Final Performance Report

Organizational Predictors of Successful Return to Work

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NIOSH FINAL PERFORMANCE REPORT

Abstract

The purpose of this project was to develop both worker and employer uses of Organizational Policies and Practices surveys (OPP) and to examine their validity and reliability. A second purpose was to examine the role of OPPs in work disability in a prospective study.

To accomplish these aims we followed 197 workers with electrophysiologically confirmed carpal tunnel syndrome (CTS) from a pre-surgical baseline to two months, six months, and 12 months post-surgery. In addition, we surveyed key informants from 76 employers (71% response rate) about OPPs.

Major findings to date are: (1) higher OPPs predict better work role functioning at six months post-surgery; (2) the change in self-efficacy from baseline to two months post-surgery predicts six month work role functioning; (3) the four worker-reported OPP dimensions (safety practices, ergonomic practices, disability management, and people oriented culture) have predictive validity; (4) there is agreement between workers and employers on OPPs at the scale level on people oriented culture but not on safety practices, ergonomic practices and disability management; (5) if a single index of OPPs is created, then there is agreement; (6) comparison with written policies was attempted but was inconclusive due to the low response rate; (7) Confirmatory Factor Analysis produced a reduced 26-item version of employer OPPs with high scale reliability and validity.

Significant Findings

At two months (n=128), only baseline health-related work role functioning predicted successful work role functioning, while being depressed (OR=0.32) and having filed a workers' compensation claim (OR=0.30) predicted not being back at work. At six months (n=122),

baseline health-related work role functioning (OR=1.04), improvement in self-efficacy from baseline to two months (OR=7.11), and working in a highly supportive organization (OR=5.20) predicted successful work role functioning.

The results show there are four worker reported-OPP dimensions using a factor-loading criterion of 0.4. Four scales are both empirically and conceptually identified through the factor analysis: people-oriented culture (items 1-4); safety climate (items 6-12); ergonomic practices (items 13-14); and disability management (items 15, 17-21). All the hypothesized safety scales (active safety leadership, safety diligence and safety training) load heavily on Factor 1 rather than separate factors as hypothesized. Factor 2 captures the people-oriented culture as specified a priori. Factor 3 confirms disability case management and proactive return to work are a much broader dimension – disability management as suggested a priori. Factor 4 is the ergonomics practices scale as hypothesized. The labor-management climate items did not separate into an independent factor. These scales were created as summated averages varying between 1 and 5.

OPP Scale Properties: Cronbach's alphas for all four scales are greater than 0.7. When an item is removed from a scale, the recalculated alpha drops, suggesting the item makes a unique contribution to the scale. The item-to-scale correlations are all greater than 0.4. Scaling success was 100% for each scale indicating strong discriminant validity. Finally, for test-retest results, the Intra-class Correlations (ICCs) range between 0.78 and 0.88 supporting the ability of workers to consistently respond over time to the same question.

Predictive Validity was assessed by examining how well baseline measures of a similar set of items predict work status at six months using logistic regression. As hypothesized, all four OPPs significantly predict six-month return to work after adjustment for age, gender and CTS symptom severity. The higher the value of each OPP, scale the greater the odds a person had

returned to work. Age, gender and symptom severity are non-significant in all four models. In each model the C-statistic is greater than 0.7 indicating a strong model fit (Hosmer and Lemeshow, 1989).

Employers' OPP mean self-ratings were generally higher than employees'. Only the scale representing People Oriented Culture showed significant concordance (rho_c=0.254, p 0.012). The OPP index (mean of four scales) had a significant concordance, rho_c=0.138, p 0.077. The hypothesized five-construct employer OPP model was tested by Confirmatory Factor Analysis. The final modified model, consisting of the five constructs resulted in a well-fitted solution (fit statistics: χ^2 729.48, df 284, p<0.000; Root Mean Square Error (RMSEA) 0.062, 90% CI 0.056-0.067; Standardized Root Mean Square residuals (SRMR) 0.066; Incremental Fit Index (IFI) 0.93; Comparative Fit Index (CFI) 0.93).

To examine the internal reliability of the scales, an acceptable level of internal consistency was established at 0.7 Cronbach alpha. In addition, the criterion item-to-total correlation was set greater than 0.4 for a well-established scale (Hays et al., 1988; Hays, 1991). Scaling success and a criterion of 90% success was applied (Hays et al., 1988; Hays, 1991). All alphas were greater than 0.8. The item-to-scale correlations were all greater than 0.55. Scaling success was 100% for each scale indicating strong discriminate validity.

Usefulness of Findings

This research fills a major gap in understanding the impact of employer practices on successful return to work. In this new area of research, development of a valid and reliable worker report measure of organizational practices and policies creates opportunities in research and evaluation for answering questions heretofore not answered because of the cost of collecting

employer data. The development of the worker-level measures of OPPs allows researchers to measure organizational behaviors in employee surveys directly.

Workers in the US who have carpal tunnel syndrome have the longest recuperation period of all conditions requiring lost workdays (NIOSH, 1996). Not surprisingly, as the prevalence of CTS rose in 1980's, workers' compensation costs for soft tissue injuries increased 19% for the period 1980-1990 (Butler et al., 1995). This study, which examined clinical, psychosocial, economic, legal, family and employment and sociodemographic predictors, identified the importance of OPPs and self-efficacy in work-related health outcomes research. Establishing that modifiable employer practices and polices are predictive of reduced individual work disability and successful return to work motivate intervention studies.

This project also demonstrated the utility of three new measures in outcomes research: work role functioning, worker OPPs, and the shorter-form employer OPPs. From a research perspective, both employer and worker perceptions of organizational policies and practices are important.

Scientific Report

Specific Aims:

Over six million of the 6.6 million injuries and illnesses reported in 1995 in the US resulted in lost work time, medical treatment, or job transfer (NIOSH, 1996). Nearly three million required recuperation away from work or restricted duties at work, or both (NIOSH, 1996). In 1995, occupational injuries alone cost 119 billion dollars in lost wages and productivity, administrative expenses, health care and other costs (NIOSH 1996). Reducing work disability and successfully returning injured or ill workers to work is thus an important part of the overall occupational safety and health strategy. Research on return to work has primarily

focused on the medical management of the injured worker, light duty and workstation redesign (Bigos and Battie, 1991). A small set of studies suggests that four organizational policy and practices (OPPs) (safety intervention, disability management, active safety leadership, labor-management health and safety committee) and a people-oriented employer culture are important determinants of successful return to work (RTW) and reduced work disability (Hunt et al, 1993; Shannon et al, 1995; 1996). The long-term goal of this research was to identify OPPs that effectively support the injured worker's return to a productive work role in society.

To investigate OPPs, we collected employer-level data on OPPs as part of an on-going longitudinal study of 250 physician-referred carpal tunnel syndrome (CTS) surgical cases in Maine that began collecting baseline data in May, 1997. The three-year Arthritis Foundation funded study followed workers at two, six and twelve months and collected information on worker, job and economic factors that predict work disability and return to work. The advantages of this focused investigation of OPPs are: (1) CTS injuries are associated with the lengthiest work absences which allows OPPs to exert multiple effects (Cheadle et al, 1994; Personick, 1997); (2) CTS injuries are associated with wide variability in work disability outcome, and thus are representative of a class of injuries that require a multidimensional model of RTW that includes medical, rehabilitative, organizational/workplace and economic factors (Adams et al, 1994; Katz et al, 1996; 1997, 1998); (3) reduced clinical and treatment variability allows a more focused examination of OPPs; (4) the availability of extensive individual level worker, job and economic data allows for extensive statistical control of important covariates improving the interpretation of results. Augmentation of this individual-level data with employer-level data on OPPs created an opportunity to examine heretofore unanswered research questions.

This research had two specific aims, one predictive and one methodological: to determine the relationship between OPPs and successful RTW and reduced work disability and to examine the validity and reliability of a worker-reported OPP measure.

