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Back Disorders Among Union Carpenters
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Abbreviations

ANSI	American National Standards Institute
BLS	Bureau of Labor Statistics
CLR	Confidence limit ratio
CPI	Consumer Price Index
CTWW	Carpenters Trusts of Western Washington
ICD-9	International Classification of Diseases (Version 9)
L&I	Labor and Industries
MSD	musculoskeletal disorder
MS	musculoskeletal symptom
NAICS	North American Industry Classification System
NIOSH	National Institute for Occupational Safety and Health
OE	overexertion
OR	odds ratio
OSHA	Occupational Safety and Health Administration
PLD	paid lost days
PLT	paid lost time
RR	rate ratio
RTW	return to work
SIC	Standardized Industry Classification
SHARP	Safety and Health Assessment and Research Program
U.S.	United States
WC	Workers' compensation

EXECUTIVE SUMMARY AND SIGNIFICANT FINDINGS

We conducted a study of back disorders among a well-defined cohort of construction carpenters. By combining sources of administrative data we had a unique picture of medical care for a large cohort of union carpenters through their workers' compensation and private health insurance coverage for the 15-year time period (1989-1998). Data for these analyses came from the Carpenters Trusts of Western Washington that allowed us to enumerate a cohort of union carpenters who had worked in Washington State. The trust also provided us with the health care claims data for these individuals including the actual line items submitted for payment, charges, and associated ICD-9 codes submitted by the care providers. The Washington State Department of Labor and Industries provided records of work-related injuries for the cohort. Because Washington has a state run worker's compensation program we were also able to secure the line items for medical care for the associated claims as well including the provider-assigned ICD-9 codes.

A number of outcomes were explored including risk of acute work-related back injury, work-related back injury from overexertion type activities, incident and recurrent work-related back injuries, and delayed return to work following injury. We also evaluated costs associated with work-related back injuries over time as well as health care utilization and associated costs covered through the workers' union provided health insurance coverage. With the exception of our analyses of delayed return to work, the analyses used a cohort approach. For analyses of work-related injuries and costs, time at risk was person hours of work as a union carpenter. For analyses of health care utilization and costs, time at risk was months of insurance eligibility. All cohort analyses were limited to 18,768 carpenters who worked at least 3 months of union hours in this 15-year period, had a month of union health insurance coverage, and worked at least a month after meeting the entry criteria. To evaluate risk factors for delayed return to work, a case-control analysis was conducted comparing odds of injured carpenters who returned to work within a month and those whose return was delayed at least 3 months. The latter requirement for the cohort anlyses was not required for these analyses allowing 20,642 carpenters for study.

Findings

Back injuries accounted for an average of over six injuries per 100 fulltime carpenters over this 15 year period, and they were responsible for nearly one-fifth of workers' compensation claims filed by the cohort. Injury rates declined significantly over time consistent with the overall decline of injuries among this group and others that have been reported [Lipscomb et al., 2003a; Murphy and Volinn, 1999; NIOSH, 2004; US DOL, BLS, 2005, 2007; Center to Protect Workers Rights, 2002 and 2007]. The decline in musculoskeletal injuries was largely responsible for this pattern.

During this period of time when work-related musculoskeletal back injuries among this cohort decreased steadily and dramatically [Lipscomb, 2008], their health care utilization rates through their private insurance followed a different pattern. Utilization rates ended in 2003 over twice as high as in 1989. This pattern of utilization raises concern that

some work-related care for back disorders could have shifted to the carpenters' health care trust, particularly in later years. Rates of utilization through the trust were also increased in the first 3-5 years following a work-related back injury with slightly different patterns associated with a prior overexertion work injury compared to a prior back injury from acute trauma.

Although we expected private health insurance payments to mirror fairly closely the patterns of use of health care services, costs did not go up as much as utilization during this 15-year period. The pattern could reflect a more substantial shift of medical care for less severe back disorders from WC to health insurance consistent with concerns others have raised regarding possible cost-shifting [Biddle, 1998; Rosenman, 2000; Ducatman; 1996; Zwerling, 1991; Butler 1997; Ramsey 1994]. However, we observed the same pattern we had for utilization when we examined charges rather than payments. Coupled with the increasing deductibles for private care over time, the findings are suggestive of cost-shifting to the union-provided insurance with some costs being borne by the worker.

