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Disability Risk in Work-related Musculoskeletal Injuries

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List of Abbreviations

AUC	Area Under the Receiver Operating Characteristic Curve
AUDIT- C	Alcohol Use Disorders Identification Test
CART	Classification and Regression Tree
CATI	Computer-Assisted Telephone Interview
CTS	Carpal Tunnel Syndrome
CTSAQ	Carpal Tunnel Syndrome Assessment Questionnaire
FABQ	Fear Avoidance Beliefs Questionnaire
RDQ	Roland-Morris Disability Questionnaire
SF-36 v2	Short Form-36 Version 2

Abstract

The vast majority of costs and lost productivity in workers' compensation are due to work-related musculoskeletal injuries. Among injured workers with these conditions, a small proportion (5-10%) develop long-term disability and account for most (80-85%) of the cost and lost work. Low back pain and carpal tunnel syndrome (CTS) are the most common musculoskeletal conditions associated with long-term work disability. If accurate methods of early identification of workers at high risk for chronic disability could be linked to effective early intervention, substantial secondary (disability) prevention could be achieved. In the absence of an accurate method to identify workers at risk for long-term disability, secondary prevention efforts cannot be well-targeted. We have completed a population-based prospective study with the principal aim of developing models of accurate long-term disability risk identification for work-related injuries involving low back pain or CTS. We hypothesized that an accurate predictive model of risk for long-term disability would include factors both intrinsic (severity of injury, self-reported pain and function, psychosocial factors) and extrinsic (employment, administrative, and health care factors) to the worker. The ultimate goal was to develop a brief screening questionnaire that could be administered within a few weeks of injury and pilot-tested in real world clinical situations. Prior to the initiation of this study, no such accurate method of risk identification had been fully developed or tested.

The prospective cohort design involved baseline collection of both computerized claim data (e.g., demographics, administrative variables) and worker self-report data (e.g., pain, physical function, psychosocial factors, work exposure factors). In addition, worker medical records from visits in the first few weeks after injury were reviewed to assign injury severity ratings developed and assessed in an early phase of the study. The low back injury severity rating was found to have good inter-rater reliability. The principal outcome variable was wage replacement status (on/off) at one year (low back) or $\geq$ 180 days lost work time in one year (CTS). For both conditions, univariate and multivariate logistic regression analyses were used to identify the strongest predictors of outcome. In addition, classification and regression tree (CART) analysis was used to develop a parsimonious predictive model that could be translated into a brief screening questionnaire.

The final analysis samples consisted of 1,885 workers with low back pain and 899 workers with CTS. Interviews were completed at a median of 18 days following claim receipt. For low back pain, the final multivariable predictive model included injury severity (rated from medical records), specialty of the first health care provider seen for the injury (obtained from administrative data), and worker-reported (during the baseline interview) physical disability (Roland-Morris Disability Questionnaire), number of pain sites, "very hectic" job, no offer of a job accommodation, and previous injury involving a month or more off work. The model showed good ability to discriminate between workers who were disabled at one year and those who were not [area under the receiver operating characteristic curve (AUC) = 0.84]. For CTS, the final multivariable prediction model (AUC = 0.76) included age, functional status score on a self-report questionnaire, employer offer of job accommodation, job physical demands, and recovery expectations.

These findings underscore the importance of factors across different domains in predicting long-term disability risk, and of factors extrinsic as well as intrinsic to the worker.

In the final CART model for low back pain, three baseline worker self-report variables were highly predictive of one-year disability: not working in the past week, rating of pain interference with work (≥5 on a 0-10 scale), and pain radiating into the leg. In the final CART model for CTS, work status at baseline was the only strong predictor of the one-year disability outcome measure.

Based on these results, we developed a brief (6-question) questionnaire to identify, soon after a back injury, workers who are at high risk for long-term disability. At recent meetings with community occupational health clinical leaders in both Eastern and Western Washington, we presented the questionnaire and invited comments. There is high interest (from approximately 20 providers) in piloting the questionnaire, and in linking the use of the questionnaire with interventions based on worker responses.

Highlights/Specific Findings

Specific Aim 1: What combination of risk factors determined soon after low back and carpal tunnel injuries accurately predict long-term (one-year) disability?

Low back pain

Significant baseline predictors of one-year work disability (on/off wage replacement) in the final multivariable model (N = 1,885) were injury severity (rated from medical records), specialty of the first health care provider seen for the injury (obtained from administrative data), and worker-reported physical disability (Roland-Morris Disability Questionnaire), number of pain sites, "very hectic" job, no offer of a job accommodation, and previous injury involving a month or more off work. The model showed good ability to discriminate between workers who were versus those who were not disabled at one year (AUC = 0.84). These results indicate that, among patients with new back injury claims involving lost work time, radiculopathy (from the injury severity rating) and substantial functional disability, and to a lesser extent, more widespread pain and previous injury with extended time off work, are risk factors for chronic disability. Responses from employers and health care providers also appear important, supporting the need to incorporate environmental factors in models of the development of chronic disability and to work with employers to facilitate early return to work.

Carpal tunnel syndrome

Among workers with claims involving work loss due to carpal tunnel syndrome (N = 899), factors in every dimension of risk were significantly associated bivariately with long-term disability (180 or more days of disability compensation). Significant sociodemographic risk factors included younger age (those aged 45 years and older had lower risk of long term disability), less than high school education, and lower income ($\leq$ $45,000/year). Gender, race, and marital status were not significant risk factors. Significant employment-related factors included no offer of job accommodation; four factors related to increased job physical demands (frequent or constant forearm twisting, pinching, or whole body vibration, and medium, heavy, and very heavy physical demands); and five factors related to job psychosocial conditions (very hectic work, job requires working very fast, excessive work, supervisor doesn't listen, and overall low job satisfaction). Baseline measures of CTS-related symptom severity and physical function were strong predictors of long-term disability. Significant psychosocial risk factors include low recovery expectations, worse mental health (SF-36 Mental Health scale), catastrophizing, and high work fear-avoidance. The CTS injury severity rating has not yet been fully evaluated. We did not consider CTS surgery as a baseline predictor because surgery typically occurred some time after the period of baseline data collection. However, we are beginning to examine the role of CTS surgery in long-term work outcomes. Health care delivery, administrative, and health behavior factors have also not yet been fully evaluated.

Multivariable analyses indicated that sociodemographic, clinical, work-related, and worker psychosocial factors early in a claim contribute unique information to the prediction of subsequent work disability associated with CTS. The final multivariable model had reasonable ability to discriminate individuals with versus without chronic disability (cross-validated AUC = 0.76).

In sum, for both low back pain and CTS, factors across multiple domains, including factors extrinsic to as well as intrinsic to the worker, are significant predictors of long-term work disability. These findings have implications for risk identification as well as for early intervention to prevent chronic disability.

Specific Aim 2: Develop a reliable measure of injury severity that can be determined from medical records

Severity rating instruments were developed using the initial report of accident and medical records up to 8 weeks following injury. The severity rating instrument for low back injury (Table 1) was found to have adequate inter-rater reliability (weighted kappa = 0.66). Its validity is supported by the strong associations found between greater injury severity and work disability at one year, even after adjusting for baseline pain and function. The severity rating instrument for CTS is shown in Table 2.

