria. This was followed by a medical chart and WCFU document review for each participant. The purpose of this chart review was to code information regarding the treatment, clinical, and relevant biopsychosocial status of the participant prior to the intervention. Reviews were conducted onsite at the WCFU in Salt Lake City. A specific medical chart review coding instrument was completed for each participant (see Appendix A). To ensure interrater reliability of the medical chart review, another graduate student independently reviewed 5% of the medical charts.

Interrater reliability was determined by dividing the total number of agreements by the total number of ratings for each item on the medical chart that was coded. Interrater reliability for this review was .95.

Phase 2

Phase 2 involved contacting each participant identified in Phase 1 for a telephone interview. The most recent address and phone number for each participant identified in the medical chart and recorded on the medical chart review coding instrument was used. Participants were given notification in the form of a letter (see Appendix B) that provided a detailed description about the study. This letter ensured patient confidentiality. Participants were encouraged to participate by offering a $10 incentive that was sent out following completion of the telephone survey via check. A self-addressed stamped postcard was included with the letter so participants could provide updated phone numbers or addresses. Participant were asked to send postcards back even if their address and/or phone number were unchanged. Other methods of obtaining contact information were used (e.g., internet searches, directory assistance) if participants were not reached at the address or telephone number listed in the WCFU database. Later, all participants with correct phone numbers were contacted to complete the survey.

Detailed records for phone calling were kept for each participant (see Appendix C). In cases where postcards were not returned, verbal consent was obtained through telephone contact. A written script (see Appendix D) adapted from DeBerard (1998) was used for initial participant telephone contacts. Follow-up concerning the letter with regards to confidentiality and participation incentives were emphasized for the

participants contacted. The assessment measures (described below) used in the telephone interview was administered at the initial time of contact unless participants requested to not participate or to participate at a later scheduled time. Two graduate students performed all of the outcome surveys over the phone. Both students were well trained to conduct standardized telephone interviews by the supervisor of the current project. While the interview was intended to last from 20 to 30 minutes based on the content of the outcome survey, the amount of time with each participant varied considerably, ranging from 20 to 75 minutes. Several participants in this study are socially isolated, lonely, and suffer from chronic pain. Further, many have not had good experiences dealing with the workers compensation system. These contextual variables were important when determining how to interact with the patient during the interview, while also maintaining a systematic approach to data collection. This required interviewers to be well trained in advanced clinical skills so they could interact with participants from a supportive, calm and respectful stance. To ensure interrater reliability, for 10% of the outcome surveys another graduate student listened on a separate line and independently coded patient responses. Interrater reliability was determined by dividing the total number of agreements by the total number of ratings for each item on the outcome survey. Interrater reliability for this review was .97

Materials and Instrumentation

There is strong evidence to suggest presurgical diagnosis and the severity of lumbar spinal pathology are not predictive of lumbar fusion outcomes (DeBerard et al.,

2001; Turner et al., 1992). This supports the notion to view LBP from a perspective that combines physical, mental, and social well-being and to use the biopsychosocial model as a foundation to conceptualize and assess outcomes in a multidimensional fashion. To select specific outcome measures a review was conducted on outcome measures used in larger-scale fusion and low back surgery studies. The list of potential outcome measures was determined by selecting the most comprehensive and feasible measure from a number of possibilities. Measures were also selected that allowed for comparisons of the present study findings directly to other published studies. Final selection was determined by ensuring each measure was published widely and evidence for psychometric reliability and/or validity was available.

Medical Chart Review Instrument

The medical chart review instrument discussed earlier in Phase 1 of the study (see Appendix A) was adapted from a previous instrument used for gathering information from the WCFU database in earlier research (e.g., DeBerard et al., 2001; LaCaille et al., 2005). This instrument consisted of several biopsychosocial variables of interest related to low back pain and surgery outcomes discussed previously in the literature review. Modifications to the instrument were made relevant to the purposes of this study. For example, an adjustment was made to include more specific diagnoses, additional surgical procedures, and types of instrumentation to address a lack of such reports in previous studies. Psychological variables including whether or not presurgical psychological evaluations were given, and if psychotropic medication or therapy was utilized prior to surgery, were also added to the measure.

Telephone Survey Instruments

Following the telephone script (see Appendix D), participants were asked using various assessments measures on their level of satisfaction with their workers compensation claim, surgical outcome, level of dysfunction and disability status, and basic demographic information. Any information not attained in the medical chart review was obtained at that time.

Fusion Outcomes

Although the review of the postsurgical medical records at WCFU may have documentation on whether solid fusion was achieved, participants were asked to confirm the status of the fusion if not obtained in chart review.

Patient Satisfaction

Patient satisfaction was determined using five close-ended questions used in previous research on spinal surgery outcomes (DeBerard et al., 2001; LaCaille et al., 2005) that are specific to their lumbar fusion procedure (see Appendix E items 5, 6, 7, 17, and 19). The items included addressed patient satisfaction related to back/leg pain improvement, quality of life improvement as a result of lumbar fusion, and satisfaction with back condition at time of follow-up. These items used a response format ranging from a 3- to 7-point scale.

Stauffer-Coventry Index

The Stauffer-Coventry Index (SCI; Stauffer & Coventry, 1972) is a measure that has been used in previous research assessing outcomes following lumbar fusion surgery

(DeBerard et al., 2001; LaCaille et al., 2005; Turner et al., 1992). Items are highly face valid The measure consists of four multiple response self-report questions regarding pain reduction, return to work, limitations of physical activities, and medication usage. The questions are highly face valid and responses reflect three subscales that categorize good, fair, and poor outcomes: Good outcomes are determined by 76% to 100% relief in leg and back pain, return to previous work status, minimal or no restriction of physical activities, occasional mild analgesics or no analgesics; Fair outcome are determined by 26% to 75% relief of leg and back pain, return to lighter work, moderate restrictions of physical activities, regular use of nonnarcotic analgesics; and Poor outcome are determined 0% to 25% relief of leg and back pain, no return to work after surgery, severe restrictions of physical activities, occasional or regular use of narcotic analgesics (see Appendix E items 1-4).

Global Perceived Effect

The Global Perceived Effect (GPE; Beurskens, de Vet, Köke, van der Heijden, & Knipschild, 1996) is a one-item response (see Appendix E, item 22) that provides a subjective report of the patient's level of improvement. The patient is asked: "Compared to when this episode first started, how would you describe your back these days?" The response is based on a 4-point Likert scale (1-complete relief of pain, 2-more than 50% relief, 3-no change, 4-increase of pain). Intraclass correlation coefficient values of 0.90 to 0.99 indicate excellent test-retest reliability of the GPE for chronic LBP patients (Kampera et al., 2010)

Verbal Numeric Rating Scale

The Verbal Numeric Rating Scale (VNRS) was used to evaluate patients' perceived level of pain at the time of the telephone interview as well as an average rating of their pain over the past week (see Appendix E, items 20 and 21). The patient was asked to verbally rate their pain from 0 to 10 (an 11-point scale), where 0 represents "no pain" and 10 represents "the worst pain imaginable." The VNRS has been widely used clinically for the assessment of pain (Jensen, Karoly, O'Riordan, Bland, & Burns, 1989; Kaplan, Metzger, & Jablecki, 1983). The VNRS shows strong test-retest reliability with Pearson coefficient as high as .99 (Gallasch, Alexandre, & Amick, 2007).

Disability Status

During the telephone survey, disability status was assessed by asking participants whether or not they currently receive total disability for their back condition (see Appendix E, item 10). This was also verified by medical chart review. Scales for physical functioning and daily activities were also considered factors determining disability.

Roland-Morris Disability Questionnaire

The Roland-Morris Disability Questionnaire (RDQ; Roland & Morris, 1983a, 1983b) is a 24-item self-report health status instrument intended to assess level of dysfunction in patients with LBP (see Appendix F). Participants are asked to provide a "yes" or "no" response to each question. To score the measure, the total number of "yes" responses is calculated. Higher scores indicate more physical dysfunction severity with a cut-off score of 14 or higher representative of a poor outcome (Roland & Morris, 1983a,

1983b). RDQ shows strong psychometric properties, with evidence of internal consistency and responsiveness (Kopec & Esdaile, 1995). The internal consistency for the RDQ is high (r = .91; Roland & Morris, 1983a, 1983b) and the measure is considered valid and sensitive to change over time for groups of patients with low back pain (Klein & Eek, 1990).

Short Form Health Survey-36, Version 2

The Short Form Health Survey (SF-36v2; Ware et al., 2000) is a 36-item general health survey that assesses eight dimensions of health-related quality of life. The eight dimensions assessed by this measure include (a) physical functioning: extent to which health interferes with performance of behavioral activities (e.g., sports, climbing stairs, and walking); (b) role physical: extent to which health interferes with usual daily activities (work, housework, or school; (c) bodily pain: intensity of bodily pain during last month and extent to which it interferes with normal work; (d) general health: current evaluation of personal health; (e) vitality: degree to which a person has vigor and energy versus worn out and tired; (f) social functioning: extent to which health interferes with normal social activities; (g) role emotional: degree to which emotional problems resulted in problems with work or daily function; and (h) mental health: degree to which a person feels nervous and depressed. The eight subscales may also be aggregated into Mental Health (MCS) and Physical Health (PCS) Component Summary scales (Ware & Kosinski, 2001). These summary scales are responsible for 80% to 85% of the variance in the eight SF-36 scales and allow researchers to perform statistical analyses on two higher-order constructs (MCS/PCS) rather than separate analyses for each of the eight

SF-36 subscales (Appendix G). Norm based scoring for all scales has a general population mean of 50 and standard deviation of 10. To date, several studies have yielded content, concurrent, criterion, construct, and predictive evidence of validity for the SF-36 (Ware et al., 2000). For the general population, reliability coefficients range from .83 to .95 for the eight scales, and two summary scores (MCS and PCS) using both internal consistency and test–retest methods (Ware, Kosinski, & Keller, 1994; Ware et al., 2000). Further, in the treatment of degenerative spine disorders, the SF-36v2 is among the most commonly used self-report measures (Glassman et al., 2009).

Pain Catastrophizing Scale

The Pain Catastrophizing Scale (PCAS; Sullivan, Bishop, & Pivik, 1995) is a 13-item self-report instrument that asks patients to reflect on a pain experience and then to provide ratings as to how often they dwell on pain-related thoughts and feelings (see Appendix H). The items are scored on a 5-point Likert scale with scoring ranging from "not at all" (score = 0) to "always" (score = 4). The total score ranges from 0 to 52 and high scores indicate that more catastrophic thoughts or feelings are experienced. The PCAS comprises one general construct and three empirically derived subscales, namely magnification (items 6, 7 and 13), rumination (items 8, 9, 10 and 11) and helplessness (items 1, 2, 3, 4, 5 and 12). For community and outpatient pain samples, psychometric studies have shown adequate internal consistency and Cronbach's alpha coefficients (α) for the total and subscale scores. In the community sample, the α for the total score was .95, while α for the rumination, magnification, and helplessness subscale scores were .95, .88, and .91, In the outpatient sample, the α for the total score was, .92. The α for the

rumination, magnification, and helplessness subscales were .85, .75, and .86 (Osman et al., 2000). Studies also support the PCAS as a useful measure in differentiating pain clinic patients with community-based samples (Sullivan et al., 1995; Osman et al., 2000).

Analysis

Data collected were analyzed using the Statistical Packages for Social Sciences (PASW, Version 18.0). The analyses addressed three primary objectives for a sample of worker's compensation patients who have undergone lumbar fusion including () to examine patient presurgical variables and understand the interrelationships between such variables; (b) to characterize multiple outcomes associated with lumbar fusion patients in terms of quality of life, function, and health status variables, as well as fusion rates, patient satisfaction, and disability; and (c) to explore the relationship of presurgical variables to outcomes and test the predictive efficacy of a multiple variable predictive model. Descriptive statistics including percentages, means, and standard deviation were used to characterize the sample in relation to the specific variables. Intercorrelations between the variables were assessed using Pearson correlation coefficients. The first and second research objectives were addressed by calculating the descriptive statistics and the intercorrelations among the presurgical predictor variables of interest and multiple outcomes associated with lumbar spinal fusion surgery. The third objective was addressed by using a series of logistic and multiple linear regression analyses to test the strength of a multivariate predictive model of patient outcomes. Specific research questions and their corresponding data analyses are summarized in Figure 3.

OBJECTIVE 1: Research questions	**OBJECTIVE 1: Data analyses**
1. What are the patient characteristics of this sample in terms of the presurgical psychosocial variables of interest? 2. What are the inter-correlations among presurgical predictor variables of interest?	1. Will be determined by calculations of descriptive statistics for each of the nine presurgical variables. 2. A correlation matrix of the presurgical variables will be generated
OBJECTIVE 2: Research questions	**OBJECTIVE 2: Data analyses**
3. What is the percentage of solid fusion in the population sample of interest? 4. What percentage of the subject sample is still work-disabled following surgery? 5. What is the level of postsurgical back pain disability among participants and is it consistent with existing back pain patient norms and previous workers compensation populations? 6. What is the percentage breakdown for patient satisfaction variables? 7. What is the percentage breakdown of good, fair, and poor outcomes (i.e., based upon pain reduction, return to work, physical functioning, medication usage) for the patient sample? 8. What is the subjective pain level reported by fusion patients? 9. What are the mean values for mental health and overall health indices (i.e., physical functioning, role functioning, social functioning, general mental health, current health perceptions, and pain perception) and are these consistent with existing patient, nonpatient, and worker's compensation population norms? 10. What are the interrelationships among the outcome variables?	3. Will be determined by percentage of solid fusion rates. 4. A dichotomous frequency (disabled vs. not disabled) will be calculated 5. Disability status and frequency of total scores and percentages for responses on the RDQ will be compared to prior samples. 6. A frequency breakdown of the 5 patient satisfaction items will be calculated. 7. The frequency of total scores an percentages for responses on the SCI will be calculated 8. VAS, GPE will be reported using descriptive statistics and total and subscale PCAS scores will be calculated. 9. Physical and mental health composite scores will be calculated for the SF-36 and values will be compared with existing norms. 10. A correlation matrix of the outcome measures will be presented.
OBJECTIVE 3: Research questions	**OBJECTIVE 3: Data analyses**
11. What are the intercorrelations among presurgical predictor variables of interest and outcomes? 12. Is a multiple-variable presurgical model predictive of determined patient outcomes?	11. Predictor analyses will be achieved by examining the Pearson r correlation coefficients between predictor variables and outcome measures 12. Multiple regression analyses will be used to assess the predictive efficacy of the model for patient outcomes. Resulting regression equation statistics will be interpreted.

Figure 3. Research questions and associated analyses.

CHAPTER IV

RESULTS

The results of this study are organized according to the following sections: (a) descriptive statistics and intercorrelations of patient and procedural variables; (b) response rates and bias checks; (c) patient outcomes; (d) intercorrelations of outcomes (e) intercorrelations between patient characteristics and outcomes; and (h) prediction of outcomes. Each research questions and their subsequent statistical analysis in the study will be addressed as outlined in Figure 3.

Descriptive Statistics

To address the first objective of this study, it was important to comprehensively identify specific patient and procedural variables for injured workers who had undergone lumbar fusion (see research question 1). Based on the information gathered from patient medical charts and surgical reports, descriptive statistics were performed for the entire sample ($N = 245$).

Table 1 includes patient characteristics for the following variables: gender, age, ethnicity, education, average weekly income, body mass index, smoking history, depression history, case manager involvement, vocational rehabilitation assignment, litigation involvement, total compensation/medical costs incurred, and number of prior compensation claims. Results indicated that 81.6% of patients were male and 18.4% female. The average age of patients at the time of their lumbar fusion was 40.0 years ($SD = 10.7$). Ethnicity data revealed that patients were 94.9% White, 4.7% Hispanic, and .4%

Table 1

Descriptive Statistics of Patient Characteristics

Patient characteristic *(N* = 245)	Frequency	Percentage	*M*	*SD*
Gender				
Male	200	81.6		
Female	45	18.4		
Age (years)			40.0	10.7
Ethnicity				
White	223	94.9		
Hispanic	11	4.7		
Other	1	.4		
Education				
<12 years	48	21.7		
HS degree/GED	123	55.7		
Trade school	37	16.7		
College degree	13	5.9		
Average weekly income ($)			632	367
Body mass index			28.6	5.3
Smoking at time of fusion				
No	149	60.8		
Yes	83	33.9		
History of depression				
No	146	59.6		
Yes	99	40.4		
History of psychological Tx				
No	168	68.6		
Psychotherapy	6	2.4		
Medication	56	22.9		
Both	15	6.1		
Case manager assigned				
No	112	45.7		
Yes	133	54.3		
Vocational rehabilitation				
No	85	34.7		
Yes	160	65.3		
Litigation involvement				
No	170	69.4		
Yes	75	30.6		
Total WCF costs incurred ($)			155,697	143,859
Prior WCF claims				
None	97	39.6		
One or more	148	60.4		

other, with ethnicity data unavailable for 10 patients. Educational history showed 21.7% of patients did not receive a high school degree or GED, 55.7% received a high school degree or GED, 16.7% completed trade/vocational school, and 5.9% received a college degree. The average weekly income of patients at the time of their injury was $632 (*SD* = 367). The average body mass index (BMI) was 28.58, which is within the overweight BMI category (25.0 - 29.9; National Institutes of Health, 1998), and consistent with national norms that show 65.1% of U.S. adults have a BMI greater than 25 (Hedley et al., 2004). Approximately 33.9% of the patient sample smoked tobacco at the time of their lumbar fusion. Medical charts indicated that 40.4% of patients had a history of depression. The data showed that 54.3% of patients were assigned a compensation claim case manager and 65.3% were assigned vocational rehabilitation, with 30.6% of patient cases involving litigation. The total average compensation and medical costs was $155,697 (*SD* = 143,859); with 60.4% of patients filing one or more prior workers compensation claims for various injuries, including both spinal and nonspinal related injuries. Due to insufficient information available in the medical charts, patients' BMI, ethnicity, education level, and smoking status were not reported as frequently as other variables. Due to missing data, subsequent analyses with these variables were limited.