The analyses confirm a significant, but decreasing, economic burden for back injuries reported through the workers' compensation system among these union carpenters for medical care and lost work time. The decline reflects both declining costs associated with acute back injuries over time as well as the previously described decrease in overexertion injury rates among this cohort between 1989 and 2003 [Lipscomb et al, 2008].

Acute back injuries were responsible for a disproportionate share of costs among these carpenters compared with overexertion injuries consistent with patterns seen in other industries as well as construction [Murphy and Courtney, 2000]. It is of note that among these carpenters, indemnity payment rates increased with increasing age as did medical payment rates, providing some indication that the injuries of older workers may be more severe and that older workers may be more difficult, or less likely, to be accommodated in this heavy industry. Among this cohort we saw increasing costs associated with second and third back injury claims, particularly if they were of a musculoskeletal nature as well as very high costs among the small group of carpenters who experienced multiple back injuries.

Both age and time in the union were associated with risk of a reported work-related back injury. Specifically those of younger age and with less union tenure were at higher risk of back injury. It is of note that, consistently, the effect of age was diminished when adjusting for time in the union. From these data we cannot determine whether differences in risk by union tenure represent inexperience, different exposures based on seniority, or perhaps both. The decline in overexertion injury rates after four years in the union, or the end of the typical apprenticeship period, certainly raises suspicions that apprentices may be more heavily involved in manual materials handling.

Second reported work-related back injuries occurred at a rate 80% higher than initial events. Although the mean difference in lost time from work was modestly higher for second injuries than for the first, the distributions of the first and second back injuries

were remarkably similar in terms of mechanism and nature of injury, as well as medical diagnoses received for treatment. These findings are consistent with injuries from like work exposures over time among members of the cohort.

In looking at medical care for these back injuries it is clear that while overexertion back injuries are common among these carpenters, the majority of these work-related back injury claims resulted in no paid lost days. Those with >90 days of paid lost days were more likely to have seen a private health care provider within 30 days of their claim (consistent with the notion that many back disorders are chronic in nature [Carey, 1999]. Additionally, this could indicate some overlap in care among the two systems.

Care from chiropractors and general practitioners were most common for both workers' compensation and private health care. Overall, chiropractic care, whether workers' compensation or private, was frequent among this group of workers which is consistent with a previous study that found skilled laborers were more likely to see chiropractors compared to service workers [Cote, 2005]. Specialist encounters comprised 9% of workers' compensation encounters and 8% of private health care encounters and were more likely as the number of paid lost days increased. Observed differences in provider care patterns by number of paid lost days is consistent with previous research where referral to specialist was associated with delayed return to work [Kominski et al., 2008], but the data do not necessarily indicate that this relationship is causal.

Usefulness of Findings and Translation

The back injury rates we observed among this cohort of carpenters are considerably higher than those reported by the Bureau of Labor Statistics, providing additional evidence that the Bureau of Labor Statistics data under estimate work-related injury risk [Lipscomb et al., 1996; Glazner et al., 1998; Rosenman et al., 2006]. The BLS reported work-related injury or illness rates of 6.8 per 100 full-time construction workers in 2003 [US DOL, BLS, 2005]. Among this well-defined cohort we observed an injury rate of 3.8 per 100 full-time carpenters for back injuries alone in that year. In light of the insured private health care access among this cohort of union workers, the findings are even more compelling.

It is not surprising that overexertion injuries from manual materials handling activities are responsible for the largest burden of back injuries among these union carpenters. Despite their substantial decline, continued efforts are needed to clearly define tasks or activities that place them at risk of injury and to identify methods to alleviate relevant exposures. This is particularly relevant given the contrasting pattern of care seen through the union-provided health insurance of these carpenters. At the same time, we should not fail to recognize the substantial contribution made by acute traumatic events to the burden of back injury.

The magnitude of the rate increase in the first year following a work injury is consistent with the report of increased health care utilization among health care workers who had experienced a musculoskeletal work injury in British Columbia [Koehorn et al., 2006]. Although we limited our before and after analyses to individuals with only one back injury, we saw a steady increase in utilization for back diagnoses through the trust as the number of work-related back injuries increased. This finding is consistent with the chronic nature of some back problems even among the employed [Koehorn, 2006; Carey, 1999; Carey, 2000; Rosenman, 2006].