To address Specific Aim One, we conducted standardized telephone interviews with 80 employers to collect employer-level OPP data. Eight OPP dimensions were measured: people-oriented culture, active safety leadership, safety diligence, standard ergonomic practices, safety training, disability case monitoring, proactive return-to-work programs, and joint labor-management relations. The employer-level data on OPPs were used to predict individual-level return to work and work disability (work limitation). A unique feature of this study was the ability to specify not only the return to work transition, but the worker's level of functioning upon return. We hypothesized:

1. OPPs will be associated with fewer total lost work days, a quicker return to work, fewer work limitations, fewer paid and unpaid work limitation and fewer CTS symptoms.

2a. Worker reports of OPPs will significantly co-vary with employer reports of OPPs.

2b. Worker reports of OPPs will predict return to work and fewer work limitations.

A second unique feature of the research was the opportunity to compare and contrast the relationships between worker and employer reports of organizational practices and policies and worker and employer level health measures. In the evaluation of the quality of occupational health services, it is necessary to know whether employer-level relationships correspond with individual level relationships.

Because of the added cost of conducting an employer interview, demonstrating that worker self-reports are valid and reliable provides new measurement tools heretofore unavailable in occupational health research for evaluating the effectiveness of occupational health service

programs. To further enhance the potential usability of these self-report measures, we also conducted a two week test re-test reliability study of the 22 item worker instrument.

This research fills a major gap in understanding the impact of employer practices on successful return to work. In this new area of research, development of a valid and reliable worker report measure of organizational policies and practices will create opportunities in research for answering questions heretofore unanswered because of the cost of collecting employer data.

Furthermore, this research addresses one of the NORA priority areas, namely occupational health services.

Workers in the US who have carpal tunnel syndrome have the longest recuperation period of all conditions requiring lost workdays (NIOSH, 1996). Not surprisingly, as the prevalence of CTS rose in the 1980's, WC costs for soft tissue injuries increased 19% for the period 1980-1990 (Butler, 1995). Establishing which modifiable OPPs are predictive of reduced individual work disability and successful return to work should lower these costs and improve worker productivity.

Background

There is growing recognition that a broader multidimensional model is required to explain the phenomenon of work disability (Berkowitz, 1985; Battie and Bigos, 1991; Fordyce, 1995; Frank, 1995). Even the wider biopsychosocial model has required expansion to adequately integrate the influence of environmental factors - physical, policy and attitudinal - that determine in large measure whether a specific impairment will result in a work disability in a specific situation (Hunt et al, 1993). Constructing a complete picture of the workplace factors that

contribute to the incidence and consequence of work disability has required the development of an integrated framework that incorporates the expected effects related to safety management and prevention (Smith, 1987; Kavanian et al, 1989), to the organizational climate (Rosen, 1986; Lewin and Schecter, 1990), and to the system of care for effectively managing health conditions and injuries (Akabas et al, 1992). From a research perspective, constructing an integrated methodological framework thus necessitates moving to a transdisciplinary perspective, weaving together the theoretical and empirical underpinnings from each of these fields.

Organizational practices and policies (OPPs) for the prevention and management of work disability are modifiable and the identification of key effects has the potential to significantly improve the prevention of occupational illnesses and injuries and to return the worker to a productive work role. Despite the face validity of this statement there is almost no research on if or how OPPs relate to worker health (Pransky et al, 1996b; Shannon et al 1995). Some early research focusing on the role of joint labor-management health and safety committees proved inconclusive (Shannon et al, 1995), while other early research compared companies with high accident rates to companies with low accident rates without specifically measuring OPPs (Cohen et al, 1975). Two recent studies have refocused research on OPPs (Hunt et al, 1993; Shannon et al, 1996). The Michigan Employer Survey found safety diligence, safety training, proactive return to work and active safety leadership were associated with lower wage loss claims and lost work day cases. Disability case monitoring had marginal effects, while ergonomics programs and wellness programs had no effects (Hunt et al, 1993). The Ontario Survey suggested the existence of labor-management health and safety committees may be associated with fewer lost work days (Shannon et al, 1996). There is a need for research on which OPPs are important and how they influence an individual worker's health.

No research has considered whether workers are valid and reliable reporters of organizational practices and policies. A basic assumption in organizational research has been that to measure organizational characteristics you need to ask management to complete an interview or questionnaire. Workers are too local to observe company-wide patterns necessary to validly answer questions and theirs is a perception of policy based on work experience whereas at the level of a personnel office it relates to objective practices. Yet what little research exists suggests workers can report on these conditions (Marsden, 1994). Part of the reason for the paucity of data is the cost of conducting employer surveys which become more costly when linked to individual worker data (Kallenberg et al, 1996). Additionally, because workers don't randomly sort within or between organizations and are often selected to participate in studies because of the organization s/he works for, new methodological developments in hierarchical modeling and random effects specification were necessary to analyze the collected data (Kallenberg et al, 1996; Marsden, 1994). Development of a valid and reliable worker report measure of OPP to be used in a range of occupational safety and health studies would significantly advance research.

Research must consider how OPPs affect individual level measures of health status and not just ecological measures derived from company administrative health databases. There is no research on OPPs that includes individual health data. All the research on OPPs, to date, uses administrative records (e.g. OSHA recordables or workers' compensation claims) to measure health. While this data can be suggestive of relationships, to estimate the impact of OPPs on worker health it is necessary to include individual health measures.

The Return-to-Work (RTW) process is one fruitful place to study OPPs. Researchers have begun to consider the role of job accommodations (i.e. ergonomic solutions) and organizational practices (i.e. utilization review/disability case management through treatment

guidelines) in bringing the worker back to work (Butler et al, 1995; Johnson et al, under review; Pransky et al, 1996b). Unfortunately, OPPs are often controlled rather than being treated as explanatory factors in this research (e.g. Cheadle et al, 1994). RTW research has been constrained in four ways: (1) it often uses data from only a Workers' Compensation (WC) claims data base (Galizzi and Boden, 1996; Harris, 1996), (2) administrative health data is often used without appropriate adjustment for the diversity of injuries or severity of injuries or to the exclusion of measuring individual level health data (Galizzi and Boden, 1996), (3) return to work is measured without considering how well the person functions at work or whether the person leaves work again (Baldwin et al, 1996; Katz et al, 1997a; Pransky and Himmelstein, 1996a), (4) while the RTW process is recognized as multidimensional, the various dimensions (e.g. individual, medical, rehabilitative, organizational or economic factors) are often not measured or controlled leaving findings open to alternative interpretations (Franklin and Fulton-Kehoe, 1996; Katz et al, 1997; 1998). Research is needed that utilizes a multidimensional model of RTW, measures individual level health data, includes multiple measures of RTW and not just the fact of RTW, and examines workers' compensation as a variable.

Carpal tunnel syndrome is an ideal condition for studying the relationship between OPPs and individual health. Workers with CTS report work disability and it is estimated that over 240,000 Americans have disabling CTS (Blanc et al, 1996). Workers in the US who have carpal tunnel syndrome have the longest recuperation period of all conditions requiring lost workdays (NIOSH, 1996). Lost work days following a CTS injury are greater in magnitude than any other upper extremity disorder (Cheadle et al, 1994) and occupational injury (Personick, 1997). This long duration allows the multiple effects of OPPs to be observed. CTS can be influenced by OPPs that prevent its development (i.e. ergonomic practices, sound safety practices and

exercise), and once injured the OPPs determine the monitoring of the person's injury and the process of returning the worker to work.

Current research on return to work for CTS shows the importance of clinical data (Butterfield et al, 1994; Katz et al, 1997a;), worker characteristics (Cheadle et al, 1994; Feuerstein, 1996; Katz et al, 1997a; 1997c), whether the person has filed for workers' compensation (Katz et al, 1997a) job factors (Katz et al, 1997a; MHIC, 1994), and the legal system (Butterfield et al, 1994). Yet, the influence of OPPs has not been shown and may play out more distally (12 months versus six weeks) than proximally (Johnson et al, under review). Higgs et al (1995) found lack of job accommodation resulted in multiple job changes. These data suggest the process of RTW is multidimensional for workers with CTS involving clinical, worker, job, and economic factors.