Table 2 includes descriptive statistics for specific procedural and diagnostic variables: average time delay from the date of injury to the patients' lumbar fusion, type of fusion procedure, type of instrumentation, number of levels fused, degree of pain prior to surgery, and number of prior back operations. The average time between patient injury and lumbar fusion was 32.7 months (*SD* = 51.1). The type of fusion procedure performed

Table 2

Descriptive Statistics of Patient Diagnosis and Surgical Variables

Variable	Frequency	%	*M*	*SD*
Time between injury and fusion (months)			32.7	51.1
Type of fusion procedure				
Posterior lumbar interbody	188	76.7		
Anterior lumbar interbody	26	10.6		
Posterior/anterior interbody	20	12.2		
Type of instrumentation				
None	3	1.2		
Pedicle screws	107	43.7		
Fusion cages	29	11.8		
Cages plus screws	106	43.3		
Number of levels fused				
One	146	59.6		
Two	92	37.6		
Three or more	7	2.9		
Degree of pain prior to surgery				
Mild	4	1.7		
Moderate	138	59.0		
Severe	92	39.3		
Number of prior back surgeries				
None	133	54.3		
One	82	33.5		
Two	24	9.8		
Three or more	6	2.4		

for injured workers was posterior lumbar interbody fusion (76.7%), anterior lumbar interbody fusion (10.6%), and 360-degree posterior/anterior interbody fusion (12.2%). Surgical reports indicated 59.6% of patients had one vertebral level fused, 37.6% had two vertebral levels fused, and 2.9% had three or more vertebral levels fused. At the time of surgery, 4.0% of patients reported mild pain, 59.0% reported moderate pain, and 39.3% reported severe pain. According to patient medical charts, 45.7% of patients had one or more back surgeries prior to the fusion.

Response Rates and Bias Checks

As previously discussed, the medical chart review (Phase 1) included a total sample size of 245 injured workers who underwent their first lumbar fusion surgery. Of the 245 patients, a total of 110 were contacted by telephone and agreed to participate in the telephone interview portion of the study (Phase 2), yielding an overall response rate of 45%. The author and one other graduate student conducted all 110 of the interviews. To evaluate differential bias between patients who completed the outcome survey (responders) and patients lost to follow-up (nonresponders), specific sociodemographic and medical characteristics were compared using univariate *t* tests and chi-squared tests (see Table 3). Analyses revealed alpha values between .00 and .95 with effect sizes ranging from -.19 to .48. Both age and BMI showed statistically significant differences between responders and nonresponders; with moderate Cohen's *d* effect size values of .48 and .39, respectively. Further, while the data showed that vocational rehabilitation and a history of prior back surgeries were statistically significantly different between responders and nonresponders, Phi and Cramer's V effect sizes of -.19 and .23 indicating only weak associations. There were no statistically significant differences between responders and nonresponders for months between date of the fusion surgery and initial date of attempted contact during Phase 2. While there were some statistically significant differences for a small number of patient variables (i.e., age, BMI, and vocational rehabilitation), it was determined that controlling for these differences would not change significant findings for the sample. In general, responders and nonresponders are still considered statistically equivalent on a number of important patient characteristics. Thus,

Table 3

Comparisons of Select Patient Variables for Patient Follow-up Versus Patients Lost to Follow-Up

Patient variables	Means or proportion (%) Responders (n = 110)	Nonesponders (n = 135)	t or chi-square p value	Effect size Cohen's d[a], Phi[b] or Cramer's V[c]
Age	42.75	37.75	.001	.48
Smoking at time of fusion	30.7	39.7	.16	-.09
Body mass index	29.66	27.60	.01	.39
History of depression	36.4	43.7	.24	-.07
Case manager assigned	50.0	57.8	.22	-.08
Vocational rehabilitation	55.5	73.3	.001	-.19
Litigation involvement	26.4	34.1	.19	-.08
Type of instrumentation			.20	.14
None	.9	1.5		
Pedicle screws	48.2	40.0		
Fusion cages	7.3	15.6		
Cages plus screws	43.6	43.0		
Number of levels fused			.64	.06
One	59.1	60.0		
Two	39.1	36.3		
Three or more	1.8	3.7		
Prior back surgery			.01	.23
None	45.5	61.5		
One	35.5	31.9		
Two	13.6	6.7		
Three or more	5.5	0.0		
Prior wcf claims			.70	-.02
None	40.9	38.5		
One or more	59.1	61.5		
Degree of pain prior to surgery			.95	.02
Mild	1.9	1.6		
Moderate	57.9	59.8		
Severe	40.2	38.6		
Months between surgery and follow-up attempt	78.69	76.69	.58	.07

[a] Cohen's d is defined as the difference between two means divided by a standard deviation for the data.
[b] Phi is defined as the square root of the chi-square statistic divided by the sample size.
[c] Cramer's V is the effect size for a greater than 2 x 2 contingency table.

it can be assumed that the following data is generalizeable to other similar workers compensation populations. To address research question 2, intercorrelations among a set of patient variables were calculated and are presented in a correlation matrix (see Table 4). The 13 variables in the matrix are part of the original set of predictors that were considered for regression analyses and include age at time of fusion, education level, body mass index, smoking at time of fusion, history of depression, history of psychological treatment, case manager, vocational rehabilitation, litigation involvement, perceived pain prior to surgery, prior back operations, and prior WCF claims.

Results revealed correlation coefficients that ranged between -.26 to .66 and 15 were statistically significant at or below an alpha level of .05. The BMI of patients at the time of surgery was positively correlated with patient's age ($r = .18$, $p < .05$) and education level ($r = .16$, $p < .05$). Smoking was negatively correlated with educational level ($r = .24$, $p < .01$) and positively correlated with BMI; thus, indicating that patients who smoked at the time of surgery were more likely to have a higher BMI and less education. History of depression was positively correlated with a history of psychological treatment ($r = .66$, $p < .01$). Patients with a case a manager assigned were more likely to be older ($r = .14$, $p < .05$) and smoke ($r = 14$, $p < .05$). Vocational rehabilitation involvement was negatively correlated with education level and positively correlated with smoking ($r = .19$, $p < .01$) and being assigned a case manager ($r = .35$, $p < .01$). Litigation involvement was positively correlated with a history of depression ($r = .26$, $p < .01$) and psychological treatment ($r = .18$, $p < .01$). The number of prior back surgeries was negatively correlated to age ($r = .15$, $p < .05$), while the number of workers compensation

Table 4

Correlations Between Patient and Procedural Variables

	Variable											
Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Age at time of fusion	---											
2. Education level	.125	---										
3. Body mass index	.178*	.160*	---									
4. Smoking at time of fusion	-.038	-.235**	.215**	---								
5. History of depression	-.063	-.073	.086	.001	---							
6. History of psychological Tx	-.063	.014	.067	-.022	.661**	---						
7. Case manager assigned	.138*	.004	.105	.142*	.121	.074	---					
8. Vocational rehabilitation	.072	-.145*	.020	.195**	.076	.087	.347**	---				
9. Litigation involvement	.058	-.098	.003	.112	.265**	.180**	-.013	.075	---			
10. Perceived pain prior to surgery	.017	-.090	.019	.119	.005	.028	.108	.025	.062	---		
11. Number of prior back operations	-.151*	.127	-.019	-.016	.002	.086	-.068	-.108	.054	-.043	---	
12. Number of WCF claims	-.015	.118	.004	.078	.054	.063	.128*	.199**	-.042	-.013	-.026	---
13. Type of instrumentation	-.112	-.126	-.020	.109	.077	.103	-.079	-.022	-.063	.045	-.021	---

$N = 245$.

* $p \leq .05$.

** $p \leq .01$.

claims was positively correlated with case manager assignment ($r = .13$, $p < .05$) and vocational rehabilitation ($r = .20$, $p < .01$). With the exception of the strong relationship between a history of depression and psychological treatment, the magnitude of these intercorrelations were fairly modest which likely minimizes problems due to multicollinearity.

Patient Outcomes

To achieve the second objective of this study, lumbar fusion patient outcomes were calculated and presented in the following sequence: (a) fusion rate, disability status and functional impairment; (b) patient satisfaction and quality of life; (c) categorization of outcome; (d) subjective pain levels; (e) general physical and mental health functioning. The results of these analyses addressed research questions 3 through 9, with specific questions highlighted in the appropriate sections.

Fusion Rates, Disability Status, and Functional Impairment

Table 5 includes the current study's fusion rates, work-disability status, and back-specific functional impairment following lumbar fusion and compares these rates to a prior fusion study with Utah workers compensation patients (DeBerard et al., 2001).

Injured workers were considered disabled only if their back condition related to the lumbar fusion procedure was the primary cause of inability to work. To address research question 3, at the time of follow-up, injured workers reported solid fusion rates of 89%, compared to 71.9% in the prior study. Research questions 4 and 5 were

Table 5

Fusion Status, Disability Status and Roland-Morris Disability Questionnaire Outcomes and Comparisons with Prior Study

	Current fusion study		Prior fusion study[a]	
Outcome	Frequency	Percentage	Frequency	Percentage
Fusion status[b]				
No	12	11.0	41	28.1
Yes	97	89.0	103	71.9
Total disability[c]				
No	75	70.8	110	76.4
Yes	31	29.2	34	23.4
RDQ—poor outcome[def]				
No	45	42.9	73	50.4
Yes	60	57.1	71	49.6

[a]DeBerard et al. (2001).
[b]Based on follow-up *n* of 109 patients.
[c]Based on follow-up *n* of 106 patients.
[d]Based on follow-up *n* of 105 patients.
[e] Poor outcome is defined as a score of 14 or greater.
[f] Overall *M*(*SD*) for patients = 13.10 (*7.56*).

addressed by calculating rates of patient work-disability and back-specific functional impairment. A total of 28.7% of survey respondents indicated that they were totally disabled and unable to work as a consequence of their back condition and was considerable higher than the prior study's disability rate of 23.4%. To measures levels of back specific functional impairment in terms of good or poor outcomes, the Roland-Morris Disability Questionnaire (RDQ) was used, which recommends a cut-off score of 14 points or higher to indicate poor outcome (Roland & Morris, 1983a, 1983b). The current study yielded an average RDQ score of 13.1 (7.6), which lies slightly below the cut-off for poor outcomes. However, 57.1% of responders met criteria for poor outcome, which reveals an increase in severe functional impairment since the prior study (49.6%).

Descriptive Statistics for Patient Satisfaction and Quality of Life

To address research question 6, Table 6 presents descriptive analyses for five patient satisfaction/quality of life variables that were reported during the telephone outcomes survey including expected pain reduction after the procedure, expected current

Table 6

Patient Satisfaction and Quality of Life Related to Fusion Outcomes

Outcome category	Frequency	Percentage
Back/leg pain after fusion[a]		
Worse than expected	43	41.0
No worse or better	24	22.9
Better than expected	38	36.2
Back pain now[a]		
Much better	21	20.0
Somewhat better	17	16.2
What I expected	12	11.4
Somewhat worse	25	22.9
Much worse	29	28.6
No expectation	1	1.0
Quality of life[b]		
Great improvement	24	23.1
Moderate improvement	27	26.0
Little improvement	10	9.6
No change	5	4.8
A little worse	7	6.7
Moderately worse	9	8.7
Much worse	22	21.2
Satisfaction with back condition[c]		
Extremely dissatisfied	17	16.0
Very dissatisfied	17	16.0
Somewhat dissatisfied	15	14.2
Neutral	15	14.2
Somewhat satisfied	22	20.8
Very satisfied	13	12.3
Extremely satisfied	7	6.6
Have fusion again?[c]		
No	32	30.2
Yes	74	69.8

[a] Based on follow-up *n* of 105 patients.
[b] Based on follow-up *n* of 104 patients.
[c] Based on follow-up *n* of 106 patients.

pain level, improved quality of life, satisfaction with back condition, and whether they would repeat the fusion. In relation to pain outcome expectations after the fusion, the first satisfaction item asked patients if their pain following fusion was "worse than expected," "no worse or better than expected," or "better than expected," which generated rates of 41.0%, 22.9%, and 36.2%. In relation to *current* pain outcome expectations, the second satisfaction item asked patients to rate on a 6-point scale whether their "back pain was better or worse than expected at this point." As determined by this item, 36.2% of patient felt their current back pain was somewhat or much better than they expected, while 51.0% indicated their current back pain was somewhat or much worse than they expected. The third satisfaction item asked patients if their quality of life was better or worse as a result of their fusion. Fifty-nine percent of respondents indicating their quality of life improved after surgery, while the remaining individuals reported either no change (4.8%) or worse quality of life (36.6%). The fourth satisfaction item refers to patients' overall satisfaction with their back condition as it is right now. Approximately 46.2% of patients felt either somewhat, very, or extremely satisfied, 39.7% felt either somewhat, very, or extremely dissatisfied, and 14.2% felt neither satisfied nor dissatisfied. The fifth satisfaction item asked patients if they would, retrospectively, have the lumbar fusion procedure again. About one third (30.2%) of the patient sample felt that they would not choose to have the fusion surgery again if they could go back in time.

Outcome Categorization

To address research question 7, the Stauffer-Coventry Index (SCI; Stauffer & Coventry, 1972) self-report instrument was used to gain information about patient

outcomes along four subscales, namely, pain relief, return to work, physical activity, and analgesic utilization. Table 7 characterizes the rates of good, fair, and poor outcomes from the lumbar fusion surgery. At follow-up, 32.4% of patients reported a poor level of pain relief since their fusion, 34.3 % reported fair pain relief since their fusion, and 33.3% reported good pain relief. In relation to employment following their most recent fusion, 44.4% returned to their previous job or work status, 26.9% returned to lighter work, and 28.7% were unable to return to work. Patients differed in terms of restrictions on their physical activities following their fusion, with 17.0% reporting minimal restrictions, 46.2% reporting moderate restrictions and 36.8% reporting severe restrictions. With regards to medication use, 49.5% reported occasional or regular use of narcotic analgesics, 14.6% reported regular use of nonnarcotic analgesics, and 35.9% reported occasional or no use of mild analgesics.

Pain Rating and Subjective Pain Response

With regards to research questions 8, Table 8 identifies two common instruments for measuring pain intensity and levels of improvement. The first pain measure is the Global Perceived Effect (GPE) scale, which asks patients to rate their pain as follows: "Compared to when this episode first started, how would you describe your back or neck pain these days?" According to this scale, 13% of patients experienced "complete pain relief," 48.1% of patients reported "more than 50% pain relief," 15.7% of patients reported "no change in pain level," and 19.4% of patients had "an increase in pain."

A second common subjective pain measure used in the study, the Verbal Numeric Rating Scale (VNRS), asks patients to rate their current pain level on a scale from 0 to

Table 7

The Stauffer-Coventry Index Outcomes

	Pain relief[a]			Employment status[a]			Physical limitations[b]			Medication usage[c]		
Category	Rating	Freq.	%	Rating	Freq.	%	Rating	Freq.	%	Rating	Freq.	%
Good	76-100% improvement	36	33.3	Return to previous work status	48	44.4	Minimal or no restrictions	18	17.0	Occasional or no use of mild analgesics	37	35.9
Fair	26-75% improvement	37	34.3	Return to lighter work	29	26.9	Moderate restrictions	49	46.2	Regular use of nonnarcotic analgesics	15	14.6
Poor	0-25% improvement	35	32.4	No return to work	31	28.7	Severe restrictions	39	36.8	Occasional or regular use of narcotic analgesics	51	49.5

[a]Based on follow-up *n* of 108 patients.
[b]Based on follow-up *n* of 106 patients.
[c]Based on follow-up *n* of 103 patients.

Table 8

Global Perceived Effect and Verbal Numeric Rating Scale

Outcome measure	Frequency	Percentage
Global perceived effect[a]		
Complete relief of pain	15	14.2
More than 50% pain relief	52	49.1
No change in the level of pain	18	17.0
The pain has increased	21	19.8
Verbal Numeric Rating Scale (VNRS)[b]		
Mild pain (0-3.5)	42	39.0
Moderate pain (4-7.5)	44	41.9
Severe pain (8-10)	19	19.0

[a] Survey item: "Compared to when this episode first started, how would you describe your back/ pain these days?"; *n* of 106 at follow-up.

[b] Self-report pain rating on a 0-10 scale for *n* of 105 patients at follow-up.

10, where 10 represents the most severe pain. At the time of the survey, 19.0% of patients rated their pain in the 8 to 10 (severe) range, 41.9% rated their pain in the 4 to 7.5 (moderate) range, and 39.0% rated their pain in the 0 to 3.5 (mild) range.