Specific Aim 3: Develop brief risk factor screening instruments that could be applied in a health care provider's office soon after low back or CTS injuries

CART analysis revealed that three worker responses in the baseline interview predicted work disability one year after low back injury: 1) not working in the past week, 2) pain interference with work (rating $\geq$5 on a scale of 0-10), and 3) pain radiating into the leg. Among workers who reported all three factors at the baseline interview, 36% were disabled at one year; in contrast, among workers with no positive responses, less than 1% were disabled at one year.

We used these questions plus three additional questions reflecting other factors that were strong bivariate predictors of one-year back pain disability in a draft of a disability risk screening questionnaire (Table 3). The draft questionnaire was presented in two focus groups of clinicians (N = 32) in Eastern and Western Washington. The questions had good face validity. The majority of these health care providers, including both primary care and specialty providers, agreed to participate in a pilot study of the questionnaire.

Specific Aim 4: Rates and predictors of re-injury within 2 years of initial low back and CTS injury

We defined re-injury as either a claim re-opening or a new claim for the index injury condition. Among the sample of workers with back injury claims that involved compensation for lost work time (N=1,855), 12% had a re-injury within four years. Among the sample of workers with claims for CTS that involved lost work time (N =

899), only 2% had claims that were closed and then re-opened, and only 3% had new CTS claims.

Translation of Findings

The key findings of this project will contribute substantially to the secondary prevention of long-term disability due to work-related back pain, the most common and most burdensome injury in the workers' compensation system. The results from this study have been used to develop the first brief questionnaire designed to screen workers for risk of long-term disability within 2-4 weeks of low back injury (Table 3). It will be tested for ease of implementation in two ongoing community-based quality improvement health care delivery pilot projects in Washington State.[1,2] These pilot projects involve reorganization of care through financial incentives so that occupational health best practices are used for the majority of injured workers in the first 12 weeks (especially at the first 3-4 health care provider visits) following injury. These efforts have been demonstrated to reduce overall disability and costs by approximately 20-30%. This was achieved, in part, by more timely communication and action by the attending providers, for example, by more timely submission of the report of injury, by timely communication with the injured worker's employer, and by timely submission of a prescription for return to work activities. However, a detailed assessment of barriers to return to work 2-6 weeks after injury has not been well-implemented because of a gap in knowledge concerning risk. We hope that the risk factor questionnaire will accurately identify, during that time frame, the workers who are at greatest risk for long-term disability and who may benefit from additional services targeted to specific modifiable risk factors. For example, workers who have pain radiating into the leg should have a more timely assessment of radicular symptoms and treated accordingly. Workers who have high levels of fear regarding work increasing their pain or causing further damage could be given a specific educational module addressing this important psychosocial risk factor. Workers who have not had an offer of work accommodation could receive a more in-depth assessment of workplace interventions/modifications. Thus, the risk factors identified in this project will help in both the early assessment of risk and in targeting services to risk factors that may be modifiable.

The risk factor models from both the low back and CTS cohorts will change the way in which future research on risk for long-term disability after work-related musculoskeletal injury will be conducted. For both conditions, a more comprehensive conceptual model, including factors both intrinsic and extrinsic to the worker, must be considered. For low back pain, much of the previous research has focused primarily on intrinsic factors in a biopsychosocial model, with little attention to the environment. Contrariwise, for work-related CTS, much of the prior research has focused on extrinsic factors, with little focus on factors intrinsic to the worker. It is apparent from our findings that a more balanced approach to risk modeling for both conditions is more likely to lead to effective secondary prevention interventions.

Outcomes/Relevance/Impact

This study is the largest population-based prospective cohort study of injured workers ever conducted with baseline assessment of both administratively available (computerized) and worker self-report data. As such, it represents the most comprehensive assessment of risk factors for long-term disability from low back and carpal tunnel injuries. In addition to meeting the study's initial specific aims, additional important findings (e.g., patterns of opioid medication use and relationship to subsequent disability) have emerged from analyses of the rich, comprehensive dataset. The study's key findings have been translated into a usable long-term disability risk assessment questionnaire for workers with low back injury, and new health care interventions relevant to the modifiable risk factors will be developed and implemented in a community-based occupational health care intervention study. The injury severity measures developed as part of Specific Aim 2 are the first such measures specific to work-related low back and carpal tunnel injuries and will be useful in future studies of these important musculoskeletal conditions.

Scientific Report

Background

Disability associated with work-related musculoskeletal disorders is an increasingly serious problem in society. Although the majority of workers with such disorders return to work quickly, a substantial number do not, and they account for the majority of associated costs. For example, a study of workers' compensation claims initiated in the United States in 1989 found that for low back pain claims, one quarter of the claimants accounted for 96% of the costs; similarly, for all claims, 25% accounted for 97% of total costs.[3] In a study of over 100,000 1992 low back claims, 10% of claimants were responsible for 86% of the total costs.[4] In 7% of the claims, disability was longer than one year, and these accounted for 75% of the costs and 84% of the total disability days. Similarly, about 7% of 1994 claims for work-related upper extremity musculoskeletal disorders had disability greater than one year, and these accounted for 60% of the costs and 75% of the total disability days.[5]

The direct and indirect costs of chronic disability to the injured worker, his or her family, employers, and society are enormous. Data support the need to identify high-risk workers soon after an injury so that an effective intervention can be made within the first few months. For example, one study found that if a worker had not returned to work by 3 months, there was a 50% chance that he or she would not be working at 15 months.[6] With accurate predictive algorithms, limited resources can be targeted toward those most in need. Furthermore, the identification of factors that predict chronic disability may also shed light on why some workers develop chronic disability, and thus guide the development of intervention strategies that may prevent this process from occurring.

Secondary prevention programs are not necessary for the majority of injured workers, because most will recover quickly. Early accurate identification of injured workers at high risk for chronic disability and early intervention for these workers has the potential to have an enormous positive impact in terms of preventing the devastating financial and personal (e.g., quality of life) costs of disability. It has not been possible from available information to accurately predict which workers with recent injuries will go on to develop chronic disability.

We previously reviewed the literature on risk factors for chronic work disability.[7] Based on this review as well as subsequent research, we identified a number of potential risk factors in different domains to investigate in this study. The demographic factor most commonly found to be associated with chronic disability is older age.[6,8-17] With respect to biomedical and injury-related factors, more severe injuries[8,9,14,15,18] and greater pain and functional disability[17,19,20] have been demonstrated consistently to predict chronic disability. With respect to work-related factors, most studies have found occupation not to be associated significantly with chronic disability.[8,9,11] Two U.S. studies found that workers in small companies had poorer outcomes,[9,10] but firm size was not predictive of cumulative compensated work absence in two Canadian studies.[8] Physically demanding work has been found to predict disability,[21,22] and workplace offer of job

accommodations/modifications has been found to be associated with shorter duration of disability.[23] With respect to psychosocial factors, worse outcomes have been found for workers who blamed work factors for their pain (as opposed to blaming themselves or other factors), rated their relations with coworkers as poor, or had low expectations of recovery.[19,24,25]

Two recent studies that have examined predictors of disability in multivariate models warrant mention. In a study of 617 New Zealand workers in three occupational groups with claims for work-related back injuries, radiating leg pain, a high body mass index, moderate to high physical disability, psychological distress, and unavailability of light duty work predicted disability compensation status at three months.[23] In a study of Canadian workers with soft tissue injuries of the back, arms, or legs who were interviewed soon after injury and still receiving wage replacement benefits at four weeks, work disability duration was predicted by functional disability, change in pain from two to four weeks after injury, and workplace offers of job modifications.[25] Poor recovery expectations also predicted longer disability duration. The demographic and workplace factors examined did not predict disability duration. It is unknown whether similar results would be found in the U.S., in a setting with different health care insurance and workers' compensation systems.