Recent policy recommendations to fundamentally change rehabilitation programs for work-related low back injuries in Ontario, Canada were based on research using a multidimensional model (Frank, 1996). In the US, changes in the occupational health system, especially in the diffusion of managed care approaches from health plans into WC and occupational health have the potential to separate the medical management of the injured worker from the workplace processes necessary to successfully return the worker to work. As the costs of soft tissue injuries continue to increase (Butler, 1995), more and more employers will be faced with decisions about how to best manage these costs. Better measures of OPPs are essential to focus research and the practice of occupational health on this multidimensional model of health and the role of the employer as well as the medical community and insurance industry in managing the health of the worker. Research that demonstrates how modifiable organizational practices affect worker health will enjoin the employer as a partner in change and not merely an observer of worker change and

change in the occupational health services community.

Also needed are better measures of RTW. Measures of return to work must move beyond the fact of return to more adequately define a 'successful' return to work (Pransky and Himmelstein, 1996a). Return to work measures are the tip of the iceberg and functional health outcomes are critical to the evaluation of the effectiveness of OPPs. If a company has a policy of bringing a worker back to work quickly, but the worker does not function well at work or becomes re-injured then a short-term study focused on return to work may miss the most significant outcome (Higgs et al, 1994). In a study of Ontario workers 85% returned to work, but 61% left work again because of a re-injury. Research is needed with new measures of 'successful' return to work

Studies to address aims

Four studies were undertaken to address the specific aims of this research. Two studies, determinants of disability and predictors of successful work role functioning, address specific aim 1 and will be submitted for publication in 2003. A methodological paper addressing Specific Aim Two discusses the validity and reliability of a worker-reported measure of employer policies and practices has been published in JOR (Amick et al., 2000). The fourth analysis, agreement between employer and employee perceptions of OPP, is being prepared for publication.

Three additional studies are planned for publication and are described below.

SPECIFIC AIM 1

Study 1: Predictors of Successful Work Role Functioning

Objective: To identify the relative contributions of clinical, individual, family and work factors in predicting successful work role functioning in patients undergoing carpal tunnel release surgery (CTRS).

Method: A community-based cohort of 197 workers was followed for six months post CTRS. Pre-surgical baseline and two-month post-surgery measures of clinical, individual, work, economic, and family factors were examined in ordinal logistic regression models. The outcome assessed whether a patient did not return to work, returned but was not performing the work role well because of health, or returned and was performing the work role well.

Results: At two months (n=128), only baseline health-related work role functioning (WRF) predicted successful WRF (OR=1.02; 95% CI 1.01-1.04), while being depressed (OR=0.32; 95% CI 0.14-0.74) and having filed a workers' compensation claim (OR=0.30; 95% CI 0.14-0.66) predicted not being back at work. At six months (n=122), baseline health-related WRF (OR=1.04; 95% CI 1.02-1.05), improvement in self-efficacy from baseline to two months (OR=7.11; 95% CI 2.47-20.46), and working in a highly supportive organization (OR=5.20; 95% CI 1.68-16.05) predicted successful WRF.

Discussion: The finding that highly supportive organizations are associated with successful WRF suggests the effectiveness of medical interventions should be considered in the context of employer behavior. The relationship between improved self-efficacy and WRF at six months and between depression and not being back at work at two months post-surgery highlights the importance of psychosocial management of musculoskeletal disorders even when surgery is

chosen as the definitive treatment. This research also demonstrates the utility of work outcome measures in health services research.

Study 2: Predictors of Return to Work following carpal tunnel release surgery

Background: Upper extremity musculoskeletal disorders are associated with substantial work disability. Prior studies of the determinants of upper extremity work disability have been methodologically limited. The objective of this study is to prospectively evaluate a multidimensional model of work disability in a community based cohort of workers with carpal tunnel syndrome.

Methods: Workers with electrophysiologically documented carpal tunnel syndrome who were scheduled for carpal tunnel release by one of fifteen community surgeons were recruited into this prospective study. Subjects completed questionnaires preoperatively and at two, six and twelve months postoperatively. The questionnaires contained a range of demographic, clinical, and individual psychosocial factors as well as workplace exposure to physical and psychosocial stressors. Predictors of work absence at six and twelve months were examined in bivariate analyses and multivariate logistic regression analyses.

Results: Six months following carpal tunnel surgery, 29 subjects (19%) were out of work. Twelve months following surgery 33 subjects (21%) were out of work. In bivariate analyses, the factors associated with work absence at six months, at $p \leq 0.01$, included preoperative physical functional status, change in self-efficacy between preoperative assessment and two months, lower income, receiving workers' compensation and representation by an attorney, work exposure to force and repetition, higher psychological job demands and lower job control, lower social support by coworkers, lower job security and more supportive organizational policies and

practices. The factors associated with work absence at twelve months included preoperative physical functional status, lower self-efficacy at two months, workers' compensation, and less supportive organizational policies and practices. Multivariate analyses confirmed a multidimensional model of work absence at both six and twelve months.

Conclusions: One fifth of workers undergoing carpal tunnel release were out of work six months later and a fifth were out of work twelve months postoperatively. Clinical, demographic, economic and workplace factors were associated with work absence. These findings indicate that strategies to reduce work absence following carpal tunnel release should address multiple dimensions of the worker and workplace.

SPECIFIC AIM 2

Study 3: Amick BC, Habeck RV, Hunt A, Fossel AH, Chapin A, Keller RB, Katz, JN. Measuring the impact of organizational behaviors on work disability prevention and management. J Occup Rehab. 2000; 10(1):21-38.

ABSTRACT

Increased rates of work disability and its associated costs have prompted businesses to develop innovative approaches to managing the health and productivity of the work force. The paper 1) provides practitioners with the results of research that demonstrates the importance of employer organizational factors in preventing and resolving work disability, and 2) provides researchers with measures that can efficiently assess organizational factors and advance clinical research by incorporating contextual factors involved in occupational rehabilitation. Data from a series of studies in Michigan are reviewed and it is concluded that employer reports of organizational policies and practices (OPPs) are important in reducing the number of work-related disabilities and their consequences for the employee and for the company. We test the hypothesis that employee reports of OPPs are reliable and valid. To test the reliability and validity of an employee version of the same instrument, we used data from a prospective community-based study of 198 workers with carpal tunnel syndrome. Four OPPs were identified as important: people-oriented culture ($\alpha = .88$), safety climate ($\alpha = .88$), disability management policies and practices ($\alpha = .88$), and ergonomic practices ($\alpha = .88$). These four scales were shown to have strong test–retest reliabilities and predictive validity. It was concluded that the conceptual model guiding the research in Michigan was supported with research from another State, Maine, using an individual-level measure of OPPs.

Background

Increased rates of work disability and its associated costs have prompted businesses to develop innovative approaches to managing the health and productivity of the work force (Thomasson et al., 1998). Work disability arises from complex interactions between the work environment and the individuals within it (Verbrugge and Jette, 1994). Thus, there is need for a systemic and comprehensive approach to injury prevention and management that incorporates the larger influences of the employer organization as well as the more tangible aspects of traditional safety measures and claims handling techniques (Akabas et al., 1992). However, there has been only limited empirical assessment of the organizational context and its potential role in disability prevention (Shannon et al., 1997; Hale and Hovden, 1998).

To date, research has focused primarily on one-dimensional models of the determinants of disability (e.g., medical, economic, individual and job accommodation), with little research on organization and prevention. But there is growing recognition that a broader multidimensional model is required to explain the phenomenon of work disability (Berkowitz, 1985; Battie and Bigos, 1991; Fordyce, 1995; Frank, 1995). Even the wider biopsychosocial model has required expansion to adequately integrate the influence of environmental factors - physical, policy and attitudinal - that determine in large measure whether a specific impairment will result in a work disability in a specific situation (Habeck, Hunt & VanTol, 1998).

Constructing a complete picture of the workplace factors that contribute to work disability incidence and its consequences requires an integrated framework. Such a framework must incorporate: (1) the expected effects related to safety management and prevention (Smith, 1987; Kavanian et al., 1989), (2) the interventions and system of care for

effectively managing health conditions and injuries that arise and minimizing their disabling effects through restoration and accommodation (Akabas et al., 1992), and (3) the organizational climate and behaviors that comprise the context of the work place in which this transpires (Rosen, 1986; Lewin and Schector, 1991).

