Prediction of Chronic Disability in Work-Related Musculoskeletal Disorders: A Prospective, Population-based Study

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Abstract

Background: Disability associated with work-related musculoskeletal disorders is an increasingly serious societal problem. Although most injured workers return quickly to work, a substantial number do not. The costs of chronic disability to the injured worker, his or her family, employers, and society are enormous. A means of accurate early identification of injured workers at risk for chronic disability could enable these individuals to be targeted for early intervention to promote return to work and normal functioning. The purpose of this study is to develop statistical models that accurately predict chronic work disability from data obtained from administrative databases and worker interviews soon after a work injury. Based on these models, we will develop a brief instrument that could be administered in medical or workers' compensation settings to screen injured workers for chronic disability risk.

Methods: This is a population-based, prospective study. The study population consists of workers who file claims for work-related back injuries or carpal tunnel syndrome (CTS) in Washington State. The Washington State Department of Labor and Industries claims database is reviewed weekly to identify workers with new claims for work-related back injuries and CTS, and these workers are telephoned and invited to participate. Workers who enroll complete a computer-assisted telephone interview at baseline and one year later. The baseline interview assesses sociodemographic, employment-related, biomedical/health care, legal, and psychosocial risk factors. The follow-up interview assesses pain, disability, and work status. The primary outcome is duration of work disability over the year after claim submission, as assessed by administrative data. Secondary outcomes include work disability status at one year, as assessed by both self-

report and work disability compensation status (administrative records). A sample size of 1,800 workers with back injuries and 1,200 with CTS will provide adequate statistical power (0.96 for low back and 0.85 for CTS) to predict disability with an alpha of .05 (two-sided) and a hazard ratio of 1.2. Proportional hazards regression models will be constructed to determine the best combination of predictors of work disability duration at one year. Regression models will also be developed for the secondary outcomes.

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 [1]. In a study of over 100,000 1992 low back claims, 10% of claimants were responsible for 86% of the total costs [2]. 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 [3].

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 [4]. 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. Currently, it is not possible to predict accurately which workers with recent injuries will go on to develop chronic disability.

We previously reviewed the literature on risk factors for chronic work disability [5]. The demographic factor most commonly found to be associated with chronic disability is older age [4, 6-15]. With respect to biomedical and injury-related factors, more severe injuries [6, 7, 12, 13, 16] and greater pain and functional disability [15, 17, 18] 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 [6, 8, 9]. Two U.S. studies found that workers in small companies had poorer outcomes [7, 8], but firm size was not predictive of cumulative compensated work absence in two Canadian studies [6]. Physically demanding work has been found to predict disability [19, 20], and workplace offer of job accommodations/modifications has been found to be associated with shorter duration of disability [21]. 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 [17, 22, 23].

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 [21]. 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 [23]. For each factor, the relationship with disability duration was strongest over the period from the fourth to the twelfth week post-accident, and negligible for the remainder of the one-year follow-up period. 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.

The goal of this prospective, population-based study is to develop statistical models that optimally predict chronic work disability from data obtained from administrative databases and worker interviews soon after a work injury. Based on these models, we will develop a brief instrument that could be administered in medical or workers' compensation settings to screen injured workers for chronic disability risk. We are studying workers with back injuries and carpal tunnel syndrome (CTS) because these two musculoskeletal conditions are associated with higher rates of chronic disability as compared with other work injuries [7, 9, 13]. We will examine potential risk factors in

five key risk domains: sociodemographic, biomedical/healthcare, work-related, administrative/legal, and psychosocial. We will develop a predictive model for our principal outcome measure (cumulative number of work disability days during the year after claim submission) and additional predictive models for the secondary outcomes (e.g., one-year work status, functional status), because the models may differ for different outcomes. We will determine whether worker self-report data add substantially to computerized administrative data in the predictive models, to assist in determining the potential cost-efficiency of collecting information from workers in a disability prediction and prevention program. Finally, we will develop a brief instrument that could be administered in medical or workers' compensation settings to screen injured workers for the key predictors of chronic disability.

We will examine variables in each of the five risk factor domains that have been found to predict chronic disability in prior research. Table 1 shows these variables, the predicted direction of their relationship to disability, and the source of information we will use (worker interview or workers' compensation administrative databases). Based on prior research, we expect that age, pain, and functional disability will be the strongest predictors of disability, but that other variables will add to the predictive model. Following is a list of specific factors in each risk domain that we hypothesize will be associated with chronic disability:

Sociodemographic: older age, lower socioeconomic status

Biomedical/healthcare: greater severity of injury, greater number of comorbid medical conditions, higher body mass index, worse self-reported health prior to injury, radiating leg pain (back injury cases only), greater time from injury or appearance of

symptoms to accessing medical care, greater baseline pain intensity and number of pain sites, worse baseline self-reported physical functioning, use of opiate or sedative/hypnotic medications for >4 weeks, greater number of sick leave days in the year prior to injury, and little treatment targeting reactivation and return to work