Specific Aims

Specific Aim 1: The principal aim of this study was to determine the combination of employment-related, biomedical/healthcare, sociodemographic, administrative/legal, and psychosocial variables at the time a claim is allowed that best predicts worker disability status one year later, for low back injuries and CTS. Because various measures of outcome are not perfectly correlated, one objective of this study was to compare the predictive models for different outcomes (wage replacement status at one year, cumulative number of lost work days during the year after claim allowance, work status, functional status). A second objective was to determine the relative importance of computerized administrative data versus worker self-report data in their ability to predict the one year disability outcome. This objective would assist in determining the potential cost efficiency of the two types of data collection (computerized data vs. self-report data) in operationalizing a disability prediction and prevention program.

Specific Aim 2: to develop a reliable measure of injury severity that could be determined from medical records.

Specific Aim 3: to develop brief instruments to be administered by the attending physician of an injured worker soon after injury. These instruments would assess the key variables identified by our models as predictors of chronic disability for each injury type.

Specific Aim 4: to determine rates and predictors of re-injury among workers with low back injury who return to work within two years following the initial disability episode.

Methods

Design

This was a population-based, prospective study. The study procedures and measures were approved by the University of Washington Human Subjects Review Committee.

Case identification

The study population consisted of workers who filed claims for wage-replacement (work disability) benefits for work-related back injuries or CTS in Washington State. Approximately two-thirds of workers in Washington State are covered by the state workers' compensation fund.

Updates to a computerized claims database maintained by the Washington State Department of Labor and Industries (DLI) were reviewed weekly. Claimants were excluded from the study if they had an aggravation or reopening of a prior claim to the same body part or if younger than 18 years of age. For each claim, we examined the contents of a text field that described the injury condition to identify CTS and back injuries. We identified all new compensable or provisional back injury work loss claims. A compensable claim is a claim that has been accepted for wage-replacement (work disability) compensation based on the worker missing 4 or more days of work due to the injury. A provisional claim receives "provisional time-loss" benefits paid if a final decision cannot be made within 14 days. We identified all new CTS claims (excluding those initially rejected by the DLI) rather than just compensable claims because the time to determination of claim compensability is much longer for CTS than for back claims and the majority of compensable CTS claims had not yet been allowed at the time of the weekly new claims updates.

Procedures

We mailed letters describing the study to all potential study participants as they were identified. One week later, we began attempting to reach each potential participant by telephone. Trained interviewers described the study, screened for eligibility, and obtained informed consent. Exclusion criteria at the time of interview were worker denial of job injury, worker denial of injury to the back or arms/hands, and inability to complete a telephone interview (e.g., due to inability to understand and speak English or Spanish, a hearing problem, or serious illness). Up to 20 attempts, over a 6-week interval, were made to contact each worker (daily during the first 10 days, then at three-day intervals). A second letter was mailed to workers who could not be contacted after 10 days of attempts. These letters contained the same information as the introductory letters, but mentioned the inability to make contact with the claimant and offered a toll-free number to suggest a good time for an interview. The interviewers conducted a baseline computer-assisted telephone interview (CATI) with workers who enrolled in the study. A thank-you letter and a $10 check were mailed to each worker who completed the baseline interview.

Eleven months after the baseline interview, study participants were mailed letters indicating that they would be telephoned soon for the follow-up interview. Up to 20 attempts were made to contact each participant. Workers were compensated $10 for completion of the follow-up interview.

Baseline interview

The baseline interview was used to obtain information not available in computerized administrative databases. This included worker and job characteristics and the hypothesized risk factors.

Sociodemographic characteristics. Workers were asked about their marital status, education, income, spouse's (if applicable) work status, and race/ethnicity. (Age and gender were obtained from administrative databases.)

Biomedical, health care, and injury-related characteristics. Workers were asked about the number of sick leave days they used in the year prior to injury, whether they had treatment aimed at reactivation, prior injuries, whether their health care provider told them when they could return to work, communication between their health care provider and their employer, comorbid conditions, date of injury or symptom onset, and their health currently and in the year prior to injury.

Claimants rated their average pain intensity in the past week on a 0 – 10 scale, where 0 = no pain and 10 = pain as bad as could be.[26,27] Such numerical pain rating scales have been demonstrated to be valid and sensitive to change.[28] Claimants were also asked about persistent pain problems prior to this claim, and whether they had persistent, bothersome pain in different parts of the body.

Pain interference with daily activities and ability to work were assessed by questions (0–10 scale) from the Graded Chronic Pain Scale.[26,27] Physical functioning was assessed by the Short Form-36 Version 2 (SF-36v2)[29] Physical Functioning and Role-Physical scales. Experts have recommended supplementing generic health status instruments such as the SF-36 with condition-specific instruments to increase the sensitivity of assessment of functional status in various patient populations.[30,31] Therefore, workers with low back injuries completed the Roland-Morris Disability Questionnaire (RDQ)[32] and workers with CTS completed the Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ)[33]. The RDQ is widely used to assess physical disability associated with low back pain, and has been demonstrated to be valid, reliable, and responsive to change.[32,34-39] The CTSAQ, which contains symptom severity and functional status scales, has also been demonstrated to be valid, reliable, and responsive to clinical change.[33,40-42]

Work-related variables. Questions from the Vermont Disability Prediction Questionnaire[19] assessed workers' perceptions of who was to blame for the injury (self, work factor, someone/something else, no one), how well he/she gets/got along with co-workers (0 = don't get along well at all, 10 = get along extremely well), and confidence that he/she will be working in 6 months (0 = not at all certain, 10 = extremely certain). Other questions assessed current work status, job demands, offer of job accommodation,

length of time employed at job where injured, communication from employer, and job satisfaction.

Administrative/legal variables. Workers were asked if they had retained an attorney and whether they had previous workers' compensation claims.

Psychosocial characteristics. Fear-avoidance (perception that return to work will cause exacerbation of symptoms or re-injury) was assessed by two items from the Fear-Avoidance Beliefs Questionnaire (FABQ) work scale ('my work might harm my back/arms/hands', 'my work might make my pain worse').[43] This scale has been found to have high internal consistency, and to be associated with work loss.[43] Problematic alcohol use was assessed by the three-item Alcohol Use Disorders Identification Test (AUDIT-C).[44] Mental Health was assessed by the SF-36v2[29] Mental Health (MH) scale, a measure of psychological distress (low scores)/well-being (high scores). Participants' responses to three questions from the Pain Catastrophizing Scale[45] concerning how much they have certain thoughts when in pain ('I feel I can't stand it anymore,' 'It is awful and I feel that it overwhelms me,' and 'I keep thinking about how badly I want it to stop') were averaged for a single measure of pain-related catastrophizing.