Practically, organizational-level research has been conducted separately from employee-level research. The typical approach to organizational research uses separate interviews conducted with one or several key organizational informants (Kalleberg et al., 1996). A basic assumption in organizational research has been that valid measurement of organizational characteristics requires having representatives of management complete an interview or questionnaire. Workers have been considered too narrowly focused to observe company-wide patterns. Worker perceptions of policy are presumed to be limited to the personal work injury experience, whereas human resource/personnel manager assessments are presumed to be 'objective' (James and McIntyre, 1996). When the focus of study is solely at the organizational level, this is a reasonable assumption. However, when the focus includes individual-level health change, it would be both reasonable and efficient to measure organizational policies and practices at the individual level.

To date, there is little information on employee assessments of organizational behaviors related to injury prevention and health. What little research exists suggests that workers can report on a variety of these conditions including: organizational hierarchy (Marsden, 1994), service quality policies and practices (Schneider and Bowen, 1985), and accident policies and practices (Zohar, 1980). In this paper we hypothesize that employee reports of organizational policies and practices (OPPs) are reliable and valid.

Our purpose in this manuscript is to provide researchers with measures that can efficiently assess organizational factors and advance clinical research by incorporating contextual factors involved in occupational rehabilitation. Specifically, we examine the multidimensionality of employee reports of organizational policies and practices, the internal consistency and the test-retest reliability of the scales, the discriminant validity of the scales (i.e., the degree an item correlates more strongly with the scale it is hypothesized to be part of compared to other scales), and their predictive validity (i.e. the degree a scale predicts what it is hypothesized to predict).

Methods

The Maine Carpal Tunnel Study II

The data used in these analyses were obtained from Maine Carpal Study II, a prospective observational community-based study of patients who received carpal tunnel surgery (CTS). Its forerunner, Maine Carpal Tunnel Study I (Katz et al., 1998, Keller et al., 1998), suggested that return to work has multiple determinants in patients with CTS, including worker- and workplace-specific factors. The overarching goal of Maine Carpal Tunnel II was to examine in detail the influence of multiple variables on the clinical and occupational outcome of carpal tunnel surgery. We chose one condition, CTS, and one treatment, surgery, to reduce the variability in underlying impairment and management, thereby permitting focused examination of psychosocial, economic, and organizational factors.

Workers were eligible for the study if they presented to one of fifteen participating surgeons with symptoms including numbness or tingling in at least two of the first four fingers and symptoms whose duration was at least one month. The physician must have had the diagnostic impression of CTS and the diagnosis required confirmation with nerve conduction testing. Workers must have been employed at least twenty hours per week at the time symptoms

developed, and been scheduled for carpal tunnel surgery. Exclusions included age less than 18 years, previous carpal tunnel surgery, pregnancy, and retirement or full-time student status. People without insurance benefits, such as temporary employees, contract employees, and some self-employed workers are likely excluded using these criteria.

Eligible workers were identified in community medical practices. Participating physicians were distributed throughout the state, and represented orthopedic, plastic surgery and neurosurgical specialties. Their names were faxed to the coordinating center in Augusta, Maine, where staff contacted patients (*sic* workers) to invite participation. Patients who were interested in participating were mailed questionnaires preoperatively, and at two, six and twelve months postoperatively. Recruitment commenced in April 1997 and was completed in October 1998. It is difficult to estimate the proportion of eligible patients who were referred to the coordinating center, as we do not have an accurate count of the number of eligible patients seen during the study period. However, we demonstrated in Maine Carpal Tunnel Study I that this community-based recruitment strategy yielded a sample of surgically treated patients that was representative of all eligible patients in the practices with respect to age, sex, and outcomes including symptom severity, functional status, work status and satisfaction with surgery eighteen months postoperatively (Levine et al., 1993; Katz et al., 1998). These data suggest our sample was typical of workers undergoing carpal tunnel surgery in Maine during the study period.

Of 233 eligible patients referred to the coordinating center, 197 agreed to participate in the study and completed a baseline questionnaire. The number completing questionnaires at two, six and twelve months were 168, 158 and 159 respectively.

Measures of Organizational Policies and Practices

A major goal of this work was to review the original OPP items used in the Michigan

research and reduce the number of questions in each scale. The Michigan questionnaire takes over one hour to complete. To create a testable short-form that retains the dimensions and specific concepts to be measured and takes 5-10 minutes to complete the following steps were taken.

(1) Factor analyses and reliability analyses used to establish the 8 scales in the Michigan study were reviewed to reduce the number of items per scale without reducing the reliability. In examining the rotated factor structure, we applied a strict criterion: an item must load 0.5 or greater on the factor to be considered a candidate item, but must not load 0.3 or greater on any other factor.

(2) The item-to-total scale correlation was examined to select those items with the most substantial correlation with the total scale. A correlation of 0.6 or greater between the item and the scale score was required to be included.

(3) Excluded items were examined to determine whether a key element of the domain had been omitted. If an item was deemed conceptually central to the scale it was included. For example, three items were added to the proactive return to work dimension: the active coordination that occurs immediately post injury, the active assistance undertaken to make early return to work possible despite limitations in function, and the critical upper-level support that motivates the participation of reluctant or production-focused supervisors who can impede return to work placements from occurring.

(4) The eight major dimensions and key concepts within each dimension were examined to determine whether important concepts had been missed. For example, in disability case management (DCM), early contact (within 24 hours) with the employee after injury has been hypothesized to be important in returning the worker to work. While there is little data on this

'sentinel effect' we felt it was an important element of the DCM process to measure. This resulted in the addition of 2 items. The second was the degree the company practiced human-centered management practices, captured in item 8, the treatment of safety equally with production and quality (Amick and Lavis, 2000).

The final questionnaire was piloted in three focus groups to understand the worker burden. Focus group #1 had six women and one man, focus group # 2 had two women, and focus group # 3 had seven women and four men. All participants had carpal tunnel syndrome. Workers had difficulty with a response scale that asked the worker to assess how much of the time the organization engages in a practice, but there was consensus that asking how much the worker agrees/disagrees with the statement is reasonable. Items that asked about specific people in the organization (e.g., responsibility for disability claim management and return-to-work coordination is assigned to a specific person or office in the company) or the role of the supervisor were deemed too difficult and were excluded.

Finally, we carefully reviewed each item to determine whether an employee could answer it, based on his or her own work experience and the relevance of the item to return to work (a major outcome of the Maine study). This led to dropping items (e.g., in people-oriented culture, job satisfaction was eliminated as not adding unique information). In addition, two items were added to capture the overall labor-management climate and labor management climate specifically related to return to work (RTW). The final set of items developed for a worker-based measure of organizational policies and practices is listed in Table II (the employer version can be obtained from the first author). We retained a 1-5 response scale to facilitate comparability with the employer measure, but changed the responses from amount of time (0%-100%) to a strongly agree to strongly disagree scale with 3 'neutral'. Each employee is asked to

respond about current job or most recent job if not currently working. The items measured correspond to the following dimensions:

(1) People-oriented culture (Items 1-5). This is a broad measure of the culture of the company measuring the extent the company involves employees in meaningful decision-making, where there is trust between management and employees, and openness to share information in a cooperative work environment.

(2) Active safety leadership (Items 6-9). This is a measure of upper management's commitment and participation in safety issues. This commitment is manifest in management's involvement, commitment of company resources and people's time to promote safety and active efforts to balance economic and health & safety actions.

(3) Safety diligence (items 9-11). These are the actual practices that company personnel engage in to protect employee safety. They include maintaining safe work environments and taking action to redress unsafe conditions.

(4) Safety training (item 12) involves the timely implementation of worker training programs in safe job practices and the job hazards they will encounter.

(5) Ergonomic practices (items 13-14) are measures of the company's use of basic activities to reduce the biomechanical workload (heavy lifting or repetitive movements) and thus "design-out" injury hazards.

(6) Disability management is composed of two sub-dimensions, disability case management (items 15-17) and proactive return to work (items 18-20). Disability case management policies and practices identify and attempt to resolve lost workdays through early intervention, effective communication with providers and coordination of the needed medical and rehabilitative interventions. Proactive return to work is the education and accommodation

assistance the company provides to return individuals back to work.

(7) Labor-management climate (items 21-22) assesses the degree to which labor and management act as partners in health and safety and in particular returning the injured worker to work.