The Pain Catastrophizing Scale (PCAS), asked respondents to indicate on a scale of 0 (not at all) to 4 (always), the frequency they experienced each of 13 thoughts or feelings that could be experienced during a painful situation. The measure provides a total scale score and three subscale scores for Rumination, Magnification, and Helplessness; with higher scores reflecting higher pain catastrophizing. Table 9 summarizes the total and subscale mean scores and standard deviations for the fusion sample and compares these to norms from a pain clinic population. The average total PCAS score for the sample was 17.88 (SD = 13.76), which lies well below the average score typically reported in pain outpatient clinic patients 28.2 (SD = 12.3, d = -.79)

Table 9

Pain Catastrophizing Scale (PCAS) Scores and Comparisons

	Fusion patients		Pain clinic patients[a]		Effect size
Scale	*M*	*SD*	*M*	*SD*	Cohen's *d*
Total score	17.88	13.76	28.2	12.3	-.79
Rumination	7.01	5.20	10.1	4.3	-.65
Magnification	3.12	2.92	4.8	2.8	-.59
Helplessness	7.74	6.63	13.3	6.1	-.87

Note. Based on *n* of 102 at follow-up.

[a] Patients undergoing evaluation and treatment at a multidisciplinary pain clinic.

(Sullivan et al., 1995). Fusion patients also showed lower average scores for the rumination ($M = 7.01$, $SD = 5.20$), magnification ($M = 3.12$, $SD = 2.92$), and helplessness ($M = 7.74$, $SD = 6.63$) subscales when compared to pain clinic patients with moderate to large effect sizes of -.65, -.59, and -.87, respectively. These data indicate fusion patients showed considerably lower levels of pain catastrophization than what is commonly found in chronic pain patients.

General Physical and Mental Health Functioning

To address research question 9, Version 2.0 of the Short-Form Health Survey (SF-36v2; Ware et al., 2000) was used to reflect various aspects of health and mental health from the perspective of the patient. The SF-36v2 groups items into eight subscales [physical functioning (PF), role-physical functioning (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role-emotional functioning RE), and

mental health (MH)] that are then combined to form the physical and mental component summary scores (PCS and MCS). Normative data allows for interpretation of the SF-36v2 subscales and summary measure scores in our sample by comparing them with the distribution of scores for other individuals. Scores are understood as variation from expected or typical scores called norms. The scores of the current sample were compared to existing normative data drawn from the general U.S. adult population ($N = 6742$) and a sample of outpatient pain/sciatica patients ($N = 481$; Ware et al., 2000). Norm based scoring was used with the fusion sample, which has a general population mean of 50 and standard deviation of 10. Patient characteristics and response rates are summarized in Table 10. The data shows that the current fusion sample demonstrated considerably lower average subscale than the norms obtained from the general population ranging from small (-.33) to large (-1.14) effect sizes. The highest effect sizes were noted on scales associated with physical health, pain, and functional limitations associated with physical health. Fusion patients also scored consistently lower than the back pain/sciatica norm reference group with effect sizes between -.16 and -.81. Related trends were observed with the largest effect sizes observed for physical health related scales. These comparisons are also presented on a graph in Figure 4. Both scores for the PCS ($M = 37.4$, $SD = 11.9$) and MCS ($M = 45.9$, $SD = 13.9$) in the current fusion sample were lower than both normative populations. While the PCS scale revealed large effect sizes when compared to the general (-1.51) and back/sciatica pain population (-.72), the MCS revealed only modest effect sizes of -.33 and -.16. Overall these data suggest that injured workers who have undergone lumbar fusion, reported poorer physical health outcomes

Table 10

SF-36(v.2) Multidimensional Health Outcomes and Comparisons

	Fusion sample		General population[a]		General population effect Size[b]	Back pain/sciatica[c]		Back pain/sciatica effect size[b]
SF-36 subscale	*M*	*SD*	*M*	*SD*		*M*	*SD*	
Physical functioning	36.8	12.9	50.0	10.0	-1.14	46.6	11.3	-.81
Role functioning	37.7	14.2	50.0	10.0	-1.01	46.4	11.4	-.68
Bodily pain	38.9	11.5	50.0	10.0	-1.03	44.6	9.3	-.55
General health	43.9	10.9	50.0	10.0	-.58	46.5	10.6	-.24
Vitality	42.9	12.7	50.0	10.0	-.61	46.5	10.2	-.31
Social functioning	40.8	15.7	50.0	10.0	-.70	46.9	11.2	-.45
Role-emotional functioning	41.9	14.2	50.0	10.0	-.66	47.6	11.3	-.44
Mental health functioning	45.6	13.3	50.0	10.0	-.37	47.6	10.9	-.16
Physical component summary	37.4	11.9	50.0	10.0	-1.15	45.6	10.8	-.72
Mental component summary	45.9	13.9	50.0	10.0	-.33	47.9	11.0	-.16

Note. Scores range from 0-100. A high score indicates better health status. Based on *n* of 105 at follow-up.

[a] General U.S. adult population; $N = 6742$ (Ware et al., 2000).

[b] Effect size represents Cohen's *d*.

[c] Norms for sample comorbid condition: back pain/sciatica (in last 6 months) with hypertension; $N = 481$.

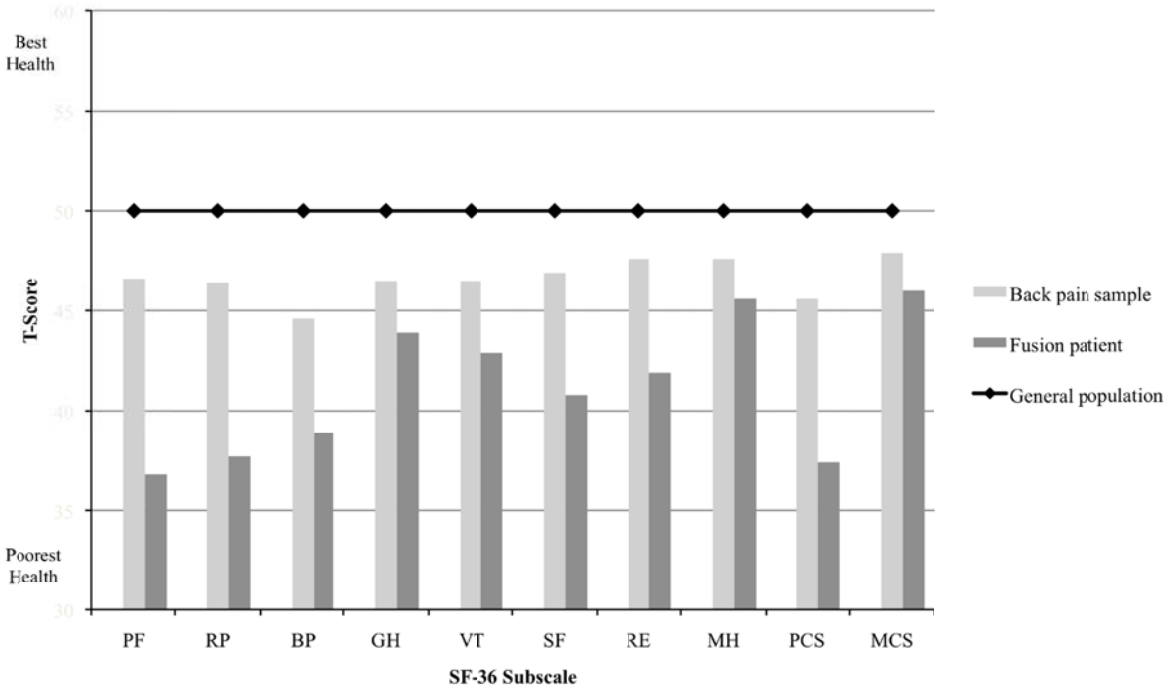

Figure 4. Short Form-36 subscale and summary scores for fusion patients, back pain/sciatica sample, and general population.

than expected for both the general public and typical pain patients. These comparisons are also presented on a graph in Figure 4.

Intercorrelations of Outcome

To address research question 10, interrelationships among outcome variables were examined by calculating Pearson r correlation coefficients for 15 different indices. Table 11 shows the correlation matrix for the following outcome variables: quality of life and satisfaction with outcome (index 1-4), Stauffer-Coventry Index (index 5-8), total disability status (index 9), RDQ total score (index 10), Global Perceived Effect (index

Table 11

Correlations Between Outcome Variables

	Variable														
Variable	1[a]	2	3	4[a]	5[a]	6[a]	7[a]	8[a]	9[a]	10[a]	11[a]	12[a]	13	14	15
1[a]	---														
2	.51**	---													
3	.52**	.39**	---												
4[a]	.62**	.32**	.68**	---											
5[a]	.62**	.43**	.47**	.62**	---										
6[a]	.35**	.18	.29**	.30**	.34**	---									
7[a]	.56**	.25**	.48**	.48**	.59**	.46**	---								
8[a]	.37**	.23*	.31**	.28**	.54**	.26**	.34**	---							
9[a]	.45**	.18	.38**	.37**	.49**	.53**	.49**	.46**	---						
10[a]	.64**	.36**	.60**	.69**	.68**	.47**	.75**	.45**	.54**	---					
11[a]	.60**	.39**	.64**	.69**	.65**	.34**	.56**	.38**	.47**	.64**	---				
12[a]	.62**	.31**	.53**	.61**	.57**	.42**	.59**	.33**	.51**	.67**	.58**	---			
13	.52**	.32**	.51**	.56**	.64**	.60**	.71**	.47**	.61**	.84**	.60**	.63**	---		
14	.54**	.35**	.36**	.34**	.29**	.16	.40**	.28**	.29**	.51**	.32**	.43**	.33**	---	
15	.20*	.29**	.12	.18	.26**	.14	.19*	.06	.10	.25*	.22*	.23*	.28**	.19	---

Note. 1=quality of life change[a]; 2=retrospectively, would repeat fusion (no=1: yes=2); 3=satisfaction with current back condition; 4=back/leg pain change[a]; 5=SCI: pain relief (%)[a]; 6=SCI: employment status[a]; 7=SCI: physical limitations; 8=SCI: medication usage[a]; 9=disability status (no=1; yes=2)[a]; 10=RDQ total score[a]; 11=Global Perceived Effect[a]; 12= VNRS[a]; 13= SF-36: Physical Component Summary; 14= SF-36: Mental Component Summary; 15=Fusion Status.

[a] Reverse coded so higher scores reflect better functioning/outcome.

* $p \leq .05$, ** $p \leq .01$, N=110.

11), Verbal Numeric Rating Scale (index 12), and the Short Form Health Survey (MCS and PCS) (index 13-14), and fusion status (index 15). In order to allow for transparent understanding of the interrelationships, 10 of the outcome indices were reverse coded to reflect higher reflect better functioning/outcome. The analysis yielded 96/105 significant correlations coefficients that ranged between .06 and .85. Moderate to large intercorrelations were observed within various categories of outcome measures. For instance, intercorrelations were between .34 and .59 for items on the SCI and between .32 and .68 on patient satisfaction/quality of life variables. The intercorrelation was moderate (r = .33) between MCS and PCS scores. The intercorrelation between GPE and VRNS was significant (r = 60), and both GPE and VRNS were significantly correlated with all other outcome variables with coefficients between .31 and .69. Similarly, disability status was significantly correlated with physical status and functional limitation measures, though it was not linked to patient satisfaction items. The RDQ total score had the strongest intercorrelations that ranged from .25 (SCI: pain relief) to .84 (SF-36: PCS). Fusion status demonstrated the weakest intercorrelations yielding only mild to no statistically significant relationships with outcome measures. As a whole, the correlation matrix indicates consistent overlap among outcome variables in a direction that would be expected. However, the extent of these relationships does not denote excessive overlap to warrant a combination of any of the outcome variables.

Correlations Between Patient Characteristics and Outcomes

To address the third and final objective of the current study, intercorrelations

between patient presurgical variables and outcomes were examined (research question 11) in order to test predictive efficacy of a presurgical multiple variable model of lumbar fusion outcomes. Tables 12 and 13 display statistically significant relationships between patient demographic factors and functional outcomes after surgery. Involvement of a nurse case management and assignment to vocational rehabilitation were significantly related to worse outcomes in terms of pain relief, return to work, physical restrictions, disability status, functional severity (RDQ score), SF-36 PCS scales and several SF-36 subscales. Litigation involvement was significantly related to return to work, disability status, functional severity, both SF-36 MCS and SF-36 PCS scales, and several SF-36 subscales. Patients with a history of depression showed a significant relationship with higher disability status, lower SF-36 MCS and SF-36 subscales scores. There were no significant relationships between prior back surgeries, pain severity at time of fusion, levels fused, and type of instrumentation with any of the outcome variables. Finally, the time between surgery and follow-up showed no significant relationships with any of the outcome variables; therefore, this variable was not included as a covariate in any of the subsequent multivariate analyses. Based on the Pearson correlations, depression history, nurse case management, vocational rehabilitation, and litigation involvement, are the predictors that consistently account for variation in outcomes.

Multivariate Prediction of Outcomes

The following section addresses research question 12 by testing the predictive efficacy of a presurgical multiple variable model for lumbar fusion outcomes. Due to the

Table 12

Correlations of Prefusion Variables with Selected Outcome Variables

	Outcome variables[a]					
Patient variable	SCI: Pain relief	SCI: Return to work status	SCI: Physical restrictions	SCI: Pain medications	RDQ total score	Disability status
Age at time of fusion	.03	.24*	.06	.07	.01	.14
Education level	-.15	-.29**	-.09	-.27*	-.10	-.22*
Body mass index	.07	-.01	.17	-.03	.16	.08
Smoking at time of fusion	.24*	.09	.27**	.08	.29**	.25*
History of depression	.06	.12	.09	.17	.15	.21*
Case manager assigned	.24*	.23*	.26**	.13	.30**	.28**
Vocational rehabilitation	.20*	.36**	.31**	.13	.37**	.24*
Litigation involvement	.16	.24*	.17	.03	.27**	.27**
Pain prior to surgery	.13	.12	.15	.06	.14	.23*
Prior back operations	-.09	.03	.04	-.02	-.03	-.08
Levels fused	.05	.00	.12	.05	.06	.06
Type of instrumentation[b]	.17	-.04	-.12	-.07	-.02	.01
Time between surgery and follow-up	.06	.12	.03	-.01	.04	.08

[a]Higher scores equate to worse outcomes/functioning.

[b]Higher indicates more advanced instrumentation and higher cost.

* $p \leq .05$.

** $p \leq .01$.

$N = 110$.

Table 13

Correlations of Prefusion Variables with Short-Form 36 Subscales and Composite Scales

	SF-36 subscale[a]									
Patient variable	Physical functioning	Role-physical	Bodily pain	General health	Vitality	Social functioning	Role-emotional	Mental health	Physical component summary	Mental component summary
Age at time of fusion	-.13	-.08	-.05	-.08	.05	.12	.01	.10	-.15	.14
Education level	.23*	.19	.15	.08	.06	.13	.18	.09	.18	.09
Body mass index	-.19	-.16	-.15	-.13	-.19	-.14	-.24*	-.15	-.14	-.19
Smoking at time of fusion	-.32**	-.12	-.26*	-.22*	-.19	-.10	-.03	-.06	-.31**	-.01
History of depression	-.22*	-.19*	-.11	-.20*	-.22*	-.26**	-.22*	-.28**	-.14	-.28**
Case manager assigned	-.28**	-.28**	-.40**	-.26**	-.27**	-.13	-.22*	-.20*	-.33**	-.16
Vocational rehabilitation	-.36**	-.34**	-.38**	-.19	-.24*	-.16	-.34**	-.16	-.36**	-.17
Litigation involvement	-.33**	-.21*	-.22*	-.29**	-.24*	-.26**	-.31**	-.18	-.26**	-.23*
Pain prior to surgery	-.13	.01	-.10	-.06	-.09	.05	.08	.05	-.14	.09
Prior back operations	-.09	.08	.00	-.06	-.04	-.06	.01	-.05	-.01	-.04
Levels fused	-.11	-.09	-.08	-.04	-.01	.00	-.06	-.05	-.09	-.01
Type of instrumentation[b]	.01	.04	-.02	.07	-.02	.04	.05	.01	.02	.03
Time betweens surgery and follow-up	-.06	-.15	-.11	-.14	-.10	-.10	-.11	-.14	-.10	-.13

[a]Higher scores equate to better outcomes/functioning.

[b]Higher indicates more advanced instrumentation and higher cost.

*$p \leq .05$.

**$p \leq .01$.

nature of this study, it was necessary to identify one multivariate predictive model to use for all logistic and multiple regression analyses. It was important that this model included a limited number of presurgical variables with the strongest evidence of predictability based on previous research. Because fewer participants were recruited for telephone interviews, we decreased the number of predictors used in the multiple regression analyses to eight patient variables. This number was based on the conventional standard of approximately one predictor per 10-15 observations (Stevens, 2009).

Several important factors were considered when determining the inclusion of specific independent variables in the model. First, final predictors were included only if there was a theoretical rational based on research with similar worker's compensation populations and suggestions from the lumbar fusion outcome and low back pain literature. Thus, it was essential that the final eight-variable model include demographic, occupational, health, psychological, and surgical variables representative of the biopsychosocial perspective. Second, issues of multicollinearity were addressed by dropping one of two variables that were highly correlated. In this case, psychological treatment was dropped from consideration due to a high positive correlation with depression. Based on these factors, the final eight-variable model included the following predictors: age at time of fusion, smoking at time of fusion, history of depression, case manager assigned, vocational rehabilitation, litigation involvement, number of vertebral levels fused, and instrumentation use.

Multivariate Prediction of Disability Status

Using the eight-variable model, the first regression analysis involved predicting

disability status. Because disability status was reported as a dichotomous variable (yes/no), logistic regression analysis was most appropriate to determine the importance of predictor variables in the model. Alternate analysis, such as a multiple linear regression, is only suitable if the outcome variable is continuous and assumptions about linearity are met. Logistic regression is used when the dependent variable has a binomial distribution of scores and does not assume a linear relationship between the independent and dependent variables.