The risk of a back injury of a musculoskeletal nature peaked at 1500 hours of time after return to work from a previous injury, and gradually decreased with increasing time back at work. This time represents close to a year of full-time work for many of these union carpenters. We have no data on accommodation or restricted work after injury. It is possible that these carpenters did receive less taxing duties upon return from an earlier injury or they may look for ways to limit stressful exposures on their own when first coming back to the job. However, the overall nature of construction work makes light duty assignments unlikely, particularly for extended periods of time.

Carpenters between 30 and 40 years of age were at greatest risk of back injuries, after adjusting for gender, time in the union, and predominant type of work. The fact that we observed individuals with the greatest union tenure carrying the lowest risk likely reflects a healthy worker effect or changes in direct physical exposure that occur with more seniority in the trade. Consistent with other reports [Lipscomb, 2000], carpenters involved in drywall work were at relatively high risk of back injury compared to their union colleagues in other forms of work; residential carpenters were at higher risk of initial injury but not for a second event (based on a small number of observations).

While secondary prevention may be warranted, among these workers we have been unable to identify factors that are strongly associated with recurrent back injuries other than prolonged work disability with the initial injury [Lipscomb et al, 2009]. With only 5% of these injured carpenters experiencing a month or more of time away from work with their first injury, targeted secondary prevention that will have substantive impact on costs among this population is difficult to operationalize. Prevention of additional injuries via accommodation may be important to prevent subsequent more expensive injuries.

Though carpenters of younger age and inexperience are at increased risk for a paid lost time back injury claim [Lipscomb, et al. 2008], older carpenters and more experienced workers, once injured, were more likely to have delayed return to work. This finding provides some evidence for a cumulative trauma effect or the inability to adapt in older age and our data for increasing experience supports this.

Relatively little is known about the delivery of health services to construction workers, and these analyses provide important information. Construction workers have one of the highest proportions of working individuals without private health insurance, and lack of coverage is more prevalent among non-union workers [CPWR, 2008]. Even among union construction workers, such as these, coverage may lapse during periods of unemployment. We recognize that our findings are not generalizable to a workforce without health insurance coverage, but the payment for work-related conditions through other sources is not limited to privately insured workers. The recent report of Dong et. al., [2007] documented that less than half of total medical expenses for work-related injuries were paid by workers' compensation with greater disparities among Hispanic construction worker. Costs were not just borne by private insurance sources, but also through public mechanisms as well as by workers and their families.

Health insurance payment rates for back pain declined between 1989 and 2003, but have been steadily increasing since 1995. Growth in these rates bears monitoring particularly in light of indications that medical treatment for back disorders may be shifting from WC to health insurance. In the United States, health care delivery for working individuals is covered by two independent insurance systems – health insurance and workers' compensation (WC). The data clearly provide evidence that among union carpenters in Washington State with health insurance coverage, medical costs for musculoskeletal back disorders do not appear to be independent of their work-related injury experiences. With the rather dramatic increase in private health care utilization for musculoskeletal back disorders as work-related musculoskeletal back injuries decreased warrants careful monitoring as we seek to truly understand the impact of back disorders among these construction workers. These trends should be followed forward in time.

Differences in cases based upon treatment in the first month after injury are also worthy of further exploration. Delays to medical or PT care were associated with increasing paid lost days indicating early treatment and referral may be important for timely return to work.

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BACKGROUND

Work-related injuries in construction

Occupational injury rates in the construction trades remain high compared to the general workforce in the U.S.[U.S. Dept. Of Labor, 2002]. Construction workers not only have higher rates of work-related injuries than other trade groups [Zwerling, 1996], but they are also among the most likely to experience serious occupational injuries [Salminen, 1994]. Fatal and lost work time injuries in the construction trades rank among the highest in the U.S. [Kisner, 1994; Sorock, 1993; Stone, 1993; MMWR, 1998; US Dept of Labor, 2002]. Rates of disabling injuries have risen in the construction trades in recent decades [Robinson, 1988], and the risk of injury does not appear to be equal for all groups of workers. Inexperienced workers (< 1 year) have been described at greater risk of having a serious work-related injury [Salminen, 1994], as have workers of smaller-size construction employers [Ringen, 1995].