These questions were asked of all workers at six months. At baseline we asked a smaller set of questions (shown in Appendix A). We created four scales at baseline: people-oriented culture (items j-k), safety practices (items a-c), ergonomics (item d), and disability management (items e-i). These baseline measures are used to predict return to work at 6 months.

Statistical Analysis

To determine whether OPPs are measured by the seven hypothesized dimensions, a factor analysis with both varimax (orthogonal) and promax (oblique) rotation was performed (StataCorp, 1997). Because the scales are conceptually intercorrelated (an organization with a strong people-oriented culture is likely to also have similarly high ratings for the other dimensions), we report oblique rotation results. The basic process was to first conduct an exploratory factor analysis and using the criterion of eigenvalues greater than one and a Scree test to select the number of factors. Then using a factor-loading criterion of .4, we examined the underlying factor structure to determine potential scaling solutions.

Based on the factor structure and underlying conceptual basis of the factors we specified a series of scales and examine their reliability and validity. To examine the internal reliability of the scales, Cronbach alphas are reported with an acceptable level of internal consistency established at .7 (Cronbach, 1951; Nunnally, 1978). In addition, we examined the item-to-total correlations with a criterion that the correlation be greater than .4 for a well-established scale (Hays et al., 1988; Hays, 1991). Then we examined the degree that an item correlates more

strongly with the scale it is hypothesized to belong in as opposed to correlating more highly with another scale. This is often termed scaling success and a criterion of 90% success is applied (Hays et al., 1988; Hays, 1991).

The two-week test-retest reliability of the OPP scales was examined using data from a random sample of 34 workers who received a second questionnaire with a reduced set of items two weeks after returning the 6-month questionnaire. To estimate the intra-subject reliability of reporting two weeks apart we estimated the intraclass correlation coefficient (ICC) following Snedecor and Cochrane (1980). An ICC of 0.7 or greater is indicative of high reliability or correspondence between reports two weeks apart.

We tested the predictive validity of the OPP scales by examining their ability to predict return to work status at 6 months. It is hypothesized that greater people-oriented culture, safety practice, ergonomics practices, and disability management increase the odds of a worker returning to work after carpal tunnel surgery. In this analysis the baseline OPP measures were each entered into separate predictive logistic regression models that include gender (female=1), age (continuous variable), and baseline CTS symptom severity (ordinal variable ranging from 1, no symptoms, to 5, severe symptoms). Six-month work status (1=at work at 6 months) is the outcome. The advantage to using the reduced set of baseline OPP measures is that they are assessed prior to surgery. The disadvantage is that the scales do not include all the same questions. Yet, the baseline OPP scales were highly correlated with the six-month OPP measures (people-oriented culture $r = 0.52$, safety climate $r = 0.68$, ergonomic programs $r = 0.55$, disability management $r = 0.60$). Odds ratios are presented with standard errors (to estimate confidence limits) and p-values. Significant results have p-values less than or equal to 0.05.

Results

Factor Analysis

In a preliminary factor analysis a four or five factor solution emerged using an eigenvalue greater than one and Scree test. Staying with the company a long time (item 5) did not load on any factor and item 16 loaded uniquely on one factor. Upon examination it was determined that (Item 16) measures a concept less central to the intervention aspects of disability management for the employer, instead it represents an independent dimension as suggested by the factor analysis. Based on the preliminary results, we dropped items 5 and 16 and specified a four-factor solution with Promax rotation.

The results show that there are four factors using a factor-loading criterion of .4. All the hypothesized safety scales (active safety leadership, safety diligence and safety training) load heavily on Factor 1 rather than separate factors as hypothesized. We refer to this as safety climate. Factor 2 captures the people-oriented culture as specified a priori. Factor 3 confirms that disability case management and proactive return to work are a much broader dimension – disability management as suggested a priori. Factor 4 is the ergonomics practices scale as hypothesized. In all cases (except item 12) the uniqueness is quite low, suggesting that the percentage of the variance in the variable explained by the factors is high. Uniqueness values over .6 are considered high indicating a problem and even item 12 is not a definite problem by this definition (StataCorp, 1997).

The labor-management climate items did not separate into an independent factor. The general safety and health question (item 22) loaded equally high on factors 1 & 2. This question did not add significant information to the safety climate scale and thus we dropped it. The

specific question pertaining to return to work (item 2$\frac{1}{1}$) loaded on the disability management factor and could be distinguished as a unique component in successful return to work efforts.

Four scales are both empirically and conceptual identified through the factor analysis: people-oriented culture (items 1-4); safety climate (items 6-12); ergonomic practices (items 13-14); and disability management (items 15, 17-21). These scales were created as summated averages varying between 1 and 5.

OPP Scale Properties

We next examined the scales and the properties of the scales. Cronbach's alphas for all four scales are greater than .7. When items are removed from the scales, the recalculated alpha drops, suggesting that each item makes some unique contribution. The item-to-scale correlations are all greater than .4. In every case the items correlated highest with scales to which they were hypothesized to belong. Therefore, scaling success was 100% for each scale indicating strong discriminant validity. In addition, we explored whether the OPP scale properties vary by whether the person is depressed or not (using a cutoff point of 52 on the mental health index of the SF-36 as recommended by Wells et al., 1989) and by gender. In neither case did the basic scaling properties change. Finally, for test-retest results, the ICCs range between .78 and .88 supporting the ability of workers to consistently respond over time to the same question. Because questions were also included about carpal tunnel functioning on the test-retest questionnaire, we were able to calculate an ICC for this established scale (Katz et al., 1994). The OPP ICCs compare favorably with the ICC (.95) for the carpal tunnel functioning scale.

The four OPP scales are inter-correlated. People-oriented culture is strongly correlated with safety climate ($r=0.72$), ergonomic practices ($r=0.58$) and disability management ($r=0.64$).

Ergonomics practices is correlated with safety climate (r=0.64) and disability management (r=0.65). Disability management is correlated with safety climate (r=0.67).

The scales are reasonably distributed with limited responses at the floor and ceiling. People-oriented culture has 9.6% of the responses at the floor (low) and 4.1% at the ceiling (high). Similarly, safety climate (11.1% at the floor and 2.8% at the ceiling), ergonomic practices (4.8% at the floor and ceiling) and disability management (1.4% at the floor and 4.1% at the ceiling) have a modest number of respondents endorsing either strongly agree (high) or strongly disagree (low) for all items in a scale. People-oriented culture has a mean of 2.72 and a standard deviation (SD) of 1.09. Safety climate (mean 2.47, SD 0.98) and ergonomic practices (mean 3.08, SD 0.94) have similar means indicating that most respondents do not consider their employers to be strong in these policies and practices. However the mean for disability management (mean 4.26, SD 1.53) suggests that this is one OPP where most employers have been active in creating programs and policies.

Predictive Validity

To examine the predictive validity of the scales we looked at how well baseline measures of a similar set of items predict work status at six months. Table V shows the logistic regression results. As hypothesized, all four OPPs significantly predict six-month return to work after adjustment for age, gender and CTS symptom severity. The higher the value of each OPP scale the greater the odds a person had returned to work. Age, gender and symptom severity are non-significant in all four models. In each model the C-statistic is greater than .7 indicating a strong model fit (Hosmer and Lemeshow, 1989).

Discussion

In this paper we described prior conceptual and empirical work in Michigan developing and testing a model of how organizational policies and practices (OPPs) affect work disability prevention and management. The model suggests that the broader company environment creates a context in which certain types of disability prevention and management interventions are implemented. Together these create an organizational ecology that influences work disability incidence, duration and costs. In particular, the results from Michigan point to the importance of OPPs for workers' compensation claims incidence and lost work days for seven industries where there were high rates of injuries and illnesses. However, the Michigan work only developed questionnaires for employer-level assessment. Building on the Michigan work, an alternative format of a revised questionnaire that can be answered by workers for measuring OPPs is presented. In a study of workers who have had carpal tunnel surgery, OPP scales are shown to be both reliable and valid. These results provide initial support for the use of this measure in worker surveys.

Importantly, the worker-level OPP scales replicate the key findings of the Michigan study. First, four scales emerged from the factor analysis that tap the three critical areas identified by Hunt and colleagues (1993). People-oriented culture taps a significant element of the wider company environment. Both safety climate and ergonomic practices assess the safety and prevention activities that an organization invests in to reduce work disability incidence. Finally, disability management represents the continuum of interventions identified as critical to returning injured workers to work and reducing costs.