The logistic regression indicated that the model fit significantly improved (chi-square = 22.79, $p \leq .001$) with the addition of the eight predictor variables. As shown in Table 14, the classification table counts the correct and incorrect estimates for the model. The columns depict the two predicted values of the dependent variable, and the rows are the two observed values of the dependent variable. Here, the model predicts 41.9% of disabled cases and 93.3% of nondisabled cases, yielding an overall rate of 78.3% that were correctly predicted. Table 15 lists the unstandardized regression coefficient (β), the Wald statistic and its significance (p), the odds ratio (Exp β), and the confidence limits on the odds ratio. The Wald statistic is the squared ratio of the unstandardized logistic coefficient and its standard error. The odds ratio is the predicted change in odds for 1 unit increase in the corresponding independent variable. In this case, odds ratios greater than 1 corresponds with an increase in likelihood of patient disability, while odds ratios less than 1 correspond with a decrease in the likelihood. Consequently, odds ratios close or equal to 1 indicate that changes in the independent variable do not increase or decrease the likelihood of disability status. As observed in Table 15, case management and litigation

Table 14

Logistic Regression Model: Disability Classification

	Predicted		
Observed	Not disabled	Disabled	% correct
Not disabled	70	5	93.3
Disabled	18	13	41.9
Overall correctly predicted			78.3

Table 15

Logistic Regression Equation Predicting Disability Status with Eight Prefusion Variables as Predictors[a]

Variable	β	Wald	*P*	Exp (B)	95% CI
Age at time of fusion	.01	.31	.58	1.01	.97 - 1.06
History of depression	.80	2.31	.13	2.22	.80 – 6.17
Case manager assigned	1.21	5.06	.02	3.35	1.17 – 9.61
Vocational rehabilitation	.65	1.40	.24	1.92	.65 – 5.62
Litigation involvement	1.04	3.51	.05	2.83	.96 – 8.33
Prior back operations	-.16	.26	.61	.85	.45 – 1.60
Levels fused	.13	.09	.77	1.14	.48 – 2.70
Type of instrumentation	.14	.32	.57	1.15	.70 – 1.89
Constant	-7.34	11.61	.001	.001	

[a] Omnibus chi-square = 22.94, $df = 8$, $p = .003$.

involvement were both significant predictors of disability status indicating odds ratios of 3.35 and 2.83, respectively. In brief, patients with case managers assigned to their compensation claim were approximately 3.3 times more likely to be disabled than those without case managers, while patient's claims involving litigation were 2.8 times more

likely to be disabled then those not involving litigation. While the other variables contributed to some of the predictive efficacy of the model, the contribution was minimal.

Multivariate Prediction of Back-Related Functional Impairment

The second regression analysis investigated the predictability of the eight-variable model on back-related functional impairment as measured by the RDQ at the time of follow-up. Because the RDQ total score was a continuous variable and assumptions regarding linearity were met, simultaneous-entry multiple linear regression analysis was considered the most fitting analysis. Results yielded a statistically significant model with an R^2 of .24 (see Table 16). This suggests that 24% of the total variance of the RDQ total score was accounted for by the set of predictors. The unstandardized beta weights

Table 16

Simultaneous-Entry Multiple Regression Model Predicting the RDQ Total Score[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	-0.07	0.06	-0.10	0.30
History of depression	1.10	1.49	0.07	0.46
Case manager assigned	3.21	1.46	0.21	0.03
Vocational rehabilitation	4.18	1.47	0.28	0.01
Litigation involvement	3.72	1.65	0.22	0.03
Prior back operations	-0.28	0.82	-0.03	0.73
Levels fused	0.39	1.27	0.03	0.76
Type of instrumentation	0.17	0.70	0.02	0.81
Constant	-2.34	5.18		.65

[a] Model summary: $p \leq .001$, $R = .49$, $R^2 = .24$, adjusted $R^2 = .18$

represent the difference in RDQ scores per unit difference in the predictor. However, because it is not possible to compare unstandardized beta weights of the predictor variables directly, interpreting the standardized beta weights helps address the contribution of respective predictor variables if the model were fit to standardized data. Standardized beta weights revealed that case management (β = .21), vocational rehabilitation (β = .28), and litigation involvement (β = .22) were significantly predictive of higher RDQ scores. These data suggest fusion patient claims involving a case manager, vocational rehabilitation, and litigation have considerable poorer outcomes; however, age, depression history, prior back surgeries, levels fused, and instrumentation type considered less important in predicting outcomes.

The subsequent analyses measured the predictability of the eight-variable model on multidimensional physical and mental health outcomes as measured by the SF-36 MCS and SF-36 PCS summary scores. As Table 17 indicates, the SF-36 PCS score was statistically significant yielding an R^2 of .24, indicating that 24% of the total variance of SF-36 PCS scores was accounted for by the eight-variable model. Standardized beta weights reflected that, case management (β = -.26), vocational rehabilitation (β = -.23), and litigation involvement (β = -.19) were significantly predictive of lower PCS scores, with lower scores reflecting poorer outcomes. Again, age, depression history, prior back surgeries, levels fused, and instrumentation type were all considered less important predictors of outcomes. The SF-36 MCS score was also statistically significant with an R^2 of .17, indicating that 17% of the total variance of the SF-36 MCS score was accounted for by the eight-variable model. As seen in Table 18, age and depression history at time

Table 17

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Physical Component Summary Score[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	-0.09	0.10	-0.09	0.37
History of depression	-1.54	2.33	-0.06	0.51
Case manager assigned	-6.07	2.29	-0.26	0.01
Vocational rehabilitation	-5.36	2.31	-0.23	0.02
Litigation involvement	-5.11	2.59	-0.19	0.05
Prior back operations	-0.86	1.28	-0.06	0.50
Levels fused	-1.26	1.98	-0.06	0.53
Type of instrumentation	-0.60	1.09	-0.05	0.59
Constant	71.5	8.11		.00

[a] Model summary: $p \leq .001$, $R = .49$, $R^2 = .24$., adjusted $R^2 = .18$

Table 18

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Mental Component Summary Score[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	.25	.12	.21	.04
History of depression	-6.54	2.84	-.23	.02
Case manager assigned	-3.69	2.79	-.13	.19
Vocational rehabilitation	-3.54	2.82	-.13	.21
Litigation involvement	-5.03	3.16	-.16	.11
Prior back operations	.40	1.56	.03	.80
Levels fused	.68	2.42	.03	.78
Type of instrumentation	.36	1.33	.03	.79
Constant	59.12	9.89		.00

[a] Model summary: $p = .016$, $R = .41$, $R^2 = .17$, adjusted $R^2 = 10$.

of fusion were both considered statistically significant with standardized beta weights of .21 and -.23. While the other variables within the model contributed to the models statically significance as a whole, when taken individually, these variables did not reach a statistically significant level. These data suggest that older patients who have no history of depression are more likely to have higher mental health functioning.

Based on the significant predictability of the eight-variable model for the SF-36 PCS and SF-36 MCS scores, it was necessary to gather more comprehensive data related to patient functioning. Thus, the following subsequent simultaneous-entry multiple linear regression analyses were performed for the eight SF-36 subscales. Tables 19 through 26 include all pertinent information with respect to these final analyses. This final step will conclude the results section of the current study.

Table 19

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Physical Functioning Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	-.09	.11	-.08	.39
History of depression	-3.20	2.47	-.12	.20
Case manager assigned	-5.22	2.43	-.20	.03
Vocational rehabilitation	-6.18	2.45	-.24	.01
Litigation involvement	-6.67	2.75	-.23	.02
Prior back operations	-1.89	1.36	-.13	.17
Levels fused	-1.61	2.11	-.07	.45
Type of instrumentation	-.72	1.16	-.06	.53
Constant	77.00	8.60		.00

[a] Model summary: $p \leq .001$, $R = .52$, $R^2 = .27$, adjusted $R^2 = .21$.

Table 20

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Role-Physical Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	.03	.12	.02	.81
History of depression	-4.28	2.86	-.15	.14
Case manager assigned	-5.07	2.81	-.18	.07
Vocational rehabilitation	-7.14	2.84	-.25	.01
Litigation involvement	-4.15	3.18	-.13	.19
Prior back operations	1.19	1.57	.07	.45
Levels fused	-1.15	2.44	-.04	.64
Type of instrumentation	.10	1.34	.01	.94
Constant	66.55	9.96		.00

[a] Model summary: $p = .005$, $R = 45.$, $R^2 = 20.$, adjusted $R^2 = 13$.

Table 21

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Bodily Pain Scale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	.03	.10	.03	.72
History of depression	-.80	2.22	-.03	.72
Case manager assigned	-7.46	2.18	-.33	.00
Vocational rehabilitation	-5.84	2.20	-.25	.01
Litigation involvement	-4.49	2.46	-.17	.07
Prior back operations	-.50	1.22	-.04	.69
Levels fused	-1.06	1.89	-.05	.58
Type of instrumentation	-1.01	1.04	-.09	.33
Constant	69.31	7.72		.00

[a] Model summary: $p \leq .001$, $R = .52$, $R^2 = .27$, adjusted $R^2 = .21$.

Table 22

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 General Health Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	-0.04	0.10	-0.04	0.70
History of depression	-2.66	2.23	-0.12	0.24
Case manager assigned	-5.34	2.19	-0.25	0.02
Vocational rehabilitation	-1.33	2.21	-0.06	0.55
Litigation involvement	-5.47	2.48	-0.22	0.03
Prior back operations	-0.97	1.23	-0.08	0.43
Levels fused	-0.09	1.90	0.00	0.96
Type of instrumentation	0.29	1.05	0.03	0.78
Constant	66.17	7.77		.00

[a] Model summary: $p = .016$, $R = .42$, $R^2 = .17$, adjusted $R^2 = .11$.

Table 23

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Vitality Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	.13	.11	.11	.26
History of depression	-4.29	2.59	-.16	.10
Case manager assigned	-6.09	2.55	-.24	.02
Vocational rehabilitation	-3.93	2.57	-.15	.13
Litigation involvement	-4.92	2.88	-.17	.09
Prior back operations	-.41	1.42	-.03	.77
Levels fused	.67	2.21	.03	.76
Type of instrumentation	-.71	1.22	-.06	.56
Constant	66.33	9.01		.00

[a] Model summary: $p = .009$, $R = .43$, $R^2 = .19$, adjusted $R^2 = .12$.

Table 24

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Social Functioning Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	.24	.14	.17	.09
History of depression	-6.59	3.25	-.20	.05
Case manager assigned	-3.55	3.19	-.11	.27
Vocational rehabilitation	-3.45	3.22	-.11	.29
Litigation involvement	-6.79	3.61	-.19	.06
Prior back operations	.01	1.79	.00	1.00
Levels fused	1.14	2.77	.04	.68
Type of instrumentation	.61	1.53	.04	.69
Constant	55.43	11.31		.00

[a] Model summary: $p = .03$, $R = .40$, $R^2 = .16$, adjusted $R^2 = .09$.

Table 25

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Role-Emotional Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	.14	.12	.11	.25
History of depression	-4.10	2.82	-.14	.15
Case manager assigned	-3.60	2.77	-.13	.20
Vocational rehabilitation	-7.55	2.79	-.27	.01
Litigation involvement	-7.54	3.13	-.24	.02
Prior back operations	.55	1.55	.03	.73
Levels fused	-.58	2.40	-.02	.81
Type of instrumentation	.31	1.32	.02	.82
Constant	67.69	9.80		.00

[a] Model summary: $p \leq .001$, $R = 48.$, $R^2 = .23$, adjusted $R^2 = .16$.

Table 26

Simultaneous Entry Multiple Regression Model Predicting the SF-36 Mental Health Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age at time of fusion	.17	.12	.15	.15
History of depression	-6.92	2.77	-.25	.01
Case manager assigned	-4.89	2.72	-.18	.08
Vocational rehabilitation	-2.67	2.74	-.10	.33
Litigation involvement	-2.76	3.07	-.09	.37
Prior back operations	-.20	1.52	-.01	.90
Levels fused	-.31	2.36	-.01	.90
Type of instrumentation	-.04	1.30	.00	.98
Constant	63.43	9.63		.00

[a] Model summary: $p = .03$, $R = .40$, $R^2 = .16$, adjusted $R^2 = .09$.

For the physical functioning (PF) subscale, the model was statistically significant with an R^2 of .27, demonstrating the eight-variable model accounted for 27% of the total variance of PF scores. Standardized beta weights reflected that, case management (β = -.20), vocational rehabilitation (β = -.24), and litigation involvement (β = -.23) were significantly predictive of lower PF scores. This indicates that claims involving a case manager, vocational rehabilitation, and litigation are more likely to reflect poorer physical health. Age, depression history, prior back surgeries, levels fused, and instrumentation type were all considered less important predictors of outcomes; however, these variables still contributed to the overall variance of the model.

For the role-physical (RP) subscale, the model was statistically significant with an R^2 of .20, indicating that the model accounted for 20% of the total variance of RP scores. The RP scale refers to patients' role limitations, such as work, parenting, or being active, due to physical problems. Standardized beta weights indicated that only case management (β = -.18), and vocational rehabilitation (β = -.25) were significantly predictive of lower RP scores, with depression history (β = -.15) and litigation involvement (β = -.13) next in line for highest predictability among variables.

The bodily pain (BP) subscale was also statistically significant with an R^2 of .27, indicating the eight-variable model accounted for 27% of the total variance of the BP score. Standardized beta weights reflected case management (β = -.33) had the highest significant predictability, with vocational rehabilitation (β = -.25), and litigation involvement (β = -.17) also showing significant predictability of lower BP scores. While the other variables within the model contributed to the models statistical significance as a whole, when taken individually, these variables did not reach a statistically significant level. These data suggest that patients reporting higher levels of bodily pain were more likely to have claims that involved litigation, case management, and vocational rehabilitation prior to their fusion procedure.

The general health (GH) subscale also showed a more modest statistically significant model (p = .016) with an R^2 of .17, demonstrating the eight-variable model accounted for 17% of the total variance of GH scores. Standardized beta weights reflected that, case management (β = -.25) and litigation involvement (β = -.22) were significantly predictive of lower GH scores. This indicates that claims involving a case

manager and litigation are more likely to reflect poorer general health. Age, depression history, vocational rehabilitation, prior back surgeries, levels fused, and instrumentation type were all considered less important predictors of outcomes; however, these variables still contributed to the overall variance of the model.

For the vitality (VT) subscale, the model was statistically significant with an R^2 of .19, which indicated the eight-variable model accounted for 19% of the total variance of VT scores.

Standardized beta weights showed case management (β = -.24) and litigation involvement (β = -.17) were significantly predictive of lower VT scores. The VT scale refers to the patient's presence of energy, and enthusiasm with the absence of fatigue and exhaustion. Thus, this analysis indicates that patients whose claim involved a case manager and litigation prior to their fusion are more likely to experience low energy and "aliveness." While the other variables in the model were not significant predictors, they still contributed to the overall variance of the model.

The social functioning (SF) subscale score was also statistically significant with an R^2 of .16, indicating that 16% of the total variance of the SF score was accounted for by the eight-variable model. While standardized beta weights indicated that a history of depression (β = -.20) was the only predictor variable in the model that reached statistically significance, both litigation involvement (β = -.19) and age (β = -.17) at the time of fusion approached significance. These data suggest that patients who had a history of depression prior to their fusion are more likely experience limitations in interpersonal behavior and prosocial activities.

For the role-emotional (RE) subscale results yielded a statistically significant model with an R^2 of .23 (see Table 16). The RE scale refers to patients' role limitations, such as work, parenting, or being active, due to emotional problems. This suggests that 23% of the total variance of the RE score was accounted for by the set of predictors. Standardized beta weights revealed vocational rehabilitation (β = .28) and litigation involvement (β = .22) were significantly predictive of lower RE scores. These data suggest that fusion patient claims involving vocational rehabilitation and litigation prior to fusion have considerable lower functioning due to emotional problems. Age, depression history, vocational rehabilitation, prior back surgeries, levels fused, and instrumentation type were considered less important in predicting outcomes.

Finally, the model for the mental health (MH) subscale score was also modestly statistically significant with an R^2 of .16, indicating that 16% of the total variance of the MH score was accounted for by the eight-variable model. However, history of depression was the only statistically significant predictor with a standardized beta weight of -.25; with case management approaching significance at -.18. While the other variables within the model contributed to the model's statistical significance as a whole, when taken individually, these variables did not reach a statistically significant level. These data suggest that patients who had a history of depression at the time of their fusion were more likely to have lower mental health functioning at the time of follow-up.

Summary of Outcome Prediction

In brief, all logistic (disability status) and multiple linear regression analyses

(RDQ scores, SF-36 PCS, SF-36MCS, and eight SF-36 subscales) demonstrated the eight variable multivariate predictive model was statistically significant. Involvement of a nurse case manager, vocational rehabilitation, and litigation at the time of fusion were the most prominent predictors across the various outcome measures. Age and depression history at the time of fusion were also predictive of some outcomes, but these were limited to outcome variables associated with mental health functioning. Interestingly, none of the diagnostic or surgical variables (prior back operations, levels fused, and type of instrumentation) were statistically significant predictors on their own in any of the regression analyses. Frequency of statistical significance across the different predictor for all analyses are as follows: age at the time of fusion (1/12), case manager (8/12), vocational rehabilitation (7/12), depression history (3/12), lawyer involvement (7/12), number of prior back (0/12), and number of levels fused, (0/12) and type of instrumentation (0/12.). Finally, the statistical significance between zero order correlations and outcomes is extremely similar to the significant variables among the multiple regression models.