Injury severity rating

We developed structured forms for rating the severity of back injury and CTS. Trained nurse reviewers used these forms to rate injury severity based on study participants' medical records from health care visits made during the first eight weeks after claim receipt. Five percent of cases were reviewed independently by a second reviewer as well as by an expert occupational medicine physician and inter-rater agreement was monitored on an ongoing basis. Injury severity ratings were completed for all study participants.

One-year follow-up

From DLI administrative data, we obtained the number of days of wage replacement benefits for injury-related inability to work ("work disability duration") in the year after claim receipt and information concerning whether or not the worker was still receiving work disability (wage replacement) benefits one year after claim receipt. Additional outcomes assessed at the one-year follow-up telephone interview included the Graded Chronic Pain Scale pain intensity and pain-related disability measures, physical disability as assessed by the generic SF-36v2 Physical Functioning scale[29] and the condition-specific disability measures, mental health (SF-36v2), and work status.

Results

Study participants

Back injury cases. Among 4,354 back injury claimants identified, 2,147 (49%) enrolled in the study and completed the baseline interview, 1,178 (27%) could not be contacted, 120 (3%) were ineligible, and 909 (21%) declined to participate. Among the 2,147 baseline interview completers, 1,517 (71%) completed the follow-up interview, 107 (5%) declined to complete it, 516 (24%) could not be contacted, and 7 (0.3%) were unable to complete the interview (e.g., too ill to be interviewed).

CTS cases. Among 3,983 CTS claimants identified, 2,055 (52%) enrolled and completed the baseline interview, 811 (20%) could not be contacted, 234 (6%) were ineligible, and 883 (22%) declined to participate. Medical records were reviewed to confirm CTS diagnoses. Among the 2,055 study participants with CTS, 1,598 (78%) completed the follow-up interview, 99 (5%) declined to be interviewed, 354 (17%) could not be contacted, and 4 (0.2%) could not complete the interview.

Specific Aim 1: multivariate prediction of one-year outcomes

Back injury sample

In a preliminary study, we analyzed data collected from workers with back injuries who enrolled in the first year of the study.[46] Baseline demographic, pain, disability, and psychosocial measures obtained from 1,068 workers were used to predict work disability 6 months after claim submission. At 6 months, 196 workers (18.4%) were receiving work disability compensation. Age, race, education, and baseline pain and disability were significant predictors of 6-month disability. Adjusting for baseline demographics, pain, disability, and other psychosocial variables, high work fear-avoidance [OR (95% CI), 4.6 (1.6-13.7)] and very low recovery expectations [OR (95% CI), 3.1 (1.5-6.5)] were significant independent predictors. These results suggest that, among individuals with acute work-related back pain, high pain and disability, low recovery expectations, and fears that work may increase pain or cause harm are risk factors for work disability six months after injury.

For the final analyses using the entire sample of workers with back injuries who enrolled in the study, we excluded study participants who did not receive work disability compensation within a year after injury (n = 240), those with missing data on age (n = 3), those who were not confirmed to have a back injury upon review of medical and administrative records (n = 3), and those who were hospitalized for their injury (n = 16). The final back injury case analysis sample size was 1,885. We had proposed to use a continuous measure of disability outcome (number of days of lost work time compensation) at one year. However, when we inspected the data obtained, it was apparent that there were problems meeting the assumptions required for proportional hazards analyses and that using a dichotomous outcome would be better for statistical

reasons. Therefore, we used logistic regression analyses to identify early predictors of receipt of work disability compensation one year after claim submission.

Key risk factors within every dimension were significant predictors of long-term disability status (on/off work disability one year after injury) in bivariate analyses. Among the sociodemographic factors, age (35-44 yrs) and education (lower) were significant predictors. Significant employment-related factors were worker's industry, no employer offer of job accommodation, shorter job tenure, supervisor who doesn't listen, and numerous markers of work exposure (whole body vibration, heavy physical demands, fast pace of work, excessive amount of work, not enough time to do job, a very hectic job, and inability to take breaks). All measured factors related to baseline pain and function were highly predictive, including greater number of pain sites, pain intensity, pain interference with daily activities, pain interference with work, Roland disability score, SF-36 physical function and role-physical scores, and change in pain since injury. Clinical status factors significantly associated with one-year disability included injury severity measured from medical records, report of pain radiation below the knee, prior injury with at least one month off work, number of prior workers' compensation claims, presence of other major medical problems, and general health in the prior year. Significant health care delivery factors included specialty of first provider seen for the injury (chiropractors were associated with a reduced risk of long-term disability), whether the health care provider discussed further injury prevention, and lack of health insurance. Administrative/legal factors that were significant included longer time from injury to the first medical visit, longer time from the first medical visit to claim receipt, and having an attorney for the claim. Health behavior factors (tobacco use, heavy alcohol use, and body mass index) were not significantly associated with long-term disability. Significant psychosocial factors included greater catastrophizing, lower recovery expectations, greater work fear-avoidance, and worse SF-36 mental health scores.

Significant baseline predictors of one-year work disability in the final multivariable model were injury severity (rated from medical records), specialty of the first health care provider seen for the injury (obtained from administrative data), and worker-reported physical disability (Roland-Morris Disability Questionnaire), number of pain sites, "very hectic" job, no offer of a job accommodation, and previous injury involving a month or more off work. The model showed good ability to discriminate between workers who were disabled at one year and those who were not (AUC = 0.84). A manuscript describing these results is currently under review.

We also examined additional important outcomes (functional status, work status, wage status, claim closure) to determine if factors predicting long-term disability varied when other outcomes were considered. Similar to the models using wage replacement compensation at one year as an outcome, the baseline variables strongly associated with self-reported work status at one year in back injury cases included lack of employer offer of a job accommodation, greater number of pain sites, and higher Roland-Morris Disability Questionnaire scores. Unlike the logistic models examining predictors of wage replacement status, recovery expectations were strongly associated with self-reported work status at one year, even after adjusting for other predictors. A few variables that

were predictive of wage replacement compensation status at one year were not strongly associated with self-reported work status at one year. Injury severity, self-report of a hectic job, type of first provider, and previous injury were either not statistically significant or of borderline significance when self-reported work status was the outcome. However, it should be noted that only 71% of the back injury sample completed the one-year follow-up interview whereas complete administrative outcome data were available for the sample, and sample differences as well as outcome measure differences may explain the varying results.

The baseline factors associated with whether a workers' compensation claim for back injury remained open or was closed during the year after claim receipt were very similar to those associated with wage replacement compensation and self-reported work status. Workers with greater self-reported physical disability [Roland-Morris disability questionnaire (RDQ) score], with more severe injury (rated from the medical records), with lower recovery expectations, and who had not been offered job accommodations were more likely to have an open workers' compensation claim one year after injury.

We also examined baseline predictors of self-reported physical disability due to back pain (RDQ scores) at follow-up. The two strongest predictors of RDQ scores at one year were RDQ scores at baseline and baseline number of pain sites. In addition, workers with higher catastrophizing scores at baseline reported greater physical disability at follow-up. Other factors were not strongly associated with physical disability at follow-up after adjusting for baseline physical disability.