The commensurability of results using different outcomes in the Michigan (employer level) and Maine (employee level) studies further supports the utility of the model.

While the four OPP dimensions represent conceptually distinct and operationally independent measures, they co-exist in a series of interdependent relationships as indicated by the high scale intercorrelations. It is likely that a people-oriented culture facilitates the development of a strong safety climate and the implementation of ergonomic practices that reduce risks, and fosters a disability management program that results in appropriate and productive work outcomes. These policies and practices would be consistent with a management perspective that views investments in people – through safety, health and accommodation - as an equally important strategy to achieving the productivity and financial goals of the organization.

Study 4: Agreement between employer and employee reports of Organizational Policies and Practices

Objective: Despite the recognized need to capture what organizations do in helping workers return to work, little effort has been made trying to develop and test measures of organizational policies and practices. By organizational policies and practices, we mean those conditions of the organization that apply to all workers or large segments of workers and that are distinct from conditions of the organization of work or the specific job. This follows a separation developed by Shannon and colleagues (1995;1996).

A unique feature of this NIOSH funded research was the opportunity to compare and contrast the relationships between worker and employer reports of organizational practices and policies. In the evaluation of the quality of occupational health services it is necessary to know whether employer-level relationships correspond with individual level relationships.

Despite strong reliability and predictive validity of worker reports there is still a need to examine correspondence between employer and employee reports (Amick et al., 2000; 2003). To

examine specific aim two we compared worker reports of organizational practices and policies with employer reports. The questionnaires were developed from The Disability Prevention Among Michigan Employers Project (Hunt et al, 1993) and described in Amick et al.,(2000;2003). Workers were asked a reduced 12 item version at baseline and a complete 42 item version at six months. We hypothesized there would be agreement between workers' and key informants' responses to the organizational policies and practices questionnaires.

Method: Of the total 76 employers responding, 65 employers were linked to employees with completed 6m OPP responses. 11 employers were excluded because their employees did not complete the 6m OPP survey. The majority of employers had only one employee in the study; eight had more than one. One employer had 14 employees, one employer had four employees, two employers had three employees each, and four employers had two employees each.

The four employer and employee scales (19 items) were analyzed using Lin's (1989) Concordance Correlation Coefficient (rho_c). Because the sample size is small, we measured significance with a .90 confidence interval and p value <.1.

Given the small sample of 65 combined employer/worker response sets, a detailed examination of the predictive validity employer OPP with regards to worker level health outcomes would not be possible. Alternately, we created a summated average OPP index from the four employer OPP scales and collapsed the index to create a dichotomous measure of a highly supportive organization. Using the outcome measures of successful work role functioning at two months and six months post surgery (Amick et al., 2003), the predictive validity of employer OPP was tested with linear regression.

In response to a reviewer's request, we attempted an analysis of the employer written policies in conjunction with the comparison of employer and worker OPPs. Although this was

not entirely possible because of the low response rate (Nineteen written policies submitted), qualitative analysis of the written documents provided some meaningful insight.

Results: Employers' OPP mean self-ratings were generally higher than employees'. Only the scale representing People Oriented Culture showed significant concordance (rho_c=0.254, p .012). The OPP index (mean of four scales) had a significant concordance, rho_c=.138, p.077.

Analysis of scale agreement by groups union/nonunion showed significant concordance for employers with unions (N=18): safety: rho_c=.444, p=.019; ergonomic practices: rho_c=.396, p=.056; disability management: rho_c=.412, p=.013. People oriented culture was in significant agreement regardless of group. There was significant concordance for employer size (greater than 250 employees, N=28): safety: rho_c=.243, p=.093; ergonomic practices: rho_c=.354, p=.022; disability management: rho_c=.216, p=.066. Responses for the people oriented culture scale were in significant agreement regardless of group.

Regression analysis revealed highly supportive organizations predict individual level measures of successful work role functioning at two months post CTRS, $F(1,44)=3.48$, p .069, and at six months post CTRS, $F(1,53)=3.57$, p .064.

Qualitative analysis of written policies provided by 19 employers indicated responsibility for implementation of organizational policies and practices was assigned at the supervisory level. This finding suggests there are likely to be differences in perceptions of the organization not only between key informants of the company and employees, but also between employees themselves.

Conclusion: The results suggest care should be taken in research that considers worker reports of all OPPs as both valid and reliable. In studies seeking to understand

Discussion: Preliminary analyses of concordance between employer and worker reports of organizational policies and practices suggest there is greatest overall agreement on the scale for people oriented culture. In addition, larger companies (>250 employees) and unionized companies are more likely to demonstrate agreement between employer and worker responses on the remaining three dimensions of safety practices, ergonomic practices, and disability management. While results suggest concurrent validity of worker responses, a number of limitations of the study need to be considered. First, the sample was very small and in most cases, comparisons were made between a single key informant for the employer and a single worker. The inability to examine aggregate responses limits the reliability of the findings. Second, the worker and employer questionnaire items were scaled somewhat differently. On a 1 (low) to 5 (high) format, workers responded with strongly disagree to strongly agree, while key employer informants responded with 0% to 100%. This difference reflects the difficulty in constructing a questionnaire that both employers and workers can answer reliably and recognizes perhaps the different perspectives of employers and workers with regard to organizational policies and practices. Part of the workers' thinking about OPPs is shaped by their daily experiences and limited interaction or exposure company-wide. Alternatively, the employer is more likely shaped by the general workers' compensation experience.

ADDITIONAL PAPERS

Study 5: Development of an Employer Questionnaire to Measure Organizational Policies and Practices Relevant to Health Research

Objective: A major goal of this work was to review the original OPP items used in the Michigan research and reduce the number of questions in each scale to support widespread use in occupational safety and health. The questionnaire used in The Disability Prevention among Michigan Employers Project (Hunt et al, 1993) contained 95 items and took one hour to complete. Seven dimensions of the organization were identified: people-oriented culture, active safety leadership, safety diligence, safety training, disability case monitoring, proactive return to work and ergonomic practices that were important for affecting the incidence of injuries and work disability, the duration of disability and overall disability prevention and management performance. We added an active labor-management health and safety committee dimension as suggested in the literature (Shannon et al, 1995).

Method: To create a testable short-form employer OPP measure, item reduction utilized (1) factor analyses and reliability analyses. In examining the rotated factor structure, we applied the following selection criteria: an item must load 0.5 or greater on the factor to be considered a candidate item, but must not load 0.3 or greater on any other factor. (2) The item-to-total scale correlation to select those items with the most substantial correlation with the total scale. A correlation of 0.6 or greater between the item and the scale score was required to be included. Excluded items were examined to determine whether a key element of the domain had been omitted. Confirmatory factor analysis (CFA) with maximum likelihood estimation was conducted following the item reduction to assess the hypothesized OPP factor structure. Several fit indices were examined to assess model-fit (i.e., how

well the hypothesized model accounts for the covariance between variables). These included: 1) the X2 statistic; 2) the Root Mean Square Error of Approximation (RMSEA); 3) the Standardized Root Mean Square Residuals (SRMR); 4) the Comparative Fit Index (CFI); 5) the Incremental Fit Index (IFI); and 6) assessment of the fitted residuals. LISREL, version 8.3, was used to perform the CFA (Joreskog & Sorbom, 1996).

Results: The sample used in this analysis is comprised of 410 organizations which responded to the Maine and Ontario OPP surveys (57 and 353), respectively. The organizations provided descriptive information regarding size, unionization, and type of business. Five scales were both empirically and conceptually identified through the item reduction procedures. These scales -- people-oriented culture; safety diligence; ergonomic practices; safety leadership; and disability management were then assessed with CFA. The hypothesized five-construct model was then modified to improve overall fit. Modifications were made, sequentially, by examining modification indices. Four pairs of error terms between variables within a common construct were allowed to correlate. A final modification was also made. The item, "company analyzes injury and illness data to identify causes and target solutions," was allowed to load to the construct Disability management in addition to its hypothesized construct Safety leadership. The final modified model, consisting of the five constructs resulted in a well-fitted solution (fit statistics: χ^2 729.48, df 284, $p<0.000$; RMSEA 0.062, 90% CI 0.056-0.067; SRMR 0.066; IFI 0.93; CFI 0.93).