CHAPTER V

DISCUSSION

The current study addressed the three following research objectives: (1) to examine patient presurgical variables and understand the interrelationships between such variables; (2) to characterize multiple patient outcomes associated with lumbar fusion in terms of quality of life, function, and health status variables, as well as fusion rates, patient satisfaction, and disability; and (3) to explore the relationship of presurgical variables to outcomes and test the predictive efficacy of a multiple variable predictive model. Each objective was successfully evaluated during the course of the medical chart review, follow-up telephone outcome survey, and examination of the data. As previously indicated, the methods for the current investigation were adapted from an earlier study on Utah workers' compensation patients who received fusion from 1990 to 1995 (DeBerard et al., 2001). Thus, the discussion will largely focus on comparisons to the prior Utah study, as well as, interpret empirical findings in accordance with the lumbar fusion outcome literature. Specific implications for our findings, as well as limitations associated with this study will be addressed.

Descriptive Characteristics of Patient and Procedural Variables

A major objective of this study was to focus on how presurgical patient and procedural variable are related to outcomes; thus, it was important to thoroughly describe several demographic, occupational, health, and surgical variables that are associated with lumbar fusion outcomes and back pain patients, in general. These data also serve as

quality comparisons to other studies evaluating outcomes in workers compensation patients who have undergone lumbar fusion as a result of a workplace injury.

Results for the current study indicated injured workers were predominately White males with an average age of 40 at the time of their lumbar fusion. These figures are consistent with prior studies on workers compensation fusion patients in Utah (DeBerard et al., 2001); Washington State (Maghout-Juratli et al., 2006), and Ohio (Nguyen et al., 2011); however, less comparable to fusion studies on general populations reporting more balanced gender and ethnicity ratios (Brox et al., 2003, 2006; Fritzell et al., 2001). Education level and weekly income were also similar to prior studies on compensated workers, which generally reflect lower education and income (DeBerard et al., 2001; Maghout-Juratli et al., 2006). For the current study, patient BMI and smoking rates at the time of surgery were moderately lower, while depression history were considerable higher when compared to rates of depression in prior studies on Utah workers (DeBerard et al., 2009; LaCaille et al., 2005). This may, in part, be due to the conservative approach those studies used when identifying positive cases of depression. The current study, focused on depression history as a predictor and did not require patients to have a diagnosis of depression at the time of surgery.

In terms of diagnostic and procedural variables, back related diagnoses for this study were very similar to other workers compensation fusion studies (see DeBerard et al., 2001, Maghout-Juratli et al., 2006, Ngyuen et al., 2011) with the most common diagnoses including degenerative disc disease (30%), disc herniation (40%), and radiculopathy (3%). Interestingly, it is well known in the literature that lumbar fusion is a

controversial operation for degenerative disc disease (Glassman et al., 2009). In fact, recent evidence suggests that fusion is no more effective than nonsurgical conservative approaches for return to work status of compensation workers with degenerative disc disease, radiculopathy, or disc herniation (Nguyen et al., 2011). Despite similarities in demographics and diagnosis, our study differed considerable from the prior Utah study (DeBerard et al., 2001) when it came to utilization of surgical devices. The current sample utilized fusion cages in 55% of cases compared to zero patients in the prior study. This is an important comparison, as the intention behind using more advanced surgical technology is to improve outcomes. While surgical instrumentation is shown to improve the rate of solid fusion, evidence suggests it does not improve disability rates when compared to fusion without instrumentation (DeFrances & Hall, 2007; Deyo & Mirza, 2006), and multidimensional outcome data regarding the benefit of these devices remains unclear (Maghout-Juratli et al., 2006). Such finding will be highlighted in the following portion of the discussion related to patient outcomes

Multidimensional Outcomes of Fusion

Based on the medical chart review, 245 injured workers met the criteria to participate in the telephone outcome survey; however, only 110 patients were available via phone for the follow-up phase of the study; yielding a follow-up rate of only 46%. Follow-up data and information gathered in patient medical charts indicated 89% of patients established a solid fusion after at least two years postsurgical follow-up. This number is considerably higher than the prior Utah (DeBerard et al., 2001) and

Washington State (Maghout-Juratli et al., 2006) studies, which report fusion rates of 71% and 75%, respectively. Despite higher fusion rates, disability rates increased from 23% in the prior Utah study to 28% in the current study. Another study found that 84% of patients using fusion cages established a solid fusion; yet, 38% were considered totally disabled as a consequence of their back condition at follow-up (LaCaille et al., 2005). Projective medical costs from 2001 to 2011 have risen approximately 174% for compensated lumbar fusion patients in Utah (Wheeler et al., in press); a rise that is strongly tied to the increase in use of more sophisticated surgical devices (e.g., interbody fusion cages; Deyo et al., 2005). Consistent findings within the literature reporting high fusion rates and poor functional outcomes associated with the use of fusion cages on workers compensation patients are very concerning, particularly when considering the costs associated these devices.

Descriptive Statistics for Patient Satisfaction and Quality of Life

Our finding indicated that on average, approximately 50% of injured Utah workers were unsatisfied with their fusion surgery, and 50% reported that their back pain after fusion was considerable worse than they expected. In terms of quality of life, 59% of the current sample reported an improved quality of life since their fusion surgery. Compared to the prior Utah study, these satisfaction and quality life rates were nearly identical. In our study, 70% of patients reported they would have the fusion again; while only 62% would in the prior study. These similarities in patient outcomes seem partly due to similarities of the two samples.

Outcome Categorization

As measured by the Stauffer-Coventry Index, 68% of the current patient sample reported good to fair pain relief compared to 75% in the prior Utah (2001) study. In both the current and prior studies, approximately 70% patients reported minimal to moderate physical activity restrictions. The most notable difference in outcome categorization between the two studies was for medication use, with 50% of current study patients and only 25% of the prior study patients reporting occasional to regular use of narcotic medication. This increase is likely due to the dramatic rise in prescription medication use over the past twenty years. Among patients with back-related disorders, from 1997 to 2004, there was a 108% increase in opioid prescriptions for pain with a 423% increase in cost expenditures associated with such medications (Martin et al., 2008). For the current study, patients' narcotic use is slightly higher than national norms of low back pain patients, which were approximately 45% in 2006 (Fingerhut, 2006). While there is no evidence suggesting that narcotic analgesic use prior to lumbar fusion predicts outcomes, a primary risk factors of increased narcotic use includes work related back injury (Rhee, Taitel, Walker, & Lau, 2007). There is also strong evidence that long-term treatment of pain with narcotic medication is known to have a significant negative impact on quality of life, concentration, pain sensitivity, libido, work ability, exercise, social functioning, and sleep (Deyo, Mirza, Turner, & Martin, 2009; Rhee et al., 2007). While the current study did not evaluate duration of medication use, this may be an important variable to address in future research.

Pain Rating and Subjective Pain Response

At the time of follow-up, approximately 40% of patients had either no change or an increase in pain after their lumbar fusion with more the 60% reporting current levels of pain as moderate to severe. Within the literature there is considerable focus on the psychosomatic aspects of chronic pain among working populations where pain is often considered exasperated by workers due to psychological distress rather than objective physical damage (Hadler, Tait, & Chibnall, 2007). Interestingly, our study reported minimal pain catastrophizing rates on the PCAS; and considerable lower than what is typically reported in pain clinic patients (Sullivan et al., 1995). This finding may indicate that fusion patients receiving compensation do not tend to overestimate or inflate their pain levels; however, this conclusion warrants further exploration.

General Physical and Mental Health Functioning

In the treatment of degenerative spine disorders, the 36-item Short Form Health Survey (Ware et al., 2000) is among the most commonly used self-report measures (Glassman et al., 2009). As expected, the present study's SF-36 scores revealed that the greatest areas of impairment were associated with physical functioning, role functioning, and bodily pain, while the areas of least impairment were related to mental health functioning. Fusion patient also revealed much poorer outcomes than the general population and the back pain/sciatica sample norms for the SF-36 MCS, SF-36 PCS and all SF-36 subscales. While there is substantial evidence suggesting poorer health related outcomes of lumbar fusion workers' compensation populations (DeBerard et al., 2001;

Maghout-Juratli et al., 2006; Trief, Ploutz-Snyder, & Fredrickson, 2006), most studies have not directly compared outcomes to noncompensated patients. A recent study, however, compared clinical outcomes of 60 lumbar fusion patients receiving workers' compensation to 58 fusion patients not receiving workers' compensation who were identified and matched on several patient variables, including SF-36 PCS and SF-36 MCS scores (Carreon et al., 2010). At 2 years after operation, patients not receiving workers' compensation had a significantly greater SF-36 PCS score compared to those receiving workers' compensation; no differences were found between SF-36 MCS scores. Further, only 16% of workers' compensation patients achieved a SF-36 PCS score that represented a clinically important difference compared to 40% of those not receiving workers' compensation. There is a need for additional comparison studies to identify barriers associated with the workers compensation system that limit improvement of clinical outcomes in patients.

Multivariate Prediction of Outcomes

The present study showed that multidimensional patient outcomes were predicted based on presurgical variables. The most consistent predictors of poorer outcomes were case manager involvement, vocational rehabilitation, and litigation involvement. Depression history also showed some predictability, specifically for outcomes associated with mental health and social functioning. Older age, which in prior research has shown some risk for poor lumbar fusion outcomes (Carreon, Puno, Dimar, Glassman, & Johnson, 2003; DeBerard et al., 2001), actually predicted higher mental health

functioning. Interestingly, none of the back related or surgical variables (i.e., prior back surgeries, vertebral levels fused, and type of instrumentation) were predictive of outcomes.

Case Manager and Vocational Rehabilitations as Predictors

In our study 42% of workers assigned a nurse case manager prior to fusion were disabled at least 2-years postsurgery follow-up, while only 16% not assigned a case manager were considered disabled. Disability among patients referred to vocational rehabilitation was 39%, compared to only 17% of patients not referred. Until our study, the association of nurse case manager assignments and referral to vocational rehabilitation on multidimensional fusion outcomes was unknown. Past research has shown these variables to be associated with worse patient outcomes for discectomy patients (DeBerard et al., 2009); and most recently, a study evaluating only return to work status among compensated fusion patients showed that patients with more rehabilitative and vocational therapy were less likely to return to work compared to those with no therapy (Ngyuen et al., 2011). Higher risk surgery cases are often referred to nurse case managers and vocational rehabilitation to help manage patient's medical treatments and facilitate return to work after surgery. While such preventative measures are often costly and time intensive, there is an assumption these programs are worth the higher expenditures based on perceived future benefits in terms of patient outcome and disability status. There is considerable need to further evaluate services to determine whether or not they benefit injured workers enough to be considered necessary.

Litigation Involvement as a Predictor

Involvement of litigation in patients' claim prior to lumbar fusion was found to be a significant predictor of several multidimensional outcomes in this study, including higher rates of disability, worse back related functional impairment, poor general health and physical functioning, role limitation due to emotional distress, and lower vitality. In fact, patient whose claims involved litigation were 280% more likely to be disabled than those without litigation. The literature supports the relationship between the role of the legal system and its impact on back surgery patient outcome with several studies indicating compensation claims involving litigation result in increased rates of disability and pain (Bernard, 1993; Greenough et al., 1994, 1998; Junge et al., 1995). Prior lumbar fusion studies, in particular, show that the legal representative of injured workers is a predictor of various negative outcomes after lumbar fusion (DeBerard et al., 2001, 2003; LaCaille et al., 2005; Ngyuen et al., 2011). DeBerard and colleagues (2001) showed patients with claims involving a lawyer were 376% more likely to be disabled 2 years following lumbar fusion when compared to claims that did not involve a lawyer. Although this is slightly more than the current sample, it is clear that litigation involvement remains a problematic issue when considering patient outcome. Variables noted by the literature possible influencing the relationship between litigation and poor outcome include the effect of patients blaming others for their injury, secondary gain (i.e., medication and/or money), and dealing with a complicated adversarial system (i.e., legal and insurance systems; Hadler, 2005; Harris, 2007). Further, injured workers who hire attorneys are typically trying to prove their functional impairment to workers

compensation fund in order to receive disability status and compensation for their injury. It is important to acknowledge this does not necessarily indicate patients are malingering; however, this outcome may be associated with complexities between the psychosomatic link of pain sensitivity and consequence of financial motivation and/or contextual variables.

Age as Predictor

While prior studies on fusion patients have indicated that older age is a predictor for poor outcomes (Carreon et al., 2003), our study did not show this relationship. Actually, results indicated older patients have higher mental health functioning as measured by the SF-36 MCS scale. There is criticism that past findings indicating age as a predictive factor for poor outcomes are partially explained by their emphasis on perioperative complications and older patients undergoing reoperation for failed fusion rather than outcome differences for varying age groups (Glassman et al., 2008). While rates of healing of vertebral bodies are lower in older aged patients (Boos et al., 1991); fusion cages have dramatically increased the rate of fusion in older populations, thus , associated complications with nonfusion are being seen less in elderly populations (Glassman et al., 2008). This is supported by recent research, which indicates older patients who undergo lumbar fusion with instrumentation show symptomatic progress in terms of quality of life comparable to those in younger patients (Glassman et al., 2008). In fact, older patients had more complications, but complications did not worsen outcomes.

Depression as a Predictor

Depression history was a significant predictor for poor outcomes on the SF 36 MCS, Mental Health, and Social Functioning scales; however, was not predictive of any disability or back related functional outcomes. Research supports the notion that psychological issues, such as anxiety, depression, fear avoidance beliefs relating to work, and back-pain related stress, among low back pain patients predicts impairment in subsequent physical health-related quality of life measures and healthcare utilization (Keeley et al., 2008). However, the evidence is mixed on how psychological distress predicts post-operative improvement in patients who have undergone lumbar fusion (DeBerard et al., 2001; LaCaille et al., 2005; Tandon et al., 1999; Trief et al., 2000). When considering the relationship between depression and spine surgery outcomes, Block and colleagues (2003) suggested the importance of surgeons to identify whether an individual is experiencing a reactive depression to their injury or if they have a pre-injury history of depression. Typically, patients with reactive depression are more likely to adjust to their condition with time; however, chronic back pain patients with a history of depression before the onset of pain have a greater risk for poor spine surgery outcomes (Block et al., 2003). Unfortunately, the current study did not specify if the onset of depression was prior to the back injury. Also, prior workers compensation studies on lumbar fusion outcomes have relied on identifying depression from physician documentation of a diagnosis of depression in the patient's medical chart at the time of fusion (DeBerarad et al, 2001; Maghout-Juratli et al., 2006; Trief et al., 2006). Thus, it is unclear if a depression diagnosis was met prior to injury. This contextual variable may

play an important role in depressions varied predictability of lumbar fusion outcomes.

Back-Related Physiological and Procedural Variables as Predictors

Perhaps the most interesting finding is there were no significant interrelationship between methods of assessing presurgical clinical severity, including pain severity, number of vertebral levels fused, and history of prior back operations, with patients outcomes. For pain severity, the finding were consistent with the prior Utah study (DeBerard et al., 2001) indicating no predictive power of a surgical diagnostic severity score for disability status, global outcome, or physical or social functioning. While prior studies have shown that multiple-level spinal fusion and a history of prior back surgeries is shown to be predictive of fusion outcomes (Franklin et al., 1994; Glassman et al., 1998; Narayan et al., 2002; Turner et al., 1992); most of these studies focused specifically on fusion rates, rather than multidimensional health-related outcomes. Further, although this study supports evidence suggesting more advanced surgical technology improves fusion rates (Maghout-Juratli et al., 2006), the data also indicate diagnostic severity has no relationship with multidimensional outcome data.

Implications

Several implications can be drawn from the current findings. Perhaps the most important implication is, over the past decade, injured workers who have undergone lumbar fusion in Utah have shown an increase in disability rates, functional impairment, and poor quality of life despite the improvement in solid fusion rates. Our findings, along

with the dramatic rise among workers compensation populations receiving lumbar fusion, specify the need for providers and surgeons to use more discretion when recommending lumbar fusion as a treatment option for injured workers without exploring alternative options. This is imperative when considering both the financial the cost associated with these surgeries, as well as the human costs such as pain, suffering, time away from family, job loss, lost activities, and inconveniences associated with being disabled. The data from this study do not, however, support the position that compensated workers cannot benefit from lumbar fusion, as several presurgical variables were predictive of patients outcomes.

When considering a biopsychosocial perspective, a second implication is based on findings indicating psychological factors (i.e., depression history) and social factors (i.e., nurse case manager, vocational rehabilitation, lawyer involvement) were highly effective in predicting long-term multidimensional patient outcomes for lumbar fusion. However, biological variables such as pain severity, number of vertebral levels identified for surgery, and prior back operations showed no relationship to outcomes. Such finding underscore the importance of moving away from the traditional medical model of treating low back pain, which suggests pain has a single underlying pathophysiological cause independent from psychological and social factors (Wright, 2005). The literature supports the notion that lumbar fusion patients who do have pathology also have limited functional recovery after surgical repair of the pathology (DeBerard et al., 2001; Franklin et al., 2004). Further, many researchers argue that a spinal fusion is appropriate only for a small number of conditions, such as spinal instability, spinal fracture, or scoliosis. In fact,

recent evidence suggests lumbar fusion is no more effective than a nonsurgical control group for return to work rates for patients with a diagnosis of disc degeneration, disc herniation, and/or radiculopathy (Ngyuen et al., 2011). Our data indicate 73% of the diagnoses for injured workers were disc degeneration, disc herniation, and radiculopathy. This issue emphasizes a fundamental concern that patients, surgeons, and providers are relying on lumbar fusion for conditions that are not indicative of the procedures utility.