Among subjects with back injuries who were working at one year, none of the baseline predictors of other outcomes were associated with changes in self-reported wages over the year. It appears that the factors that predict work disability are not associated with changes in wages one year after injury.

Specific aim 1 also included the objective of determining the relative importance of computerized administrative data versus worker self-report data in their ability to predict the one-year disability outcome. Available administrative data include age and gender as well as information about industry, provider type, attorney involvement, prior claims, and timing of injury, medical care, claim receipt, and claim allowance. Industry, type of first provider seen for the injury, time from injury to first medical visit, time between first medical visit and claim receipt, and having an attorney for the claim were all significantly associated with long-term disability bivariately among workers with back injuries. However, provider type was the only administrative variable that was significantly associated with long-term disability in the final multivariable model resulting from analyses of all available baseline measures obtained from both computerized administrative databases and the worker interview. This finding indicates that self-reported data have substantially greater value than administrative data in the prediction of long-term disability.

<u>CTS cases</u>

For purposes of analyses examining baseline predictors of work disability compensation in the year after submission of a CTS claim, we excluded claims ultimately not accepted for disability compensation for CTS and claims with no days of paid work loss compensation. This left a sample of 899 for these analyses. We explored several different outcome measures for the CTS sample, which differed from the back injury sample in pattern of work loss after claim filing. Inspection of the work loss days for the CTS sample suggested that less than versus at least 180 days of disability compensation was a reasonable indicator of long-term work disability in this cohort. Baseline demographic variables, symptom severity, functional limitations, lack of job accommodation, job physical demands, job psychosocial conditions, and worker psychosocial characteristics predicted chronic disability bivariately. Multivariable analyses indicated that sociodemographic, clinical, work-related, and worker psychosocial factors early in a claim contribute unique information to the prediction of subsequent work disability associated with CTS. The final multivariable model had fair ability to discriminate individuals with versus without chronic disability (cross-validated AUC = 0.76). These findings were reported in the American Journal of Industrial Medicine.[47]

We also examined baseline factors associated with other measures of long-term disability in workers with CTS. Other outcomes included self-reported work status and functional status scores on a CTS questionnaire at one year, change in wages, and claim status. The baseline factors associated with self-reported work status and functional status at one year were similar to those that were associated with receipt of at least 180 days of wage replacement benefits. Baseline variables that were strongly associated with self-reported work status one year after filing a claim included not receiving an employer offer of job accommodation, pain interference with work, and whether symptoms were bilateral or unilateral. The strongest predictor of functional status at one year was the baseline CTS functional status score. Other baseline factors associated with functional status at follow-up included gender and fear-avoidance. The baseline variables associated with longer duration of wage replacement benefits, self-reported work status, and self-reported functional status at one year were found not to be associated with change in the workers' wages or with whether the claim had closed.

Specific Aim 2: measure of injury severity

We developed an instrument to rate back injury severity from medical records. The back injury severity rating was designed so that the presence of symptoms or objective signs with high specificity would result in a higher score. Trained nurses reviewed each study participant's medical records (including history, physical examination findings, current symptoms, and diagnoses) from the first medical visit for the worker's compensation claim. The nurses also reviewed the medical records from subsequent visits over the next eight weeks for corroboration of the initial findings. We chose an 8-week timeframe because it can take that long to have a second or third visit, and because occasionally that period of time is necessary to obtain more complete information concerning the nature of the back problems. After the initial training in the use of the instrument, 5% of the cases were rated for injury severity independently by two nurses. In addition, a 5% sample was

compared to a "gold standard reviewer," an occupational medicine physician or an occupational health nurse. Additional training was provided as needed. Overall weighted percent agreement (calculated by giving exact agreement a weight of 1, disagreement by one category a weight of 0.66, disagreement by two categories a weight of 0.33, and disagreement by three categories no credit) between the nurse raters and an occupational medicine physician or occupational health nurse was 90%. Weighted Kappa (chance-corrected agreement) was 0.66, indicating a substantial level of agreement.

The low back injury severity instrument (Table 1) is used to classify workers with back injuries into one of four categories, based on the most complete information available from medical records closest to the time of the injury: 1) mild sprain or strain or minor physical examination findings; 2) major sprain or strain as evidenced by substantial immobility; 3) evidence of radiculopathy or positive straight leg raising test; and 4) knee or ankle reflexes absent, injury-related bladder complaints, or motor abnormalities. Due to the small number of cases in the last category, we combined the last two categories for data analyses.

The validity of the low back injury severity rating has been assessed by examining its association with long-term disability[48] and its role as a confounding variable in the prediction of long-term disability from early opiate medication use.[49] Compared to workers with minor findings (e.g., mildly decreased mobility), those with substantial immobility or radiculopathy had significantly increased odds of receiving wage replacement compensation at one year.[48] Receipt of opioids in the first few weeks after injury was associated with about a 4-6-fold increased risk of subsequent disability in bivariate analyses. This relationship was substantially attenuated after adjustment for baseline pain, function, and injury severity.[49]

The same methods used for the low back injury severity rating were applied in the development of the CTS injury rating scale. A five-level severity rating instrument was developed and applied to all cases (Table 2).

Specific Aim 3: brief disability risk screening questionnaire

To develop a brief questionnaire to identify workers with back injuries at high risk for long-term disability, we used CART analysis to identify single items from the baseline interview and administrative data available early in claims that were most predictive of long-term disability. Long-term disability was defined as receiving wage replacement benefits one year after claim filing. To determine the combination of items that best predict long-term disability, we conducted a recursive partitioning analysis using CART software to create classification trees.[50,51] CART creates decision trees starting with a "parent" node that is split into "child" nodes by choosing the factor that most accurately separates subjects into high and low risk groups. The child nodes may then be split and this process continues until the node has too few cases or no further splitting is possible. The trees can then be pruned to obtain a smaller number of terminal nodes.

In the primary CART analysis, baseline worker rating of pain interference with ability to work; self-report of current work status; and report of pain, numbness, or tingling in the leg were chosen as the top three variables. Workers who rated pain interference with ability to work as 4 or lower on a scale of 0 (no interference) to 10 (unable to carry on any activities) had a very low risk of long-term disability (< 2%). Among workers with ratings of 5 or higher, about 22% developed long-term disability. Among subjects who rated pain interference with work as 5 or higher, said they were not working at the time of the baseline interview, and reported pain radiating in the leg, 36% were receiving work disability payments one year later. This model accurately classified the one year disability status of 77% of the workers. The sensitivity was 72%, specificity was 78%, and the positive predictive value was 35%. The AUC was 0.79. A manuscript reporting these results is currently under review.

Based on these results, we developed a brief questionnaire (Table 3) to be used at the time of a medical appointment approximately 2-4 weeks after injury. The questionnaire includes the three items from the CART model (pain interference with work, work status, and radiating pain) as well as questions about an offer of job accommodations from the employer, certainty of work in six months, and work fear-avoidance (variables identified in both the multivariate logistic regression analyses and in other studies as important predictors of long-term disability due to a back injury).