To examine the internal reliability of the scales, an acceptable level of internal consistency was established at .7 Cronbach alpha (Cronbach, 1951; Nunnally, 1978). In addition, the criterion item-to-total correlation was set greater than 0.4 for a well-established

scale (Hays et al., 1988; Hays, 1991). Scaling success and a criterion of 90% success was applied (Hays et al., 1988; Hays, 1991). All alphas were greater than 0.8. The item-to-scale correlations were all greater than 0.55. In every case the items correlated highest with scales to which they were hypothesized to belong. Therefore, scaling success was 100% for each scale indicating strong discriminate validity.

Study 6: Development and Validation of a Second Generation Measure of Upper Extremity Functioning

Objective: A number of measures have been developed to assess upper extremity functioning for use in clinical research (Beaton et al., 1999; Hudak et al., 1996; Pransky et al., 2000; Stock et al., 1995; 1996). The Brigham and Women's measure of upper extremity functioning was one of the earliest developed and has been widely used in treatment and clinical outcome studies (Levine et al., 1993; Katz et al., 1996). As outcomes research has expanded to also include population-based studies, measures developed for clinical studies need to be augmented to assess functioning at the upper end of the distribution to reduce ceiling effects. The performance of a second-generation eleven-item Brigham and Women's Upper Extremity Functioning Scale developed to meet this need is compared with the original eight-item instrument using statistical methods based on classical test theory (Nunnally & Bernstein, 1994) and item response theory (Hambleton, Swaminathan, & Rogers, 1991). The clinical responsiveness, convergent and predictive validity of the two scales were also contrasted.

Methods: The data used in these analyses were obtained from a prospective observational community-based study in Maine, i.e., the Maine Carpal Tunnel Study II (CTS II). In CTS II, 197 patients (84 men and 113 women) with confirmed diagnostic impression of CTS

agreed to participate in the study and completed a baseline questionnaire. The number completing questionnaires at two, six, and twelve months were 168, 158 and 159 respectively.

Measures

The 11 item revised Brigham and Women's Upper Extremity Functioning (UEF) measure presented to patients, all items were rated on a 5-point Likert-type scale ranging from 1 = no difficulty to 5 = cannot do at all. However, for ease of interpretation, all analyses presented in this paper are based on reverse scored items, i.e., 1 = cannot do at all and 5 = no difficulty. This coding scheme enables us to describe the latent trait, upper extremity functioning, in a logical fashion with low scores representing poor functioning and high scores representing good functioning. The final scale is scored as a summated average rescaled between 0 and 100 (by multiplying each value by 20) with 100 = complete functional ability and 0 = functional incapacity.

Other Measures. The SF-12 physical components scale is calculated based on established scoring algorithms (ref SF-12 manual). The scale is a general measure of physical health status that varies between 0 and 100 (good physical health). Age is a continuous measure, while gender is coded as 1=male and 2= female. Current workers' compensation claim is measured as a dummy variable (1 equals current claim). Return to work is measured as a dummy variable where 1 equals working either full- or part-time at either period of measurement (two or six months).

Analyses

Classical test theory statistics, including item difficulties, corrected item-total correlations, and Cronbach's coefficient alpha with item deleted, were calculated. The acceptable level of internal consistency was considered 0.7 (Cronbach, 1951; Nunnally and

Bernstein, 1994). Corrected item-total correlations were evaluated using a criterion that the correlation should be greater than 0.4 (Hays et al., 1988; Hays, 1991).

The two-week test-retest reliability of the scales was examined using data from a random sample of 35 workers who received a second questionnaire with a reduced set of items two weeks after returning the six-month questionnaire. To estimate the intra-subject reliability of reporting two weeks a part, we estimated the intraclass correlation coefficient following Snedecor and Cochran (1980). The two-week test-retest reliability was estimated by calculating an intraclass correlation following the formula, intraclass correlation = F-1/F+N-1, where F is the overall F-statistic and N is the number of groups. Since subjects were observed twice, the group number is 2. The sample for this calculation is 34 people who were randomly chosen at the six-month questionnaire administration and received a second questionnaire two weeks after returning the first questionnaire. An intraclass correlation coefficient of 0.7 or greater was considered acceptable (Beaton, 1997 responsiveness paper).

For the IRT analysis, a polytomous response model was preferred, but the limited sample size ($\underline{n}$ = 198), required that we use the unidimensional two-parameter logistic model (2PLM) for dichotomous responses (Birnbaum, 1968; Lord, 1980). Research has shown that this model can be applied with samples as small as 200 (Drasgow, 1989).

The two-parameter logistic model, (Birnbaum, 1968), which assumes no guessing, is appropriate for attitude, opinion, or personality surveys and symptom surveys such as the UEF.

Upper extremity functioning (UEF) items were dichotomously scored, with the upper two categories (no difficulty and mild difficulty) coded in the positive or "endorse" direction and the lower three categories (moderate difficulty, severe difficulty, and cannot do at all) coded in the negative (reject) direction. While somewhat arbitrary, this procedure was justified, because

preliminary data analysis indicated that the "cannot do at all" response was used very infrequently.

Item and person parameters were calibrated using BILOG 3.08 (Mislevy & Bock, 1990), which uses a marginal maximum likelihood estimation procedure. BILOG default parameters were used, except that the number of quadrature points was set to 10 and maximum EM and Newton cycles were specified as 30 and 6, respectively.

Clinical Responsiveness. It was hypothesized that the new UEF measure would register a significant change following carpal tunnel surgery. Standardized response means (SRM) were calculated for those who said that surgery improved the quality of life (Fortin et al., 1995; Katz et al., 1992; Liang et al., 1990). We calculated SRMs separately for those who felt surgery did not improve their quality of life because we expected their functioning scores might deteriorate. The SRM is the mean of the observed differences between the pre- and post-surgical scale scores divided by the standard deviation of the differences. Following Beaton et al. (1997), confidence intervals (95%) were calculated under the assumption that difference scores follow a normal distribution.

Concurrent Validity. We hypothesized the new UEF scale will covary in meaningful ways with the SF-12 physical components scale and the pain item at all four measurement points. Using linear regression, partial correlations were estimated between the UEF scale and the SF-12 physical components scale and pain question (Ware et al., 1996) at baseline, 2-, 6-, and 12-months follow-up. Covariates included age, gender, education, income, occupational group, and workers' compensation claim status. Adjusted partial correlations were tested using a t-statistic.

Predictive Validity. We hypothesized that the new UEF scale predicts successful return to work. We focus on two- and six-month return to work (RTW) since the majority of patients

have returned to work by six months. Log odds are estimated limits for a one-point transition on the UEF scale using a multivariate logistic regression model. Odds ratios with 95% confidence limits are presented for a 10-point transition on the UEF scale. All models include age, gender, education, income, occupational group, and workers' compensation claim status. In predicting 6-month RTW, baseline UEF is included in the model along with two-month UEF.

Results

Results of the CTT analyses of UEF scale are as follows. Item-total (corrected) correlations, which were acceptable for all items, ranged from $\underline{r} = .46$ to $\underline{r} = .78$. The alpha reliability (Cronbach, 1951) for the entire scale was $\alpha = .92$. Examination of the alpha coefficients with the item deleted indicates that there would be essentially no improvement in the scale's reliability by removing any item. Overall reliability for original 8-item scale was $\alpha = .91$. The mean UEF score across all patients for the 11-item scale was 3.3 ($\underline{SD} = .8$).

A principal components analysis was conducted to assess the unidimensionality of the 11-item UEF scale. The fact that the first factor accounted for 56% of the variance, combined with evidence from the scree plot (e.g., first eigenvalue = 6.14 and second eigenvlaue = 1.00) provided support for the conclusion that UEF scale meets the unidimensionality assumption necessary to fit the 2PL model (Ackerman, 1991; Drasgow & Parsons, 1983).