Another implication is how to address the dramatic increase in use of fusion cages since the prior 2001 Utah lumbar fusion study (DeBerard et al., 2001). Many argue financial incentives are the reason for higher rates of lumbar fusion, which coincide with a rise in use of advanced surgical technology (Lieberman, 2004). The market for spinal instrumentation is estimated to be $2 billion a year, with a 20% annual growth rate. Reimbursement for lumbar fusion procedures is more favorable than reimbursement for most other back procedures performed by orthopedic surgeons due to elaborate spinal devices used and the longer length of surgery (Waldman & Armstrong, 2010). Further, several surgeons incomes are largely determined by their consulting and royalty arrangements with surgical device manufacturers. This offers surgeons strong incentives to perform lumbar fusion with surgical devises that do not have adequate evidence to support their utility.

Although recommendations for systematic selection of patients based on risk factors are deemed necessary, our study clearly indicates such practices are not occurring with compensated Utah workers. Consequently, another important implication is how we can move forward in applying our understanding of predicting patient outcomes to better

serve the patient. To do this, we need to consider the amount of control patients and providers have in addressing these issues before moving forward with surgical procedures. This is a systematic issue within the workers compensation system, which needs to improve their efforts in evaluating what is working and not working in terms of patient outcomes. For example, the paradoxical finding that nurse case manager involvement and referral to vocational rehabilitation results in poorer outcomes, indicates a further need to determine whether or not injured workers benefit enough to justify the use of such services. Because the indications for an invasive and expensive procedure, like lumbar fusion, is variable based on diagnosis, our study represents a clear need to shift investigative efforts to determine how to better serve injured workers who may or may not be good candidates for lumbar fusion surgery.

A final implication of our study is the importance of understanding outcomes from a broad multidimensional perspective that includes pain, back specific function, work disability, generic health status, and patient satisfaction. Our finding showed the majority of injured workers had higher expectations of benefiting from their lumbar fusion compared to the reality of their outcome. When patients are in significant pain after an injury, surgeon and provider recommendations for how to proceed will likely be interpreted as the best intervention to achieve successful outcome. However, how outcome is determined, may be operationally defined very differently across patients (i.e., quality of life, pain reduction); surgeons (i.e., solid fusion); and the workers compensation system (i.e., disability status). This is particularly important when comparing new finding to past studies evaluating lumbar fusion outcomes.

Limitations and Future Research

Several limitations were noted for the current study. One important limitation is the low follow-up rate of only 46%. This was unfortunate, in that prior studies have reported at least a 50% follow-up rate (DeBerard et al., 2001; LaCaille et al., 2005). Several variables may play a role as to why the rate of nonresponders has increased. The clearest difference between workers who responded to the survey and who did not respond was age, where responders were on average five years older than nonresponders. In the past decade, society's reliability on landlines has dramatically declined with more people using wireless devices as their primary mode of communication, particularly among younger adults (Blumberg & Luke, 2009). As the percentage of cell phone use increases, health researchers have reported more difficulty collecting telephone survey data due to higher costs (i.e., cell phone minutes) and tendency to screen calls (Krisberg, 2009). Also, because our study included workers who had fusion surgery between 1998 and 2007, it is possible that contact information for injured workers who had landlines and switched over to cell phones did not have information updated in the WCFU database, particularly if their claim was closed.

Another limitation was the inclusion of data from only one state's perspective of the workers' compensation system. Because this was a relatively homogenous sample of injured workers from Utah, the generalizability of findings may be limited to other workers compensation populations. Weinstein and colleagues (2006) indicates rates of lumbar fusion performed within the US varies considerable based on geographic region due to financial incentives to surgical intervention, and differences in clinical training and

hospital environments. Also, other workers compensation systems may provide different incentives for returning to work, which, in turn, may mediate outcomes.

An additional limitation is although multidimensional patient outcomes were collected prospectively, the study design was retrospective, which limits the probability that patient variables were reported consistently in the database. For example, variables such as socioeconomic status, educational level, smoking history, body mass index, were not considered in the multivariate regression analyses due to poor documentation in patient medical charts or missing data. Further, the predictive value of depression history should be interpreted with caution, as the current study did not specify if the onset of depression was prior to or after the initial back injury. In fact, to date, no known studies have evaluated depression history prior to injury as a predictor of outcomes; thus, further research is clearly needed to address this issue.

Lastly, there was also a limitation in how we dealt with interrater reliability when conducting the outcome surveys. Interrater reliability was determined by having another graduate student listen to the outcome survey on a separate line and independently code patient responses for 10% of the surveys. Because the interviewer was aware that another observer was coding their interviews, this might have influenced the way they interviewed the participants. Further, the interviewer's style of interviewing may have biased the responses.

When considering these limitations, there are several recommendations for future research in the area of lumbar fusion outcome research for injured workers. Due to the high costs associated with lumbar fusion and the potential for less costly nonsurgical

approaches to be equally effective, randomized controlled trials comparing lumbar fusion to alternative nonsurgical approaches are clearly needed among workers compensation populations. Also, because of the inherent difficulties associated with using randomized designs when comparing fusion outcomes between compensated versus noncompensated patients, there is a need for increased use of matched case control studies to evaluate these differences more systematically. Future studies on lumbar fusion within workers compensation populations will need to use more experimental designs with larger patient samples to provide more details regarding presurgical patient variables. There is also a pressing need for systematic prospective outcomes data to be collected among patients within the workers compensation system. This could be done by using electronic prospective outcomes databases often implemented in other health care setting (e.g., hospitals, physician practices, and insurance carriers), which would allow for a greater opportunity to understand factors that influence patient outcomes.

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APPENDICES

Appendix A

Medical Records Review Instrument

Medical Records Review Instrument

DEMOGRAPHIC/COMPENSATION VARIABLES		
1. Patient Name:	**2. Address:**	**3. Phone Number (home):**
4. Claim Number:	**5. Gender** **0=not reported** **1= Male** **2= Female**	**6. SSN:**
7. Study Number:	**8. Date of Birth:**	**9. Date of Injury:** **10. Hire Date:** **11. Months worked for employer prior to injury:**
12. Marital Status At Time of Injury: 0=Not reported 1=Married 2=Divorced 3=Separated 4=In a significant relationship (i.e., boyfriend or girlfriend) 5=Single	**13. Date of Index Lumbar Fusion Surgery:**	**14. Time interval between injury and fusion surgery? (Days):**
15. Date WCFU File Created:	**16. Patient's Weekly Wage at Time of Injury:** _____ 0=not reported	**17. Case Manager Assigned?** 0 = not reported 1 = no 2 = yes
18. Occupation At Time of Injury:	**19. Child Care Responsibility:** 0=Not reported 1=No 2=Yes **Total # Dependents**_____	**20. Lawyer involvement in compensation case? (prior to surgery)** 0=not reported 1=no 2=yes
21. Red Flags **A. AGE (AG) - Claimant age over 50.....1=yes 2=no** **B. ALCOHO (AL) - History of Alcoholism.....1=yes 2=no** **C. CREDIB (CR) - Questionable Validity.....1=yes 2=no** **D. CUMTRA (CT) - Cumulative Trauma.....1=yes 2=no** **E. DISVAL (DI) - Disputed Validity Settlement....1=yes 2=no** **F. DRUG (DR) - History of Drug Abuse.....1=yes 2=no** **G. EDUCAT (ED) - Education Level.....1=yes 2=no** **H. EMPLOY (EF) - Employment Factors.....1=yes 2=no** **I. FNCOVER (FO) - Functional Overlay.....1=yes 2=no** **J. FRAUD (FR) - Fraud.....1=yes 2=no** **K. LEGAL (LG) - Claim Involves Litigation.....1=yes 2=no** **L. LIEN (LI) - Claim Involves Lienholder.....1=yes 2=no** **M. NESPEK (NE) - Language Barriers.....1=yes 2=no** **N. OBESE (OB) - Obesity.....1=yes 2=no** **O. OFFCR (OF) - Claimant Officer/Partner.....1=yes 2=no** **P. OTHER (OT) - Other Factors.....1=yes 2=no** **Q. OVRPAY (OP) - Compensation Overpayments....1=yes 2=no** **R. PIREF (PR) - Private Investigator Referred...1=yes 2=no** **S. PREEXI (PR) - Pre-Existing Condition.....1=yes 2=no** **T. PRIORS (PS) - Claiman has prior claims.....1=yes 2=no** **U. PSYCH (PF) - Psychological Factors.....1=yes 2=no** **V. PTSD (PT) - Post-Traumatic Stress Dis.....1=yes 2=no** **W. SOCIAL (SF) - Social Factors.....1=yes 2=no** **Y. SUBSYM (SS) - CLMT has subjective sympt.....1=yes 2=no** **X. SYSDIS (SD) - Systemic Diseases..... 1=yes 2=no**		**22. Description of Accident** **a. Accident Code**_____ **b. Injury Type Code:** **c. ICD-9 Code**_____ **b. Narrative:**_____ _____ _____ _____

WORK/COMPENSATION VARIABLES		
23. Date Last Worked:	**28. Total Paid Temporary Comp:**	**40. Percent Physical Impairment Paid Out:**
24. History of prior industrial claim? (Generic) 0=not reported 1=no 2=yes Total Number_____ Specific Code #'s_____ Type of Injury_____	**29. Total Paid Permanent Comp:**	**41. Expected Duration**
	30. Total Paid Comp:	**42. Medical Stability Date:**
25. History of prior industrial claim? (Low Back Pain) 0=not reported 1=no 2=yes Total Number_____ Specific Codes #'s_____	**31. Total Paid Medical:**	**43. Return to Work** 0=not reported 1=no 2=yes
	32. Total Paid ALAE:	**44. Return to Work Date**
26. Vocational Rehabilitation following surgery? 0=not reported 1=no 2=yes	**33. Total Paid Rehab**	**45. Time to Medical Stability From Date Of Fusion (days):**
	34. Total Paid to Date	
27. Modified Employment Available 0=not reported 1=no 2=yes	**35. Total ALAE**	
	36. Total MEDICAL:	
	37. Total REHAB:	**WCFU Adjustor Name:**
	38. Total Comp	
	39. Grand Total Incurred:	

PHYSICAL/HEALTH/SURGICAL VARIABLES

46. Physical Exam Data
a. Height_____
b. Weight_____
c. Straight Leg Raise (30-70 degree raise produces radicular pain below knee)
0=Not Reported
1=Positive
2=None
d. Femoral Tension Sign (Anterior thigh pain in a radicular pattern with flexion of knee and hip extension in a prone position)
0=Not Reported
1=Positive
2=None
e. Depressed Patellar Reflexes
0=Not Reported
1=Positive
2=None
f. Depressed Ankle Reflexes
0=Not Reported
1=Positive
2=None
g. Back pain without radiation
0=Not Reported
1=Positive
2=None
h. Radicular Pain
0=Not Reported
1=Positive
2=None
3=Left/Right to Thigh
4=Left/Right to Leg
5=Left/Right to Foot
i. Motor Weakness (asymmetric)
0=Not Reported
1=Positive
2=None
3=Hip Flexors
4=Knee Extensors
5=Ankle Dorsoflexors
6=Great Toe Dorsoflexors
7=Ankle Plantar Flexors
j If yes, does motor weakness correspond to nerve root placement?
0=Not Reported
1=Positive
2=Negative
9=Not Applicable
k. Any Nonorganic signs present?
0=not reported
1=superficial or NonAnatomic Tenderness
2=Pain with Simulated Axial Loading or Rotation
3=Distraction (SLR different sitting v. supine)
4= Regional Disturbance (Nonanatomic sensory pr motor deficit)
5 = Overrreaction

47. Number of Prior Low Back Operations?
0=None

48. Patients' Primary Surgical Diagnosis
0=Not Reported
Options: (Washington Study, 2006)
1=Radiculopathy
2=Disc Herniation
3= Stenosis
4= Spondylolisthesis
5= Degenerative disc disease
6= Other_____
Turner et al., 1992 (Meta Analysis)
1= Disc Herniation
2=Degenerative disc disease (internal disc derangement
3= Degenerative Scoliosis
4= Segmental Instability
5= Pseudoarthrosis
6= Spondylolisthesis
7= Spinal Stenosis

49. Patients' Secondary Surgical Diagnosis
0=Not Reported
Options: (Washington Study, 2006)
1=Radiculopathy
2=Disc Herniation
3= Stenosis
4= Spondylolisthesis
5= Degenerative disc disease
6= Other_____
Turner et al., 1992 (Meta-Analysis)
1= Disc Herniation
2=Degenerative disc disease (internal disc derangement
3= Degenerative Scoliosis
4= Segmental Instability
5= Pseudoarthrosis
6= Spondylolisthesis
7= Spinal Stenosis

58. Surgical Complications
0=Not reported
1=none
2=In hospital mortality
3=Deep infection
4=Superficial infection
5=Deep vein thrombosis/ thrombophlebitis
6=Pulmonary embolus
7=Dural Tear-CSF Leak
8=Nerve Root Injury
9=Operation at wrong level
10=Vascular injury
11=Failed back syndrome
12=other_____
_____

59. Additional Procedures Performed

60. Was Solid Arthrodesis Achieved?
0=Not Reported
1=No
2=Yes

50.General Health Problems (List up to 5)
0=None reported
1=Diabetes
2=Heart Disease
3=Stroke
4=Arthritis
5=Asthma
7=Hypertension
8=Colitis
9=Psoriasis
10=Cancer history
11=Trauma history
12=Infectious history
13=Auto-immune history
14=Steroid usage
15=Other

51. Imaging Studies Conducted prior to surgery?
0=none reported
1=X-ray
2=CT
3=MRI
4=CT Myelogram
5=Discography
6=Other_____

52. Number of Levels Fused
0=not reported
1=One Level
2=Two Levels
3=Three or three plus

53. Type of Fusion
0=not reported
1=Posterolateral gutter fusion
2= Posterior lumbar interbody fusion (PLIF/TLIF)
3= Anterior lumbar interbody fusion (ALIF)
4= Anterior/posterior spinal fusion
5=Other_____

54. Type of Instrumentation Used?
0=Not Reported
1=None
2= Pedicle screws and rods
3= Titanium Cages Type_____
4= Both Screws and cages
5= Other _____

55: If Yes, was instrumentation removed?

1=One 2=Two 3=Three or more ____How many?_____ Date:_____ MD:_____	**56. Post-Operative Treatment?** 0=Not reported 1=Patient Education/Counseling 2=Physical Therapy 3=Manipulation 4=Activity Restriction 5=Devices (Corsets/Casts) 6=Injections 7=Functional Restoration/RehabPrograms	0=Not Reported 1=No 2=Yes **57. Lifting Restrictions in Pounds Following surgery?:**
PHYSICAL/HEALTH/SURGICAL VARIABLES		
61. Previous Chiropractic Treatment? 0=not reported 1=no 2=yes	**62. Amount of Pain Before Surgery?** 0=No Pain or Minimal Pain 1=Mild 2=Moderate 3=Severe	**63. Use of Pain Meds Prior to Surgery** **0=not reported** **1=no** **2=yes**
64. Significant testing after surgery? 0=None Reported 1=X-ray 2=CT 3=MRI 4=CT Myelogram 5=Discography 6=Other_____	**65. Smoking at time of Surgery?** 0 = Not reported 1 = No 2 = Yes	**66. Alcohol Use at time of Surgery?** 0=Not reported 1=no 2=yes
67. Non prescription Drug Use prior to Surgery? 0=Not reported 1=no 2=yes Type:_____	**68: Psychology Evaluation prior to Surgery:** 0=Not reported 1=no 2=yes **Copies obtained?** 1=no 2=yes **69: If Yes, Diagnosis:** 0=Not reported 1=no 2=yes DSM-IV Code_____	**70: History of Depression?** 0=not reported 1=no 2=yes
71: History of Psychological Treatment 0=Not Reported 1=Psychotropic Medication: Type _____ 2=Therapy 3=Both	**72. Educational Level** 0=Not reported 1=Less than 12 years 2=12 years (HS Degree) 3=Some College 4=Trade School/AA 5=College Degree 6=Advanced Degree	**73. Ethnicity** 0=Not reported 1=White 2=Black of African American 3=Hispanic 4=Asian or Pacific Islander 5=Native American Indian 6=Other (Specify_____)
Notes:		

Appendix B

Letter of Information

Analysis of Utah Workers' Compensation Patient Outcomes Following Lumbar Fusion

Department of Psychology
2810 Old Main Hill
Logan, UT 84322-2810
Tel: (435) 797-1462

Date

«FirstName» «LastName»
«Address1»
«City», «State» «PostalCode»

Dear Participant:

Professor Scott DeBerard, Ph.D. and graduate student Jessica Gundy, M.A. from the Department of Psychology at Utah State University (USU) are conducting a research study to evaluate outcomes following lumbar fusion. USU has established a research partnership with the Workers' Compensation Fund of Utah (WCFU) and with their permission, we obtained your name and address from their database. The research team at USU is very interested in hearing about your results from this spine treatment and sends this letter to inform you in advance of our request for a telephone interview. We hope to have approximately 250 participants in this study. To select participants for this study, information regarding your prior fusion procedure was collected from the WCFU database. Participants were selected based upon this review and the information is now stored in a confidential manner at USU. There is minimal risk involved in participating in this research study.

During the months of October through December of 2009, one of our interviewers from USU will call you about an outcome survey of patients who have undergone the lower back surgical procedure called lumbar/spinal fusion. The interview will be conducted over the telephone, at your convenience, and will take approximately 20 to 30 minutes. The interview will consist of primarily 'yes/no' or rating-type questions and will be conducted from a private office to maintain privacy of the interviews. Your consent to participate in the study will be requested by the interviewer before the interview begins.