We conducted two meetings with experts in occupational medicine, surgery, and primary care who treat injured workers in order to present the questionnaire and invite feedback. One meeting was conducted in western Washington (10 providers) and one in eastern Washington (22 providers). Both groups agreed upon the value of the questions that were selected from the statistical models and discussed possible intervention strategies that could be targeted to workers identified as high risk based upon the screening questionnaire. Possible interventions include phone calls to employers to encourage work accommodations so that workers are able to return to work, targeted physical therapy, and education to address fear-avoidance and recovery expectations. Approximately 20 physicians who participated in these meetings volunteered to participate in pilot testing of this screening tool.

We have also conducted preliminary CART analyses of data provided by workers with CTS. We examined models predicting receipt of at least 180 days of wage replacement in the two years after claim filing in workers (N = 899) with compensable carpal tunnel claims (eligible for wage replacement benefits for missing at least 4 days of work). Overall, among these workers who received at least one day of wage replacement, 29% received wage replacement for 180 days or more during the two years after filing a claim. The best predictive model includes only self-reported work status at the baseline interview filing. Among subjects who were working at the time of the baseline interview (about 3 weeks after filing a workers' compensation claim), 15% received at least 180 days of wage replacement benefits. In contrast, among subjects who were not working at the time of the baseline interview, 54% received at least 180 days of wage replacement benefits. This model accurately classified 74% of workers and the AUC was 0.71.

We did not include surgery for CTS in the models predicting long-term disability because in most cases the surgeries occurred a number of months after the baseline interview. However, many workers receive their first wage replacement benefits at the time of surgery. About 64% of workers who had CTS surgery started wage replacement benefits at the time of surgery. We are beginning analyses to examine the relationship between surgical treatment for CTS and duration of disability benefits.

Specific Aim 4: predictors of re-injury

Among the analysis sample of 1885 workers with back injuries, 40% filed at least one new workers' compensation claim for any type of injury and 9% filed more than one claim within four years of follow-up. About 10% filed a claim for a new back sprain and about 61% of these were compensable claims (involving wage replacement benefits for missing at least 4 days from work.) In about 3% of cases, a workers' compensation claim was reopened because of need for additional medical care or wage replacement benefits related to the initial injury. Combining reopenings and new back claims as a measure of reinjury, 12% of workers with compensable back injuries had a reinjury within four years. It should be noted that 22% of our sample of 1885 workers with new compensable claims for back injuries had at least one prior claim for a back injury and 10% had a prior compensable claim (with wage replacement benefits) within the five years prior to the workers' compensation claim identified in this study.

Factors that were associated with long-term disability in workers with back injuries were not predictive of reinjury (measured by combining new claims for back injuries with reopenings of the index claim). Risk of reinjury was not associated with age, gender, education, industry, job physical demands, type of physician, health in the prior year, previous injury with at least one month of missed work, administrative delays, mental health scales, or measures of pain or functional status. Factors that are predictive of a long duration of disability once someone is injured do not appear to predict the risk of new injuries at work among workers who return to work.

Among workers with compensable claims for CTS (N=899), 33% had at least one new claim for any type of injury and 6% had two or more. About 44% of the new claims were for upper extremity injuries and 11% were for CTS. Only 2% had a CTS claim that was closed and reopened during the four year follow-up. We plan in the future to examine predictors of new claims and re-openings of claims in the CTS sample.

Discussion

Significant baseline predictors of work disability (receipt of wage replacement compensation) one year after filing a new claim for a back injury in the final multivariable model were injury severity (rated from medical records), specialty of the first health care provider seen for the injury (obtained from administrative data), and worker-reported physical disability (Roland-Morris Disability Questionnaire), number of pain sites, "very hectic" job, no offer of a job accommodation, and previous injury

involving a month or more off work. The model showed good ability to discriminate between workers who were/were not disabled at one year. These results indicate that, among patients with new lost work-time back injury claims, radiculopathy and substantial functional disability, and to a lesser extent, more widespread pain and previous injury with extended time off work, are risk factors for chronic disability. Employment and health care factors also appear important, supporting the need to incorporate environmental factors in models of the development of chronic disability and to change behaviors of employers and health care providers to facilitate early return to work.

We also examined additional important outcomes at one year to determine if factors predicting long-term disability varied when other outcomes were considered. Baseline predictors were generally similar for functional status, work status, and claim closure, especially lack of employer offer of a job accommodation, greater number of pain sites, and higher RDQ scores. Workers with higher RDQ scores, with more severe injury (rated from the medical records), with lower recovery expectations, and who had not been offered job accommodations were more likely to have an open workers' compensation claim one year after injury. Recovery expectations were also strongly associated with self-reported work status at one year, even after adjusting for other predictors. Unlike the models predicting wage replacement compensation status at one year, injury severity, self-report of a hectic job, type of first provider, and previous injury were either not statistically significant or of borderline significance when self-reported work status was the outcome. However, only 71% of the back injury sample completed the one-year follow-up interview whereas complete administrative outcome data were available for the sample, and sample differences as well as outcome measure differences may explain the varying results. Among subjects with back injuries who were working at one year, none of the baseline predictors of other outcomes were associated with changes in self-reported wages over the year. It appears that the factors that predict long-term work disability are not associated with changes in wages one year after injury among workers who return to work. However, these findings generally support the consistency of early risk factors across different measures of outcomes at one year.

The results of the CART analyses of the back sample data suggest that after identifying workers who are at high risk of long-term disability, health care providers will need a variety of strategies to improve return to work outcomes. It is of interest that pain interference with work, regardless of how asked (either by a rating of degree of pain interference with work, by a rating of the degree of limitations in work or daily activities, or by simply asking whether the worker was currently working), was a more important predictor of long-term disability than the worker's rating of pain intensity. This suggests the potential importance of interventions targeted specifically at improving the worker's ability to accomplish his/her work roles and tasks, rather than targeted solely on pain reduction.

Specific aim 1 also included the objective of determining the relative importance of computerized administrative data versus worker self-report data in the prediction of the one-year work disability outcome. Provider type was the only administrative variable that was significantly associated with wage replacement status at one year in the final

multivariable model resulting from analyses of all available baseline measures obtained from both computerized administrative databases and the worker interview. This finding indicates that self-reported data contribute substantially more than administrative data to the prediction of long-term work disability.

Analyses of data from the CTS sample indicated that work disability compensation at a single point in time one year after claim filing was not a good outcome measure, as work disability tended to occur at different times within the sample, often around the time of surgery. This pattern of disability differed from that of workers with back injuries, for whom work disability status at one year was a good marker of chronic work disability. Baseline demographic variables, symptom severity, functional limitations, lack of job accommodation offer, job physical demands, job psychosocial conditions, and worker psychosocial characteristics predicted chronic disability (defined as at least 180 days of disability compensation) bivariately. Multivariable analyses indicated that sociodemographic, clinical, work-related, and worker psychosocial factors early in a claim contribute unique information to the prediction of subsequent work disability associated with CTS. The final multivariable model had fair ability to discriminate individuals with versus without chronic disability. In both the CTS and the back injury models, condition-specific measures of symptom severity and physical disability, administered approximately three weeks after claim filing, were strong predictors of subsequent work disability (wage replacement compensation).