Bureau of Labor Statistics (BLS) data are the primary information source on occupational injuries and illnesses in the construction trades, but there is evidence that BLS rates significantly underestimate the magnitude of construction injuries [Glazner, 1998; Lipscomb, 1996] and the full magnitude of time lost [Evanoff, 2002]. BLS estimates are based on reports from OSHA logs from a probability sample of employers; employment statistics are used to estimate full-time workers. Through a cohort approach, using individual person-hours of work as the denominator, we identified rates of medical or lost-time claims for carpenters much higher than BLS estimates [Lipscomb, 1996]. Among this cohort, the highest rate of claims was for back injuries which occurred at a rate of 2.6 per 100,000 person-hours worked.

Back disorders

Back pain is the second most common reason for work absenteeism, the third leading cause of work disability, and the leading cause of activity limitation among young adults [Deyo, 1988; Kelsey, 1988]. In 2000, 25% of the 1.6 million reported lost time workplace injuries in the U.S. involved the back [BLS, 2001]. Occupational back injury accounts for nearly a third of workers' compensation costs [Federal Register,1992]. Most who report occupational back pain recover within one-month, with as many as 90% returning to work in three months [Cheadle, 1994; Rossignol, 1992]. Yet, back pain remains the most expensive health care problem among working adults, with much of the cost generated by a small percentage of cases [Frymoyer, 1991; Girolama,1991].

In the U.S. [Cheadle, 1994] and Canada [McIntosh, 2000] being employed in construction has been reported to be associated with delayed return to work. Older workers may not necessarily be more at risk of injury, but when they do experience injuries the consequences are more severe. For example, workers over 45 who sustain a work-related back injury requiring time away from work are less likely to return than younger workers [Dasinger, 1999; Gluck, 1998; McIntosh, 2000; Oleinick, 1996]. And while return to work may mark the end of the first episode of work disability [Baldwin, 1996], many continue to have problems which require modification of activities [Carey,1995; Pransky, 2000; Von Korff, 1994]. Workers provided modified duty have

been reported to have decreased disability [Ryden, 1988; Wiesel, 1994], as have workers who report high levels of control over their work and rest periods [Krause,2001].

Despite high rates of injury and prolonged disability, there is little literature specifically related to occupational back problems among carpenters [Lipscomb 1997; Waller, 1989; 1990]. Carpenters have exposures to recognized occupational risk factors for back pain - heavy work, materials handling, pushing, twisting, frequent heavy lifting, requirements for sudden unexpected maximal effort, and awkward postures [Schneider, 1994]. Demands are increasing for these workers with the use of heavier, bulkier materials such as 12-16 foot sheets of drywall weighing over 100 pounds per sheet. These are all important issues for carpenters with high rates of back disorders, known exposures to recognized risk factors, and little opportunity for modified work due to the predominantly heavy nature of their work.

Intuitively, determining severity of the injury, or disorder, would be important in predicting long term disability. Yet for back problems few case definitions have been accepted in the scientific community [Dempsey, 1997; Frank, 1995; Wickstrom, 1982]. Back pain is a symptom; it is not an objective measure, but functional evidence of disease or illness. The relationships between detectable tissue injury and back pain, impairment, and disability are poorly defined - likely, in part, due to lack of diagnostic precision. Clinical studies show that no more than 50% of patients with low back pain have identifiable structural abnormalities [Damkot, 1984; Frymoyer,1983]; as few as 20% of cases can be accurately diagnosed despite advances in radiological technologies [Dempsey, 1997]. Measures used to assess severity of acute trauma are not sensitive enough to grade most occupational injuries to carpenters due to a “floor effect". The vast majority of injuries to carpenters treated in the emergency room had an Abbreviated Injury Score (AIS) of 1 indicating minor injury [Waller, 1989]; the rating had little relationship to the length of time out of work. Hospitalization has been used to control for severity in analyses of disability following work injury [Cheadle, 1994]. Yet, in Waller’s work (1989), 74% of carpenters who were still impaired six months after injury had only received outpatient care.