Work-related: smaller firm size, loss of job within two months of claim allowance, no offer of a modified or light duty job, lack of communication between the attending doctor and the employer regarding return to work, greater physical demands of work, biomechanical factors of work, lower job satisfaction, and little confidence regarding return to work

Administrative/legal: greater time from claim receipt to claim allowance by the workers' compensation system, employer protest in regard to claim validity, and worker retention of an attorney for the injury or claim

Psychosocial: worse baseline mental health, alcohol abuse, greater fear-avoidance (perception that return to work might cause symptom worsening or re-injury), and greater pain-related catastrophizing (excessive focus on pain, magnification of the threat associated with pain, and feeling helpless to control pain)

Methods

Design

This is a currently ongoing, population-based, prospective study. The study procedures and measures have been approved by the University of Washington Human Subjects Research Committee.

Case identification

The study population consists of workers who file claims for wage-replacement (work disability) benefits for work-related back injuries or carpal tunnel syndrome in Washington State. Approximately two-thirds of workers in Washington State are covered by the state workers' compensation fund. The back injury cohort will consist of 1,800 study participants and the CTS cohort will consist of 1,200 participants. Based on prior research with this population, we estimate a 60% response rate for the baseline interview. Therefore, we plan to identify and approach for study participation 5,000 workers with newly submitted claims.

Updates to a computerized claims database maintained by the Washington State Department of Labor and Industries (DLI) are reviewed weekly. Claimants are 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 examine the contents of a text field that describes the injury condition to identify CTS and back injuries. We identify all new compensable or provisional back injury time-loss claims. A compensable claim has been accepted for time-loss (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 identify 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 are not determined compensable at the time of the weekly new claims updates.

Procedures

We mail letters describing the study to all potential study participants as they are identified. One week later, we begin attempting to reach each potential participant by telephone. Trained interviewers describe the study, screen for eligibility, and obtain informed consent. Exclusion criteria at the time of interview are 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, are made to contact each worker (daily during the first 10 days, then at three-day intervals). A second letter is mailed to workers who cannot be contacted after 10 days of attempts. These letters contain the same information as the introductory letters, but mention the inability to make contact with the claimant and offer a toll-free number to suggest a good time for an interview. The interviewers conduct a baseline computer-assisted telephone interview (CATI) with workers who enroll in the study. A thank-you letter and a $10 check are mailed to each worker who completes the baseline interview.

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

Baseline interview

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

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

Biomedical/health care. Workers are asked about the number of sick leave days they used in the year prior to injury, whether they have had treatment aimed at reactivation and return to work, 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 rate 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 [24, 25]. Such numerical pain rating scales have been demonstrated to be valid and sensitive to change [26]. Claimants are also asked about persistent pain problems prior to this claim, and whether they have persistent, bothersome pain in different parts of the body.

Pain interference with daily activities and ability to work are assessed by questions (0-10 scale) from the Graded Chronic Pain Scale [24, 25]. Physical functioning is assessed by the Short Form-36 Version 2 (SF-36v2) [27] 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 [28, 29]. Therefore, workers with low back injuries complete the Roland-Morris Disability Questionnaire (RDQ) [30] and workers with CTS complete the Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ) [31]. 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 [30, 32-37]. The CTSAQ, which contains symptom severity and functional status scales, has also been demonstrated to be valid, reliable, and responsive to clinical change [31, 38-40].

Work-related. Questions from the Vermont Disability Prediction Questionnaire [17] assess 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 assess current work status, job demands, availability of job modifications, length of time employed at job where injured, communication from employer, and job satisfaction.

Administrative/Legal. Workers are asked if they have retained an attorney and whether they have had previous workers' compensation claims.

Psychosocial. Fear-avoidance (perception that return to work will cause exacerbation of symptoms or re-injury) is 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' [41]. This scale has been found to have high internal consistency, and to be associated with work loss [41]. Problematic alcohol use is assessed by the three-item Alcohol Use Disorders Identification Test (AUDIT-C) [42]. Mental Health is assessed by the SF-36v2 [27] 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 [43] 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') are averaged for a single measure of pain-related catastrophizing.

Injury severity rating

We have developed structured forms for rating the severity of the CTS and back injury. Trained reviewers will use these forms to rate injury severity based on study participants' medical records from health care visits made during the first six weeks after claim receipt. Five percent of cases will be reviewed independently by a second reviewer as well as by an expert occupational medicine physician, and interrater agreement will be monitored on an ongoing basis.