We also examined other measures of long-term disability in workers with CTS, including self-reported work status and functional status scores on a CTS questionnaire at one year, change in wages, and claim status. The baseline factors associated with self-reported work status and functional status at one year were similar to those that were associated with receipt of at least 180 days of wage replacement benefits. Baseline variables that were strongly associated with self-reported work status one year after filing a claim included not receiving an employer offer of job accommodation, pain interference with work, and whether symptoms were bilateral or unilateral. The strongest predictor of functional status at one year was the baseline CTSAQ functional status score. Other baseline factors associated with functional status at follow-up included gender and fear-avoidance. The baseline variables associated with longer duration of wage replacement benefits, self-reported work status, and self-reported functional status at one year were found not to be associated with change in the workers' wages among subjects who were working at one year or with whether the claim had closed.

The back injury severity measure developed in this study was found to have acceptable inter-rater reliability. Evidence supporting its validity came from its significant associations with other indicators of injury and disability, including early receipt of opioid medication and wage replacement status at one year. This measure promises to be useful in future studies of back injuries when a measure of injury severity is needed. We are planning to perform similar evaluations of the CTS injury severity measure in the future.

The brief long-term back disability risk screening questionnaire also is promising for both future research studies as well as application in real-world settings. We plan to pilot the questionnaire as part of an ongoing quality improvement health care delivery project in Washington State and to develop early interventions that could be targeted to workers based on their questionnaire responses.

Conclusions

For both low back injury and CTS, models of disability prediction should be comprehensive and include factors both intrinsic (age, pain, function, injury severity, psychosocial) and extrinsic (workplace physical and psychosocial characteristics, health care, administrative) to the worker. Such a multidimensional approach is more likely to lead to treatment approaches targetted at the most modifiable risk factors, especially those related to healthcare delivery, workplace factors, and issues related to administrative systems. This type of approach is also more likely to be associated with the development of treatment approaches specific to identified modifiable factors. The important psychosocial issues identifed in this and other studies (work fear-avoidance, low expectations of return to work) may be amenable to early education and other approaches.

Data from a parallel community-wide health care intervention study we have been conducting in Washington State suggests that early incentivization of occupational health best practices, including more timely payment of benefits, can prevent approximately 20% of the disability engendered currently in the system. One gap in this project has been the inability to accurately identify barriers to return to work by approximately four weeks of disability. The brief questionnaire developed for low back injury for this study appears to be acceptable to the providers participating in the intervention study; thus, pilot testing and implementation are planned shortly. In addition, because the State workers' compensation system is a single payer system with broad influence through payment incentives, it is likely that specific additional incentives related to the identification of early risks and application of interventions targetted to these risks can be accomplished. Thus, the disability risk identification study is likely to provide substantial added value to current gaps in the health care intervention study.

The comprehensive approach to risk identification apparent for both low back injury and CTS suggests that similar models are likely to be valid for other common musculoskeletal conditions that, taken together, account for the vast majority of disability in the nation's workers' compensation systems. Combining accurate risk identification and incentivized delivery of occupational health best practices soon after injury holds promise for future research and payment policy.

Publications

1. Turner, J.A., Franklin, G., Fulton-Kehoe, D., Egan, K., Wickizer, T.M., Lymp, J.F., Sheppard, L., Kaufman, J.D.: [2004] Prediction of chronic disability in work-related musculoskeletal disorders: a prospective, population-based study. BMC Musculoskeletal Disorders, 5:14.
   Describes the study aims and methods.

2. Turner, J.A., Franklin, G., Heagerty, P.J., Wu, R., Egan, K., Fulton-Kehoe, D., Gluck, J.V., Wickizer, T.M.: [2004]. The association between pain and disability. Pain, 112:307-314.
   Reports the analyses examining: (1) the optimal cutpoints of pain intensity ratings (0-10 numerical scale) for discriminating various levels of disability among workers with CTS and low back injuries (LB), (2) whether these cutpoints differ for these two conditions and for different disability measures, and (3) whether the relationship between pain intensity and disability is linear or nonlinear in each injury group. We found that pain intensity rating categories of 1-4, 5-6, and 7-10 optimally discriminated disability levels among those with LB injuries. For the CTS group, the relationship between pain and disability was linear. Among workers with LB injuries, when pain level was 1-4, a decrease in pain of more than 1 point corresponded to clinically meaningful improvements in functioning, but when pain level was 5-10, a 2-point decrease was necessary for clinically meaningful improvement in functioning. These findings were useful in accomplishing Specific Aims 1 and 3 and may be useful in our future work to accomplish Specific Aim 4.

3. Turner, J.A., Franklin, G., Fulton-Kehoe, D., Sheppard, L., Wickizer, T., Wu, R., Gluck, J.V., Egan, K.: [2006] Work recovery expectations and fear-avoidance predict work disability: a longitudinal, population-based study of workers' compensation back injury claimants. Spine, 31:682-689.
   Reports on the ability of our measures of worker pain, disability, and psychosocial characteristics, which we obtained at a median time of 18 days after claim receipt, to predict disability six months later. At 6 months, 18% of the workers in our sample were receiving work disability compensation. Age, race, education, and baseline pain and disability were significant predictors of 6-month disability. Adjusting for baseline demographics, pain, and disability, and other psychosocial variables, high work fear-avoidance (OR= 4.6) and very low work recovery expectations (OR= 3.1) were significant independent predictors. These findings were useful in accomplishing Specific Aims 1 and 3 and may be useful in accomplishing Specific Aim 4.

4. Stover, B.D., Turner, J.A., Franklin, G., Gluck, J.V., Fulton-Kehoe, D., Sheppard, L., Wickizer, T. M., Kaufman, J., Egan, K.: [2006] Factors associated with early opioid prescription among workers with low back injuries. J. Pain, 7:718-725.
   Reports on the anyalyses examining associations between worker sociodemographic and other characteristics and opioid prescription within six weeks of first medical visit for workers' compensation claims for work loss due to back injury. We examined administrative, pharmacy, and worker-reported data. Among workers with

low back injuries, workers with more severe back injuries are more likely to be prescribed opioids, but reasons for prescription disparities based on ethnicity and tobacco use warrant further study. These findings were useful in accomplishing Specific Aims 1 and 3 and may be useful in accomplishing Specific Aim 4. This is the first publication of the low back injury severity rating scale.

5. Turner, J.A., Franklin, G., Fulton-Kehoe D., Sheppard L., Wickizer TM., Wu R., Gluck JV., Egan K., Stover B: [2007] Early predictors of chronic work disability associated with carpal tunnel syndrome: a longitudinal workers' compensation cohort study. AJIM, 50:489-500.

Reports the analyses identifying early predictors of chronic work disability associated with carpal tunnel syndrome (CTS) and to test the hypothesis that variables from each of several domains (sociodemographic, clinical, work-related, and psychosocial) would add unique predictive information. Baseline demographic variables, symptom severity, functional limitations, lack of job accommodation, job physical demands, job psychosocial conditions, and worker psychosocial characteristics predicted chronic disability bivariately. Each domain of variables added significantly to the prediction of chronic disability. The final multivariable model had fair ability to discriminate individuals with versus without chronic disability. Sociodemographic, clinical, work-related, and worker psychosocial factors early in a claim contribute unique information to the prediction of subsequent work disability. These findings were useful in accomplishing Specific Aims 1 and 3 and may be useful in accomplishing Specific Aim 4.