Participation in research is voluntary and you may withdraw at any time without consequence. We want to emphasize this research is being conducted <u>independently</u> from WCFU and that your participation in this research will in no way affect your compensation status or treatment now or at any time in the future. *All patient data will be examined by USU and the WCFU in a <u>combined</u> summarized manner. Individual cases will not be revealed or examined by USU or the WCFU.*

Study records that identify you will be kept confidential as required by law. Federal Privacy Regulations provide safeguards for privacy, security, and authorized access. Except when required by law, you will not be identified by name, social security

number, address, telephone number, or any other direct personal identifier in study records disclosed outside of USU. In the unlikely event that we learn that you are having serious thoughts of, or are engaging in behaviors related to harming yourself or others, we may need to report this to the appropriate authorities.

All of your responses will be strictly confidential. To maintain your confidentiality, all information will be kept in a locked file cabinet in a locked room at USU. Only the researchers will have access to this information. To protect your privacy, your name and identifying information will be replaced with a confidential ID number, which will be used in any datasets generated from this project. Your name and identifying information will be stored separately from these datasets in order to maximize your privacy.

We are interested in documenting outcomes following lumbar fusion and learning how to better predict lumbar fusion outcomes. We are hopeful that the information you provide may help future candidates for this procedure by predicting those patients who are most likely to benefit from this procedure. People who have been treated for back pain often report a mixture of both positive and negative results. Your unique experience, whether positive or negative, is very important to us.

If you have questions or concerns you may contact Dr. DeBerard (telephone contact and email address is below). If you are interested in receiving a summary of our study results, please notify us and we will send you a copy. We will be offering a $10.00 incentive to you that will be sent to you following completion of the telephone survey via check.

The Institutional Review Board for the protection of human participants at USU has approved this research study. If you have any pertinent questions or concerns about your rights or a research-related injury, you may contact the IRB Administrator at (435) 797-0567. If you have a concern or complaint about the research and you would like to contact someone other than the research team, you may contact the IRB Administrator to obtain information or to offer input.

To help us in contacting you, please fill in your name, address, phone number and the best time to contact you on the enclosed postcard and drop it in a mailbox. Returning the postcard does not imply that you are giving your consent to participate; consent will be asked of you at the time of your telephone interview. Your participation will be greatly appreciated since this is a very important study. If you have any questions, please do not hesitate to call me at (435) 797-1462.

Sincerely,

Scott DeBerard, Ph.D.
Research Director
Utah Lumbar Fusion Outcome Study
scott.deberard@usu.edu

Jessica M. Gundy, M.A.
Graduate Assistant
Utah Lumbar Fusion Outcome Study
jessica.gundy@aggiemail.usu.edu

Appendix C

Fusion Study Telephone Survey Cover Sheet

FUSION STUDY TELEPHONE SURVEY COVER SHEET

SUBJECT NUMBER:

NAME:

GENDER: male female

AGE:

Checklist	
Verify subject phone and address?	Yes
Circle address for subject payment?	Yes
Review chart for completeness?	Yes
Review survey for completeness?	Yes

DATE(S) OF FUSION:

TELEPHONE NUMBERS: 1st #: ( ) _____-_____ **2nd #:** ( ) ___ - _____

3rd #: **( )** _____-_____ 4th #: **( )** _____-_____

ADDRESSES

1: _____
_____
_____

#3: _____
_____
_____

#2: _____
_____
_____

#4: _____
_____

Date	**Time**	**Outcome of Call**
1.		
2.		
3.		
4.		
5.		
6.		

7.		

CONTACT HISTORY:
FINAL STATUS OF SUBJECT PARTICIPATION:
1= Contacted but declined to participate
2= Contacted and completed only part of survey
3= Contacted and completed entire survey
4= Could not be reached
5= Participated and want a study summary sent to them.
6= Other

Appendix D

Telephone Outcome Script

UTAH FUSION OUTCOME STUDY
TELEPHONE INTERVIEW SCRIPT

Hello. Is this the_____residence? (If wrong number, then terminate).

This is calling from Utah State University. We are conducting a study to learn more about people who have undergone spinal fusion to treat their back pain.

Earlier this month a letter describing the study was sent to you? Did you receive it?

If yes: (Proceed with the rest of the introduction).

If no: I am sorry it did not reach you. The letter was to inform you of this call and the nature of the study. (Proceed to the introduction).

INTRODUCTION

As the letter (or The letter indicated) indicated you were chosen for this study because you underwent a fusion procedure to treat your back pain through the Worker's Compensation Fund of Utah. Your opinion of how you have progressed since this procedure is critical to this study and results of the survey will be used to help others who are considering having a fusion. Your participation is voluntary and your treatment or compensation status will in no way be affected by your participation. For your participation in the survey we will be sending you $10 and if you wish we could also send you a brief report of the study findings. All of your answers will be kept confidential as provided by law and you may skip any questions you prefer not to answer. Okay?

Please feel free to ask questions at any time during the survey. The survey will take about 20 to 30 minutes to complete. Would you be willing to participate?

Yes, *verbal consent obtained*: (Proceed with survey)

No, *verbal consent not obtained*: Would you prefer we call you back at a better time?

Yes: Date:
Day:
Time:

No: Okay, thank you for your time. (Do not proceed with survey)

Appendix E

Stauffer-Coventry Index, Global Perceived Effect, Verbal Numeric Rating Scale, and Patient Satisfaction Items

Stauffer-Coventry Index, Global Perceived Effect, Verbal Numeric Rating Scale, and Patient Satisfaction Items

<table>
<tr><td colspan="3">Utah Lumbar Fusion Outcome Study Telephone Survey - General Questions
The next part of the survey will involve some general questions about how you have done since you had your fusion. Please respond to each question according to how you feel today. Okay?</td></tr>
<tr><td>1. Since yourfusion, how much pain relief have you experienced in your back and lower extremities? Please provide a percent rating from 0 to 100. _____

Category Rating:
1=Good (76-100 % improvement)
2= Fair (26-75% improvement)
3= Poor (0-25% improvement)</td><td>2. With regard to your employment after fusion, which of the following best describes your status after treatment?
1=Return to previous work status following surgery
2=Return to lighter work following surgery
3=No return to work following surgery</td><td>3. With regard to your physical activities after fusion, which of the following best describes your status after treatment?:
1=Minimal or no restrictions of physical activities.
2=Moderate restrictions of physical activities
3=Severe restrictions of physical activities</td></tr>
<tr><td>4. With regard to your use of analgesic medications after fusion, which of the following best describes your usage:
1=Occasional mild analgesics or no analgesics
2=regular use of nonnarcotic analgesics
3=occasional or regular narcotic analgesics</td><td>5. With regard to your back/leg pain following fusion, which of the following is true:
1=Back or leg pain is worse than expected
2=Back or leg pain is no worse or better than expected
3=Back or leg pain is better than expected</td><td>6. Is your quality of life better or worse as a result of fusion? That is, is it:
1=A great improvement
2=A moderate improvement
3=A little improvement
4=No change
5=A little worse
6=Moderately worse
7=Much worse</td></tr>
<tr><td>7. Given what you know: If you could go back in time, would you choose to have the fusion again?
0=Undecided
1=No
2=Yes</td><td>8. What was your principal occupation/job title at the time of your injury?:</td><td>9. Are you currently working?
1. No
2. Yes, Full Time
3. Yes, Part Time
4. No answer</td></tr>
<tr><td rowspan="3">10. If not working, which of the following best describes why you are not employed?:
1. I am still disabled
2.I am not disabled & I want to work but cannot find a job.
3. I was laid off.
4. I am a student.
5. I am a homemaker.
6. I am retired
7. Other_____
8. No answer</td><td>11. How many days have you worked in the past 4 weeks?</td><td>12. How many hours a week do you usually work at your job?</td></tr>
<tr><td>13. Did you change jobs because of your back problem?
1=no
2=yes
3=not applicable
0=No answer</td><td>14. Do you currently retain an attorney because of you back/neck problems?
1=no
2=yes
0=No answer</td></tr>
<tr><td>15. Do smoke now?
1=no
2=yes
0=No answer
15.a. Ever Smoked? 1=yes/2=no</td><td>16. Have you had any back operations since your fusion?
1=No
2=No, but I’m scheduled to
3=Yes
Operation Types:</td></tr>
<tr><td>17. Overall, is your back or leg pain problem better than or worse than you expected it to be at this point? That is, is it?
1. Much better
2. Somewhat better
3.What I expected
4. Somewhat worse
5. Much worse
6. No expectations</td><td>18. What is the highest year in school you completed?
1. Less than High School
2. Some High School
3. High School Graduate/GED
4. Attended or graduated from technical school
5. Attended college but did not graduate
6. College graduate
7. Graduate Studies</td><td>19. If you had to spend the rest of your life with your back condition as it is right now, how would you feel about it?
1. Extremely dissatisfied
2. Very dissatisfied
3. Somewhat dissatisfied
4. Neutral
5. Somewhat satisfied
6. Very satisfied
7. Extremely satisfied</td></tr>
</table>

20. On a scale from zero to ten, where zero represents no pain and ten represents the worst pain imaginable, how would you rate your current pain level? **#:**_____	**21. Now, using the same scale, how would you rate your level of pain on average over the past week?** **#:**_____	**22. Compared to when this episode first started, how would you describe your back/neck these days?** 1. Complete relief of pain 2. More than 50% pain relief 3. No change in the level of pain 4. The pain has increased

Appendix F

Rolland-Morris Disability Questionnaire

Disability Questionnaire

Now we are going to ask you more specific questions about your back.... "When your back hurts, you may find it difficult to do some of the things you normally do. The list I'm going to read you now contains some sentences people have used to describe themselves when they have back pain. As I read the list, think of yourself today. When I read a sentence that describes you today, please indicate so by telling me yes. If the sentence does not describe how you feel today, please indicate so by telling me no. Do you have any questions?

Yes	No	Items
1	2	1. I stay at home most of the time because of my back.
1	2	2. I change positions frequently to try and get my back comfortable.
1	2	3. I walk more slowly than usual because of my back.
1	2	4. Because of my back I am not doing any of the jobs I usually do around the house.
1	2	5. Because of my back, I use a handrail to get upstairs.
1	2	6. Because of my back, I lie down to rest more often.
1	2	7. Because of my back, I have to hold on something to get out of an easy chair.
1	2	8. Because of my back, I try to get other people to do things for me.
1	2	9. I get dressed more slowly than usual because of my back.
1	2	10. I only stand up for short periods of time because of my back.
1	2	11. Because of my back, I try to not bend or kneel down.
1	2	12. I find it difficult to get out of a chair because of my back.
1	2	13. My back is painful almost all of the time.
1	2	14. I find it difficult to turn over in bed because of my back.
1	2	15. My appetite is not very good because of my back pain.
1	2	16. I have trouble putting on my socks (or stockings) because of pain in my back.
1	2	17. I only walk short distances because of my back pain.
1	2	18. I sleep less well because of my back.
1	2	19. Because of my back pain, I get dressed with help from someone else.
1	2	20. I sit down for most of the day because of my back.
1	2	21. I avoid heavy jobs around the house because of my back.
1	2	22. Because of my back pain, I am more irritable and bad tempered with people than usual.
1	2	23. Because of my back, I go upstairs more slowly than usual.
1	2	24. I stay in bed most of the time because of my back.

Appendix G

Short Form Health Survey, Version 2,

Standard Interview for SF-36 Health Survey

Short Form Health Survey, Version 2
Standard Interview for SF-36 Health Survey

1. In general, would you say your health is:

- ❑ Excellent
- ❑ Very good
- ❑ Good
- ❑ Fair
- ❑ Poor

2. Compared to one year ago, how would you rate your health in general now?

- ❑ Much better now than a year ago
- ❑ Somewhat better now than a year ago
- ❑ About the same as one year ago
- ❑ Somewhat worse now than one year ago
- ❑ Much worse now than one year ago

3. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

a. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

b. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf?
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

c. Lifting or carrying groceries.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

d. Climbing several flights of stairs.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

e. Climbing one flight of stairs.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

f. Bending, kneeling or stooping.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

g. Walking more than one mile.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

h. Walking several blocks.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

i. Walking one block.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

j. Bathing or dressing yourself.
- ❑ Yes, limited a lot.
- ❑ Yes, limited a little.
- ❑ No, not limited at all.

4. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

a. Cut down the amount of time you spent on work or other activities?
☐ Yes ☐ No

b. Accomplished less than you would like?
☐ Yes ☐ No

c. Were limited in the kind of work or other activities
☐ Yes ☐ No

d. Had difficulty performing the work or other activities (for example, it took extra time)
☐ Yes ☐ No

5. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

a. Cut down the amount of time you spent on work or other activities?
☐ Yes ☐ No

b. Accomplished less than you would like
☐ Yes ☐ No

c. Didn't do work or other activities as carefully as usual
☐ Yes ☐ No

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?
- ❑ Not at all
- ❑ Slightly
- ❑ Moderately
- ❑ Quite a bit
- ❑ Extremely

7. How much bodily pain have you had during the past 4 weeks?
- ❑ Not at all
- ❑ Slightly
- ❑ Moderately
- ❑ Quite a bit
- ❑ Extremely

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

- ❑ Not at all
- ❑ Slightly
- ❑ Moderately
- ❑ Quite a bit
- ❑ Extremely

9. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks.

a. did you feel full of pep?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

b. have you been a very nervous person?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

c. have you felt so down in the dumps nothing could cheer you up?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

d. have you felt calm and peaceful?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

e. did you have a lot of energy?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

f. have you felt downhearted and blue?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

g. did you feel worn out?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

h. have you been a happy person?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

i. did you feel tired?
- ❑ All of the time
- ❑ Most of the time
- ❑ A good bit of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?
- ❑ All of the time
- ❑ Most of the time
- ❑ Some of the time
- ❑ A little of the time
- ❑ None of the time

11. How TRUE or FALSE is each of the following statements for you?

a. I seem to get sick a little easier than other people
- ❑ Definitely true
- ❑ Mostly true
- ❑ Don't know
- ❑ Mostly false
- ❑ Definitely false

b. I am as healthy as anybody I know
- ❑ Definitely true
- ❑ Mostly true
- ❑ Don't know
- ❑ Mostly false
- ❑ Definitely false

c. I expect my health to get worse
- ❑ Definitely true
- ❑ Mostly true
- ❑ Don't know
- ❑ Mostly false
- ❑ Definitely false

d. My health is excellent
- ❑ Definitely true
- ❑ Mostly true
- ❑ Don't know
- ❑ Mostly false
- ❑ Definitely false

Appendix H

The Pain Catastrophizing Scale (PCAS)

Pain Catastrophizing Questionnaire

Okay, everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint pain, or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures, or surgery.

We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.

0—not at all 1—to a slight degree 2—to a moderate degree 3—to a great degree 4—all the time

Ask yourself, when I'm in pain…

	I worry all the time about whether the pain will end.
	I feel I can't go on.
	It's terrible and I think it's never going to get any better.
	It's awful and I feel that it overwhelms me.
	I feel I can't stand it any more.
	I become afraid that the pain will get worse.
	I keep thinking of other painful events.
	I anxiously want the pain to go away
	I can't seem to keep it out of my mind.
	I keep thinking about how much it hurts.
	I keep thinking about how badly I want the pain to stop.
	There's nothing I can do to reduce the intensity of the pain.
	I wonder whether something serious may happen.

CURRICULUM VITAE

JESSICA M. GUNDY

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EDUCATION

Ph.D.	**Utah State University, Logan, UT**
2012	Combined Clinical/Counseling/School Psychology (APA Accredited) *Doctoral Dissertation*: Outcomes and Presurgical Predictor Correlates of Lumbar Fusion in Utah Workers' Compensation Patients *Chair*: M. Scott DeBerard, Ph.D.
M.A.	**California State University, Los Angeles, CA**
2007	General Psychology *Master's Thesis*: An Investigation of Eating Attitudes and Prevalence of Eating Disorders Among Students in Culinary Arts School *Chair:* Brigitte K. Matthies, Ph.D.
B.A.	**University of Montana, Missoula, MT**
2001	Professional Psychology – with Honors

HONORS & AWARDS

2010-2011	Dissertation Fellowship ($5,000) - Utah State University
2008; 2009; 2010	Graduate School Travel Award (3-$300) - Utah State University
2008; 2009	Departmental Travel Award (3-$300) - Utah State University
2007-2008	Presidential Fellowship ($12,000) - Utah State University
2006-2007	Graduate Equity Fellowship ($1500) - CSU, Los Angeles
2006	Emeriti Fellowship ($1000) - CSU, Los Angeles
2006	Travel Conference Award ($600) - CSU, Los Angeles
1999-2001	Western Undergraduate Exchange Scholarship, University of Montana
1998-2001	Deans Lists - University of Montana
1999-Present	Psi Chi National Honors Society
2000-Present	Golden Key National Honors Society

PROFESSIONAL ASSOCIATIONS

America Psychology Association (APA), Division 12; Division 38, Student Member
Utah Psychological Association (UPA), Student Member
Society of Behavioral Medicine (SBM), Member
Association for Contextual and Behavioral Sciences (ACBS), Student Member

Association for Behavioral and Cognitive Therapies (ABCT), Student Member

CLINICAL EXPERIENCE

10/10-Present **Behavioral Health Therapist -** Clinical Health Practicum
Logan Regional Hospital Cancer Center - Logan, UT
Brief assessment and individual psychotherapy services for patients diagnosed with various types of cancer; consultation with families, medical providers, and personnel; treatment targets end of life issues, treatment compliance, support system development, persistent pain, and behavioral activation.
Supervisor: M. Scott DeBerard, Ph.D.