One-year follow-up

From DLI administrative data, we will obtain the number of days of wage replacement benefits for injury-related inability to work ("work disability duration") in the year after claim receipt (primary outcome of interest) and information concerning whether or not the worker is still receiving work disability (wage replacement) benefits (secondary outcome) one year after claim receipt. Additional secondary outcomes assessed at the one-year follow-up telephone interview include the Graded Chronic Pain Scale pain intensity and pain-related disability measures, physical disability as assessed by the generic SF-36v2 Physical Functioning scale [27] and the condition-specific disability measures, mental health (SF-36v2), and work status.

Sample size

Addressing the study hypotheses. We calculated the approximate power to detect relationships between the candidate risk factors and long-term disability, using two-sided tests with an alpha level of 0.05 and assuming that 7.8% of back injury claimants and

11% of CTS claimants in the sample will be disabled at one year (based on data from prior years). For a sample size of 1,800 workers with back injuries and 1,200 with CTS who complete baseline interviews, the statistical power to detect a hazard ratio of 1.2 is 96% for low back and 85% for CTS if subjects are equally allocated on the variable and there is no correlation with other covariates. With moderate correlation with other covariates ($r = 0.25$) and moderately uneven subject allocation on the variable, this reduces to 91% and 75%.

Statistical analysis

Our primary objective is to develop a predictive model for the primary outcome. We will use proportional hazards regression [44] to examine potential risk factors for the cumulative number of days for which work disability compensation was paid in the year after claim receipt. We will build a model to relate the candidate predictors to work disability duration by selecting from all possible combinations of variables. We will perform variable selection within each risk domain, across risk domains, and overall. We will select the model with the highest cross-validated prediction accuracy.

We will develop regression models for several other one-year outcome measures, including physical disability, work status, and work disability (wage replacement benefit) status. For the dichotomous outcome variables, we will use logistic regression. We will build a regression model (proportional hazards or logistic, as appropriate) for each outcome variable using the method described above for the primary outcome variable. To examine whether the self-report baseline data add substantially to the administrative data in predicting outcomes, we will build a proportional hazards regression model as described above, but considering only the administrative variables.

Development of instrument to screen for chronic disability risk. To develop a parsimonious disability prediction instrument that assesses the key variables identified by our models as predictors of chronic disability for each injury type, we will use two approaches. One approach will be based on the predictive model obtained using the previously-described methods. In order to convert this model into a survey instrument, we will first fit another regression model using categorical variables in place of any continuous variables. The coefficients of this model will be converted into scores that can be summed to obtain the predicted time on disability. The second method is also based on the predictive model obtained. We will fit a recursive-partitioning algorithm [45] using the subset of variables obtained for the predictive model. This will result in a tree diagram that can be followed to arrive at a predicted time on disability. The timeline of the study does not permit an evaluation of this screening instrument. We hope to pilot the instrument, refine it, and evaluate its utility in a future study of injured workers.

Conclusions

The unique study environment in Washington State, in which two-thirds of workers are covered by a state workers' compensation fund, enables us to conduct this population-based study, to interview workers soon after musculoskeletal injury claim submission, and to link interview information with medical and claims information. These data will be used to identify the optimal combination of sociodemographic, biomedical, work-related, administrative/legal, and psychosocial risk factors for predicting chronic disability, and to develop a brief screening instrument that could be used early after injury to accurately identify workers at high risk for chronic disability.

Competing interests

None

Authors' contributions

JAT, GF, DF-K, JDK, and TMW participated in the conceptualization and design of the study. JAT drafted the manuscript and JFL drafted the sample size and statistical analysis sections. All authors contributed to, and read and approved, the final manuscript.

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Table 1. Key risk factors in five domains: predicted direction of relationship to one-year disability and source of information

Risk factor	Predicted direction of relationship to disability	Source of information: Worker interview	Medical records	Administrative database
Sociodemographic				
Age	+			X
Socioeconomic status	-	X		
Biomedical/healthcare				
Injury severity	+		X	
Co-morbidity, poor health before injury	+	X		
Radiating leg pain (back injury cases)	+	X		
Delay to care	+			X
Pain intensity and sites	+	X		
Physical disability	+	X		
Opiate, sedative use	+			X
Sick leave in prior year	+	X		
Treatment aimed at reactivation, return to work	-	X		
Communication between doctor and employer	-	X		

Work			
Firm Size	-		X
Job loss	+	X	
Job modifications	-	X	
Physical demands	+	X	
Job satisfaction	-	X	
Confidence regarding return to work	-	X	
Administrative/legal			
Time from claim receipt to allowance	+		X
Employer protest	+		X
Attorney	+	X	
Psychosocial			
Mental health	-	X	
Alcohol abuse	+	X	
Fear-avoidance	+	X	
Catastrophizing	+	X	