In addition, adequate model-data fit is an essential aspect of an IRT analysis. Overall, the BILOG results indicated good fit. Given the small number of items (< 15), the chi-square index was inappropriate for assessing fit. Therefore, fit was assessed on an *ad hoc* basis using three criteria: root mean standardized posterior residual, ease of convergence, and plots of the fitted response functions. Root mean square standardized posterior residuals were all less than the suggested criterion value of 2.0, ranging from a low of 0.29 to high of 1.62. In addition,

convergence was good, i.e., the iteration history showed that the "largest change" values became progressively smaller and ended below the termination value (0.01 by default). Examination of the fit plots also provided support for the conclusion that the data fit the model.

Discussion: This paper illustrates the utility of mdern psychometric methods in occupational safety and health.

Study 7: Longer Distal Motor Latency Predicts Better Outcomes of Carpal Tunnel Release

Objective: Carpal tunnel syndrome (CTS) is among the top 10 occupational injuries and illnesses associated with work disability in the US workforce in terms of both reported frequency and days away from work. In 1994, over 39,000 work-related cases were reported, at an incidence rate of 4.8 new cases per 10,000 workers. These cases represented a median of 20 days away from work. Carpal tunnel release is a well-established treatment for CTS and is usually performed after the failure of conservative therapies, such as activity modification, use of splints, and corticosteroid injection. However, the surgical procedure is not always successful in reducing symptoms. Many factors other than the technical success of surgery can affect the extent of pain relief and functional improvement after the procedure. For example, symptoms and function may fail to improve or may reoccur among patients who return to a job without altering the exposure to the physical risk factors. Better data on the associations between specific presurgical clinical variables and surgical outcomes would help physicians and patients decide whether to proceed with carpal tunnel surgery.

Nerve conduction tests are often considered the definitive diagnostic test for CTS. Longer distal sensory and motor latencies (DSL and DML, respectively) reflect worse nerve dysfunction.

However, findings in the literature on whether and how presurgical nerve conduction tests are associated with surgical outcomes are inconsistent.

To clarify this issue, we analyzed data from a prospective observational study of patients undergoing carpal tunnel release, with a broad range of clinical and sociodemographic variables that might be associated with the surgical outcome. The goal of the analysis is to test the null hypothesis that preoperative distal latencies of the median nerve are not associated with the level of upper extremity symptom, functional limitations, and satisfaction with surgery.

Methods: A total of 109 surgically treated workers with carpal tunnel syndrome across the state of Maine completed questionnaires assessing preoperative levels of symptom and functional limitations and general physical health (SF-12). A second questionnaire assessed the six-month postoperative outcomes of symptom severity, functional limitations, and satisfaction with surgery. The bivariate associations between the preoperative nerve conduction variables and the six-month surgical outcomes were assessed by Spearman correlation coefficients. Similarly, the nerve conduction variables and six-month surgical outcome measures were also compared with other baseline variables. For dichotomous variables, *t* tests were performed for the outcome variables and the nerve conduction variables. Linear regression analyses further examined the association between DML and each of the outcome measures while adjusting for other variables also associated with the outcome measures at *P* values of 0.05 or less. All analyses were performed in SAS™ (SAS Computing Software, Cary, NC).

Results: Longer preoperative distal latencies of the median nerve at the wrist were associated with better six-month surgical outcomes. The Spearman correlation coefficients indicated longer distal motor and sensory latencies were associated with less postoperative levels of symptom

severity and functional limitations and greater satisfaction with surgery. On average, patients with more severe electrophysiologic impairment, as defined by the nerve impairment classification, have better surgical outcomes. Patients with more severe electrophysiologic impairment had greater improvement from the preoperative to the six-month postoperative evaluation in the self-reported levels of symptoms and functional limitations. Along with more prolonged DML, other preoperative variables associated with better surgical outcomes included better general physical health (PCS-12), higher income, working at the time of surgery, having good social support at work, control over one's job, and having attended college. Factors associated with worse surgical outcomes were the presence of other musculoskeletal disorders, hiring an attorney, receiving workers' compensation, and worse functional limitations of the upper extremity at baseline just before surgery.

Multiple linear regressions were performed to assess the independent associations between preoperative distal motor latency and six-month symptom severity and functional limitation, adjusting for other factors that could influence these outcomes. First, we regressed the six-month postoperative symptom severity and functional limitations against DML. Then we regressed these six-month outcomes against DML and the other covariates, including the preoperative values of functional limitations of the upper extremity, education level, working at baseline, income, general physical health (PCS-12), and the presence of other musculoskeletal disorders. In these models, the significant predictors of worse symptom severity were lower DML ($\beta = -0.11$, $P = 0.04$), lower income ($\beta = -0.19$/\$10,000 income intervals, $P = 0.01$), and worse general physical health ($\beta = -0.28$/10 points of PCS-12, $P = 0.003$). The significant predictors of worse functional limitations were worse general physical health ($\beta = -0.33$/10 points of PCS-12, $P = 0.0001$) and ever receiving workers' compensation benefits ($\beta = 0.41$, $P = 0.01$). DML had a

borderline association ($\beta = -0.07$, $P = 0.12$) with postoperative functional limitations. To determine whether the association between DML and outcome was explained by PCS-12, we removed the PCS-12 and indeed found that the association was stronger. This finding suggests that PCS-12 mediates some of the effect of DML on outcomes. In summary, the associations between longer DML and less severe symptoms and functional limitations documented at six months in univariate analysis persisted in multivariable models but were somewhat weaker when adjusted for other covariates. PCS-12 seems to explain some of the effect of DML on the outcomes.

Discussion: In this prospective observational cohort study of workers undergoing carpal tunnel release, more severe preoperative nerve conduction abnormalities were associated with better surgical outcomes. Longer distal motor and sensory latencies were correlated with less severe symptoms and fewer functional limitations of the upper extremity and with higher levels of overall satisfaction with the surgery measured six months postoperatively. These findings largely persisted after adjustment for covariates. The association between DML and outcomes was not especially strong and the outcomes were particularly heterogeneous for patients with mild nerve impairment (DML values less than six msec).

These findings may seem paradoxical. One might suspect that a longer DML, indicating more severe damage to the nerve, would be associated with less success from surgical decompression because of residual nerve damage. However, most patients in the cohort had mild-to-moderate nerve conduction impairments. This may have occurred because participants were workers who used their hands in their work and likely sought treatment before the impairments became advanced enough to create permanent axonal damage.

The data here support the supposition that the outcome of carpal tunnel surgery is affected by many factors. The effect of DML on these outcomes persisted in multivariate analyses that adjusted for relevant covariates. However, the regression coefficients were smaller and less significant in regressions that adjusted for covariates, indicating some confounding.

The most prominent prognostic factor was a patient's preoperative general physical health score (PCS-12). General physical health and DML both influenced the functional limitation outcome; however, DML had little effect for those with better general health scores. The effect of DML on six-month postoperative functional limitation was striking in patients with lower PCS-12 values. The formal test for an interaction failed to reach statistical significance, however ($P = 0.12$). There was no suggestion of an interaction between PCS-12 and DML in predicting 6-month postoperative symptom severity scores. At both high and low levels of PCS-12, a more prolonged DML was associated with better outcome. In general, postoperative symptom severity was more strongly associated with DML than postoperative functional limitations. This finding may reflect that symptom severity included patients' reports of symptoms, numbness, and pain, all of which are direct results of CTS. Alternatively, upper extremity functional limitation can be affected by other musculoskeletal and medical conditions.

Previous studies have reported mixed conclusions regarding the relationship between the preoperative latencies and carpal tunnel release outcomes. Studies that did not show effects may not have had a large range of latencies or outcomes to detect associations between latencies and the outcomes. If we limit our analysis to those who have distal motor latencies below 6 msec, then there seems to be little affect of DML on the outcome measures. In addition, this study used validated continuous outcome measure. Other studies have used categorical outcome measures,

which may have decreased their sensitivity to detecting differences. Furthermore, this study was unique in its attempt to identify other factors that confound or mediate the associations between nerve conduction and surgical outcomes. We found, for example, that patients with worse general preoperative health have less severe nerve dysfunction and worse outcomes.

ANTICIPATED FUTURE PAPERS

Dissertations

(1) Predictors of change in self-efficacy following carpal tunnel release surgery

(2) Organizational predictors of job accommodation following carpal tunnel release surgery

Other

(3) Changes in pain pre-post carpal tunnel release surgery

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