09/10-Present **Advanced Student Therapist**–Child/Adolescent Practicum
Avalon Hills Residential Eating Disorders Program - Adolescent - Petersboro, UT
Psychodiagnostic assessments and report writing; individual therapy with adolescents focused on body image; family therapy; peer-supervision; multidisciplinary consultation.
Supervisors: Tera Lensegrav-Benson, Ph.D.

01/10-Present **Graduate Assistant Therapist** - Clinical Assistantship
Avalon Hills Residential/ Intensive Outpatient Eating Disorders Program, Adult Facility - Paradise, UT
Individual therapy for residential and intensive outpatient adult patients; family therapy; transition coordination for patients' outpatient treatment team; primary therapist for experiential groups including acceptance and commitment therapy (ACT), mindfulness, dialectical behavior therapy (DBT), and process group; collaboration with multidisciplinary treatment team.
Supervisors: Tera Lensegrav-Benson, Ph.D.; Martin Toohill, Ph.D., Michael P. Twohig, Ph.D. (consultation supervisor)

08/09-07/10 **Behavioral Health Consultant/Liaison** - Clinical Health Practicum
Student Health and Wellness Center - Utah State University
Behavioral health services within an integrated primary care setting including intake assessments, individual psychotherapy, behavioral consultation services, and collaboration with primary care providers; targeted behavioral issues including eating disorders, obesity, chronic pain, treatment adherence, substance abuse, PTSD, ADD/ADHD.
Supervisor: M. Scott DeBerard, Ph.D.

06/09-12/09 **Graduate Student Therapist** – Practicum in Psychology
Avalon Hills Residential Eating Disorders Program - Adolescent Unit - Petersboro, UT and Adult Unit - Paradise, UT
Co-led experiential groups including recovery maintenance, ACT, mindfulness, spirituality, DBT skills, and process group; treatment team collaboration and consultation.
Supervisors: Tera Lensegrav-Benson, Ph.D., Martin Toohill, Ph.D.

08/08-05/09 **Graduate Student Therapist** - Counseling Practicum
Counseling and Psychological Services - Utah State University
Individual and group counseling for students presenting with a variety of behavioral health issues (e.g., trauma, eating disorders, anxiety/mood disorders, stress management, insomnia); co-led DBT skills group; crisis consultations; outreach services (veterans and body-image workshops); mental health screenings; clinical case presentations.
Direct Clinical Hours: 141; *Total Hours:* 464
Supervisors: David Bush, Ph.D., Jodie Benabe-Matz, Intern

08/07-05/08 **Therapist in Training -** Integrative Clinical Practicum
Psychology Community Clinic - Utah State University
Mental health services for children, adolescents, and adults in the community; intake assessments; individual and family psychotherapy services; parent-training; psychoeducational assessments (e.g., LD, ADHD); comprehensive psychological evaluations; classroom observations; treatment planning; clinical case presentations.
Supervisors: Susan L. Crowley, Ph.D., Gretchen Gimpel Peacock, Ph.D.

RELATED APPLIED CLINICAL EXPERIENCE

June 2010 **Veterans Affair Training Videos** - Acceptance and Commitment Therapy (ACT) for Combat and Military Sexual Trauma.
Project Coordinator: Robyn Walser
Role played the client role for training videos with a therapist who is an expert in delivering ACT to veterans struggling with post-traumatic stress.

Spring 2009; 2010 **Body Image Fair**
Counseling and Psychological Services - Utah State University
Provided presentation and exhibits on topics including "Men's issues with body image" and the National Eating Disorder Association (NEDA) slogan, "Be comfortable in your genes."

Spring 2009 **Residential Housing Couples Workshop**
Counseling and Psychological Services - Utah State University
Co-led 60-min presentation on dating and relationship issues. (2 workshops)

November 2008 **Veteran's Day Mental Health Awareness Outreach**
Counseling and Psychological Services - Utah State University
Provided information at a university veterans event about mental health conditions typical in veteran populations (e.g., substance abuse, depression PTSD); offered resources to help male and female veterans coping with transition issues associated with military service.

Fall 2008 **University Student Anxiety Screening/Awareness**
Counseling and Psychological Services - Utah State University
Conducted brief anxiety screenings for students. (3 hours)

02/07-07/07 **Applied Behavioral Therapist**
Autism Spectrum Therapies - Culver City, CA
Extensive training in the principles of applied behavioral analysis; direct therapy services in a paid therapist position for individuals with autism and their families; taught acquisition and maintenance of appropriate social and academic skills.

RESEARCH EXPERIENCE

2008-Present **Research Assistant -** *Lumbar Fusion Outcome Project*
Utah State University – Department of Psychology
Supervisor: M. Scott DeBerard, Ph.D.
Co-developed project; co-principle investigator on grant; conducted all patient medical chart reviews; administered standardized outcome surveys; managed outcome data collection and analysis in SPSS; manuscript writing and submissions; multiple paper and poster presentations at professional conferences.

2009-Present **Research Project Coordinator –** *Eating Disorder Outcome Studies*
Utah State University - Center for Clinical Studies & Avalon Hills Residential Treatment Program
Supervisor: Michael P. Twohig, Ph.D.
Evaluated multidisciplinary intervention for patients in a residential eating disorder facility; involvement in writing Institutional Review Board proposal and revisions; assisted in grant writing and submission; intervention implementation; data analysis of pre-post assessment; currently developing multiple-baseline study on an exposure-based and ACT intervention.

2006-2007 **Research Project Coordinator -** *Culinary Student Eating Behavior Study*
California State University, Los Angeles – Department of Psychology
Supervisor: Brigitte K. Matthies, Ph.D.
Designed and coordinated study on eating behavior and attitudes for students in culinary arts school; participant recruitment; data collection, management in SPSS, and analysis; report writing.

2006-2007 **Research Assistant -** *Women's Health Project Lab*
California State University, Los Angeles – Department of Psychology
Supervisor: Fary M. Cachelin, Ph.D.
Examined treatment barriers for ethnic minority populations struggling with eating disorders; evaluated parental factors and treatment modalities for obesity and weight related concern in children; data management in SPSS; data analysis; report writing; conference presentation.

2006-2007 **Research Assistant** - *Pasadena Pain Rehabilitation Institute*
Pasadena, CA
Supervisor: Harold Gottlieb, Ph.D., Phillip Corrado, Ph.D.
Evaluated clinical correlates of psychogenic pain and attachment style;

data collection; data interpretation; MMPI interpretation; report writing.

1999-2001 **Research Assistant -** *Early Infant Development and Attachment Project*
University of Montana, Missoula – Department of Psychology
Supervisor: Lynne S. Koester, Ph.D.

1998-2001 **Research Assistant** - *Interparental Conflict and Child Adjustment Study*
University of Montana, Missoula - Department of Psychology
Data collection for studies of contingency responding by mothers to infants; videotaped observation coding of mother-infant interaction; data entry.
Supervisor: Paul Silverman, Ph.D.
Conducted child and parent interviews; evaluated children's emotional coping strategies and adjustment to parental discord; reliability coding; data entry.

PEER REVIEWED PUBLICATIONS

Deberard, M. S., Wheeler, A. J., **Gundy, J. M.** & Grew, J. (in press) Presurgical biopsychosocial variables predict medical, compensation, and aggregate costs of percutaneous or open lumbar discectomy in Utah Workers' Compensation Patients. *The Spine Journal.*

Crosby, J. M., **Gundy, J. M.**, Armstrong, A., Nye, E., Bowman, A., & Twohig, M. P. (2010). How well are we doing at reporting participant characteristics in our research? *The Behavior Therapist. 33,* 125-147.

Gundy, J. M., Woidneck, M. R., Pratt, K. M., Christian, A. W., & Twohig, M. P. (in press). Acceptance and Commitment Therapy: The state of the evidence in the field of health psychology. *Scientific Review of Mental Health Practice.*

BOOK CHAPTERS

DeBerard, M. S., **Gundy, J. M.,** Pratt, K. M, & Wheeler, A. J. (in press). Carpal Tunnel and Rotator Cuff Surgeries. In A. R. Block & D. B. Sarwer (Eds.) *Presurgical Psychological Screening: Understanding Patients, Improving Outcomes.*

MANUSCRIPTS UNDER REVIEW

Woidneck, M. R., Pratt, K. M., **Gundy, J. M.**, Nelson, C., & Twohig, M. P. A Review of the Effectiveness of Acceptance and Commitment Therapy with Minority Populations. *Professional Psychology: Research and Practice.*

Wheeler, A. J., **Gundy, J. M.,** Deberard, M. S. Using presurgical psychological variables to predict compensation and medical costs of lumbar fusion patients receiving workers' compensation in Utah. *Spine.*

MANUSCRIPTS IN PREPARATION

Gundy, J. M., Crosby, J. M., Field, C. & Twohig, M. P. Evaluating the acceptability of exposure-based treatment for children and adolescents: Client and therapist perspectives.

Gundy, J. M., Mitchell, P. R., Lensegrav-Benson, T., Quakenbush-Roberts, B., & Twohig, M. P. Quality of life outcomes for residential treatment of eating disorders.

Matthies, B., **Gundy, J. M.**, & Cachelin, F. Duration of culinary arts school training is associated with increased scores on measures of eating disorders behaviors.

CONFERENCE PRESENTATIONS

Mitchell, P. R., **Gundy, J. M.**, Lensegrav-Benson, T., Quakenbush-Roberts, B., & Twohig, M. P. (2010). *Quality of life outcomes for residential treatment of eating disorders*. Poster to be presented at the Annual Convention of the Association for Behavioral and Cognitive Therapies in San Francisco, CA.

Gundy, J. M., Wheeler, A. J., & DeBerard, M. S. (2010). *Biopsychosocial predictors of return to work status in a sample of lumbar fusion worker's compensation patients.* Focus paper presentation at the North American Spine Society (NASS) Annual Meeting in Orlando, FL.

Wheeler, A. J., **Gundy, J. M.**, & DeBerard, M. S. (2010). *Presurgical biopsychosocial variables predict medical and compensation costs in compensated lumbar fusion patients: A look at recent changes.* Focus paper presentation at the North American Spine Society Annual Meeting in Orlando, FL.

Gundy, J. M., Wheeler, A. J., & DeBerard, M. S. (2010). *Cost effectiveness of case manager and vocational rehabilitation services in a sample of lumbar fusion worker's compensation patients.* Poster presented at the Society of Behavioral Medicine's Annual Meeting and Scientific Sessions in Seattle, WA.

Wheeler, A. J., **Gundy, J. M.**, & DeBerard, M. S. (2010). *Using presurgical psychological variables to predict compensation and medical costs of lumbar fusion patients receiving workers' compensation in Utah*. Poster presented at the Society of Behavioral Medicine's Annual Meeting and Scientific Sessions in Seattle, WA.

Woidneck, M. R., Pratt, K. M., **Gundy, J. M.**, Nelson, C., & Twohig, M. P. (2010). *A Review of the Effectiveness of Acceptance and Commitment Therapy with Minority Populations.* Poster presented at the Association for Contextual Behavioral Science World Conference VIII in Reno, NV.

Crosby, J. M., **Gundy**, **J. M.,** Nye, E., Bowman, A., & Twohig, M. P. (2009). *How well are we doing at reporting participant characteristics in our research?* Poster presented at the Annual Convention of the Association for Behavioral and Cognitive Therapies in New York, NY.

DeBerard, M. S., **Gundy, J. M.,** Doty, J., Grewe, J. R., & LaCaille, R. A. (2009). *The use of retrospective-cohort designs in behavioral medicine research.* Poster presented at the Society of Behavioral Medicine's Annual Meeting and Scientific Sessions in Montreal Quebec, Canada.

Gundy, J. M., Matthies, B., Cachelin, F., Regan, P. & DeBerard, M. S. (2008). *Duration of culinary arts school training is associated with increased scores on measures of eating disorders behaviors*. Poster presented at the Society of Behavioral Medicine's Annual Meeting and Scientific Sessions in San Diego, CA.

DeBerard, M. S., LaCaille, R. A., Spielmans, G. I., Parlin, M. A., **Gundy, J. M.** & Grew, J. (2008). *Patient satisfaction with the Utah workers' compensation system following lumbar discectomy: A validity study.* Poster presented at the Annual Meeting for the Society of Behavioral Medicine in San Diego, CA.

Gundy, J. M. & Cachelin, F. (2006). *Differences in perceptions of food amounts between purging-type and nonpurging type eating disordered women.* Poster presented at the Obesity Society's Annual Scientific Meeting in Boston, MA.

Kamman, T., **Gundy, J. M.,** & Koester, L. (2000). *Infant emotions during variations in maternal availability: Correlations with types of maternal contingency.* Poster presented at the University of Montana Conference on Undergraduate Research in Missoula, MT.

Kamman, T., **Gundy, J. M.**, and Silverman, P. (1999). *The relationship between regulation of emotional complexity and the use of denial as a coping strategy in children.* Poster Presented at the Western Psychological Association Conference in Irvine, CA.

GRANT ACTIVITY

2008-2010 (funded)	**Research Co-Principle Investigator** Lumbar fusion outcomes in Utah Workers' Compensation Patients: A replication study. *Amount:* $30,000 *Funding Source*: Workers' Compensation Fund of Utah *Principal Investigator*: M. Scott DeBerard
April 2010 (not funded)	**Research Co-Investigator** The relationship between biopsychosocial risk factors, perceived workplace safety, and sustained injuries among Utah workers. *Amount*: $30,000 total *Funding Source:* Utah Labor Commission *Principal Investigator*: M. Scott DeBerard
February 2010 (not funded)	**Research Co-Investigator** Cognitive Behavioral Therapy as a treatment for workers compensation lumbar fusion patients with neuropathic back pain. *Amount:* $50,000 *Funding Source*: North American Spine Society *Principal Investigator*: M. Scott DeBerard

PROFESSIONAL DEVELOPMENT TRAINING

June 2010	ACT in Real Time: A workshop to Actively Refine your ACT Skills. *Presenters*: Robyn Walser, Ph.D.; Mary Sawyer, Ph.D. ACBS World Conference VIII in Reno, NV.

June 2010	Enhancing Values Work in Psychotherapy: Practical Tools and Exercises. *Presenters*: Joanne Dahl, Ph.D., Jennifer Plumb, M.A. ACBS World Conference VIII in Reno, NV.
June 2010	ACT With Challenging Patients. *Presenter*: Kirk Strosahl, Ph.D. ACBS World Conference VIII in Reno, NV.
April 2010	An Integrated Approach to Complex Psychological Trauma. *Presenter*: John Briere, Ph.D. 16th Annual Utah State University Counseling & Psychological Services Conference
June 2009	Professional Ethics Workshop: Ethical and Legal Aspects of Supervision. *Presenter*: Stephen Behnke, J.D., Ph.D. Utah Psychological Association & Utah State University
April 2009	Two-Day Experiential Workshop on Acceptance and Commitment Therapy. *Presenter*: Steven C. Hayes, Ph.D Utah State University, Logan, UT
April 2009	An Introduction to Acceptance and Commitment Therapy. *Presenter*: Steven C. Hayes, Ph.D 15th Annual Utah State University Counseling & Psychological Services Conference
January 2009	Ethics and Ethical Decision Making for Utah Psychologist. *Presenter*: Stephen Behnke, J.D., Ph.D. Utah Psychological Association & Utah State University, Logan, UT
October 2008	Acceptance and Values-Based Multicultural Training to Increase Multicultural Competency and Engagement in Faculty Members and Graduate Students. *Presenters:* Michael P. Twohig, Ph.D. & Melanie D. Rodriguez, Ph.D. Utah State University, Logan, UT
Fall 2008	Seminar: Acceptance and Commitment Therapy. (3 credit semester) *Instructor:* Michael P. Twohig, Ph.D. Utah State University, Logan, UT

TEACHING EXPERIENCE

Fall 2009	**Course Instructor** - Utah State University Developmental Psychology: Conception to Adolescence Taught one semester covering key information on the basic aspects of developmental psychology; organized and executed lectures, used relevant demonstrations; assistant with student research proposals;

constructed quizzes and tests; held regular office hours; mentored TA assigned to course.

Summer 2008 **Course Instructor -** Utah State University
General Psychology
Taught one semester covering introductory topics in psychology; planned and carried out instruction using a variety of teaching methods including lecturing, learning activities, and discussion; constructed quizzes and tests; allocated final grades.

2008-2010 **Guest Lectures/Seminars** - Utah State University
Introduction to Psychology: Lab Series (2 lecture)
Topic: Acceptance and Commitment Therapy for Eating Disorders.
School Psychology Graduate Course (1 lecture)
Topic: Self-Injury: What School Psychologists Should Know.
History and Systems in Psychology (4 seminars)
Topic: Seminar leader for undergraduate students on various topics

2006-2007 **Teachers Assistant -** California State University, Los Angeles
Introduction to Psychology (Fall/Spring/Winter quarters)
Professor: Gaithri Fernando, Ph.D.
Obtained materials needed for classes; proctored examinations; maintained regular office hours to meet with students; graded examinations, assignments, and papers; recorded grades.

2006-2007 **Teachers Assistant -** California State University, Los Angeles
Experimental Psychology (Fall/Winter/Spring quarters)
Professor: Fary M. Cachelin, Ph.D.
Led discussions and laboratory sections; provided assistance to students in developing final research projects; managed and graded student assignments and research activities; proctored tests.