6. Franklin GM, Stover BD, Turner JA, Fulton-Kehoe D, Wickizer TM. Early opioid prescription and subsequent disability among workers with low back injury: the D-RISC study [in press, Spine].

Reports the analysis testing the hypothesis that opioid prescriptions within 6 weeks following the first medical visit for a low back injury would be associated with work disability at one year, even after adjustment for important covariates such as baseline pain and function and examines whether early receipt of opiods would predict one-year disability independently of injury severity and other key baseline variables (e.g., psychosocial characteristics) previously found to predict subsequent (six-month) disability in this cohort. Nearly 14% (254 of 1843) of the sample were receiving work disability compensation at 1 year. More than one-third of the workers (630 of 1843) received an opioid prescription within 6 weeks, and 50.7% of these (319 of 630) were received at the first medical visit. After adjustment for pain, function, injury severity, and other baseline covariates, receipt of opioids for more than 7 days (OR=2.2; 95% confidence interval, 1.5-3.1) and receipt of more than 1 opioid prescription were associated significantly with work disability at 1 year. These findings were useful in accomplishing Specific Aims 1 and 3 and may be useful in accomplishing Specific Aim 4.

Inclusion of gender and minority study subjects. Please see the gender and minority inclusion table.

Inclusion of children. We attempted to contact 205 individuals under the age of 21; 116 of these enrolled in the study.

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Table 1. Back Injury Severity Rating Instrument

Score	Evidence of Severity of Disease
1	Mild sprain or strain and/or minor physical examination findings (mildly decreased mobility and/or range of motion; paravertebral tenderness, including muscle spasm or muscle tightness). May include equivocal straight-leg raise
2	Major sprain or strain, indicated by substantial immobility (ie, can't get up; difficulty walking, turning in bed, or sitting) without evidence of nerve injury or radiculopathy. May include equivocal straight-leg raise greater than 45°
3	Evidence of radiculopathy with appropriate symptoms (ie, pain or tingling radiating down the leg below the knee, or dermatomal sensory loss) or clearly positive straight-leg raising test, less than or equal to 45°
4	Absent reflexes (knee or ankle), bladder complaints, or motor abnormalities. Includes dermatomal sensory loss or muscle weakness (i.e., foot raising, extending toes, or standing on toes)

Table 2. Carpal Tunnel Syndrome Injury Severity Rating Instrument

Score	Evidence of Severity of Disease
1	Sensory symptoms (pain, numbness, paresthesias digits 1-3) without positive provocative test (i.e., Tinel's, Phalen's, median nerve compression test)
2	Sensory symptoms (digits 1-3) with provocative test (any 1 +, even if 1 is + & 1 negative
3A	Presence of sensory findings (i.e., pinprick deficits in median nerve distribution on exam)
3B	Nonspecific motor findings on examination (i.e., "weak hand grip" or "decreased median strength bilat" but no evidence of thenar weakness or wasting)
4	Presence of motor signs specific to median nerve (i.e., evidence of thenar wasting or weakness)

Table 3. Brief Questionnaire for Patients with New Back Injuries

1. Do you have pain, numbness, or tingling that travels down your leg?
   ___ Yes
   ___ No

2. In the past week, how much has pain interfered with your ability to work, including housework, rated on a scale from 0 to 10 where 0 is "no interference" and 10 is "unable to carry on any activities"?

No interference							Unable to carry on any activities		
0	1	2	4	5	6	7	8	9	10

3. During the past week, have you worked for pay?
   ___ Yes
   ___ No

4. Since your injury, has your employer offered you light duty, part time work, a flexible schedule, special equipment, or other job modifications if needed to allow you to work?
   ___ Yes
   ___ No

5. How certain are you that you will be working in six months, using a scale of 0 to 10, where 0 is "not at all certain" and 10 is extremely certain"?

Not at all certain							Extremely certain		
0	1	2	4	5	6	7	8	9	10

6. Are you concerned that your work will make your injury or pain worse?
   ___ Yes
   ___ No
   ___ I am not sure

Principal Investigator/Program Director (Last, First, Middle): Franklin, Gary, M

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Disability Risk in Work-related Muskuloskeletal Injuries

Total Enrollment: 4588 **Protocol Number:**

Grant Number: 5 R01 OH04069

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race

Ethnic Category	Sex/Gender			
	Females	Males	Unknown or Not Reported	Total
Hispanic or Latino	233	332		565 **
Not Hispanic or Latino	1,910	2,104		4,014
Unknown (individuals not reporting ethnicity)	4	5		9
Ethnic Category: Total of All Subjects*	2,147	2,441		4,588 *
Racial Categories				
American Indian/Alaska Native	67	64		131
Asian	52	25		77
Native Hawaiian or Other Pacific Islander	21	24		45
Black or African American	64	70		134
White	1,643	1,842		3,485
More Than One Race	167	226		393
Unknown or Not Reported	133	190		323
Racial Categories: Total of All Subjects*	2,147	2,441		4,588 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)

Racial Categories	Females	Males	Unknown or Not Reported	Total
American Indian or Alaska Native	10	7		17
Asian	5	4		9
Native Hawaiian or Other Pacific Islander	1	0		1
Black or African American	4	4		8
White	41	60		101
More Than One Race	49	83		132
Unknown or Not Reported	123	174		297
Racial Categories: Total of Hispanics or Latinos**	233	332		565 **

* These totals must agree.
** These totals must agree.

Form Approved Through 9/30/2007
OMB No. 0925-0001

Department of Health and Human Services **Final Invention Statement and Certification** *(For Grant or Award)*	DHHS Grant or Award No. 5R01 OH004069-05

A. We hereby certify that, to the best of our knowledge and belief, all inventions are listed below which were conceived and/or first actually reduced to practice during the course of work under the above-referenced DHHS grant or award for the period

09/30/2001 *original effective date* through 09/29/2007 *date of termination*

B. Inventions (Note: If no inventions have been made under the grant or award, insert the word *"NONE"* under Title below.)

NAME OF INVENTOR	TITLE OF INVENTION	DATE REPORTED TO DHHS
	NONE	
(Use continuation sheet if necessary)		

C. First Signature —The person responsible for the grant or award is required to sign (in ink). Sign in the block opposite the applicable type of grant or award.

TYPE OF GRANT OR AWARD	WHO MUST SIGN *(title)*	SIGNATURE
Research Contract	Principal Investigator or Project Director Gary M. Franklin	Gary M Franklin
Health Services Grant	Director	
Research Career Program Award	Awardee	
All other types (*specify*):	Responsible Official	

D. Second Signature — This block ***must*** be signed by an official authorized to sign on behalf of the institution.

Title	Name and Mailing Address of Institution
Executive Director of Office of Sponsored Programs	University of Washington Office of Sponsored Programs 1100 NE 45th St., Suite 300 Seattle, WA 98105-4683
Typed Name Carol Zuiches	
Signature [signature] DEBRA SIMMONS ASSOCIATE DIRECTOR	Date 12/13/07