Simply classifying back pain by report of pain compared to pain requiring medical care in a prevalence study at Dow Chemical, revealed interesting differences by occupational task. Managers reported back pain more frequently, but craftsmen had a higher prevalence of back pain requiring medical care [Burchfield, 1992]. Causality is not established by these data, but more interesting hypotheses become evident. Differences by job classification could reflect the effect of job exposures on severity of disease, the ability to cope with pain at different levels of physical demand, varying propensities to report pain or seek care, or different perceived or real social and economic consequences to reporting. Several studies have classified cases by phases of work disability; acute (1st 30 days), sub-acute (30-90 days) and chronic (>90 days) [Cheadle, 1994; Dasinger, 1999; Krause, 2001; Oleinik, 1996]. The sub-acute phase is often considered the most critical phase for intervening in order to prevent long-term disability.

The importance of recurrence There is significant evidence that both occupational and non-occupationally defined back pain tend to be recurrent [Baldwin, 1996; Biering-Sorensen, 1983 (I. and II.); Carey, 1995]. Most people experience back pain at some time in their lives, yet many never seek care or lose work time. The cost burden of the isolated attack is minimal, with high cost - for medical care and disability - being associated with recurrent cases [Girolamo, 1991].

Disability is more likely among patients who report prior episodes of pain than among those with an isolated event [Deyo, 1988], and individuals with a previous history of work absence have been reported to have five times the risk of chronic absenteeism compared to people with their first episode [Biering-Sorenson, 1983]. Postal workers with a history of laminectomy had six times the risk of disability after return to work compared to controls matched on occupational task [Ryan, 1990]. This study did not allow assessment of particular work groups at greater risk due to matching on work task. Controls were people without any prior history of back problems making it impossible to determine how much the increased risk was related to surgical history rather than to back pain history alone.

Some reports have been conflicting. Among postal workers, prior history of a claim for a back disorder was strongly associated with filing a subsequent compensation claim for a back disorder (OR=16), as was the prior history of any non-back injury claim [Daltroy, 1991]. In another study, also among postal workers, no association was found between history of back problems, work-related or otherwise, and subsequent occupational back injury in the next 3 years [Zwerling, 1993]. There are reports that individuals who had a prior injury with successful return to work are more likely to return after subsequent injury than workers with no prior history [Dansinger, 1999; McIntosh, 2000]. The latter finding could represent differences in work responsibilities, accommodations or even the importance of a previous successful return.

The reported frequency of recurring back problems also varies. In an industrial population in England, there was a 48.5% recurrence rate in the first year among workers who sought medical care [Troup, 1982]. These episodes were not necessarily attributable to work and it was not clear that the initial episode of medical care was the first for back pain. A review of compensation claims at Boeing over a 15 month period revealed 43 recurrent back claims among 857 people who filed a claim during this period [Bigos, 1986]. The actual rate of recurrence is unclear, as the number who returned to work was not defined; to be at risk for recurrence, the worker would had to have returned to work after the incident claim. Among Canadian workers who had lost-time back compensation cases, 36% had at least one recurrence in a three year follow up period, with the risk of recurrence greater in the first year after injury for those with longer periods of absence from work. Recurrence was not defined by filing another injury report, but by exacerbation of symptoms and work absence after return. There was also a gradual increase in the duration of absence with each recurrence [Rossignol, 1993], potentially representing worsening symptoms or pathology, or the tendency of care givers to recommend longer absence from work with recurrent episodes.

The rate of recurrence of back pain has been reported to decrease with time after the first event [Tsai, 1993], suggesting that there may be periods of time when preventive measures might have greater impact. Recurrence has been reported to be more likely if pain was experienced earlier in life, and recent medical care is more predictive of recurrence than any previous care [Biering-Sorensen, 1983]. The number of days out of work with back pain in the previous year was predictive of recurrence among all Canadian workers [Rossignol, 1992]. Two or more previous attacks of back pain were predictive of recurrence in an industrial prevalence study [Troup, 1982]. No association with recurrence was seen among people who reported the need to alter their job activities because of back problems if they had not also sought care for their back [Biering-Sorenson, 1983], perhaps reflecting the ability to cope due to personal resources, job flexibility, or the lack of seriousness of the underlying problem. Some have reported more recurrences among those with gradual onset of symptoms, while others have reported that acute traumatic events - such as falls - are associated with a greater likelihood of recurrence [Biering-Sorenson, 1983; Burton, 1989; Heliovaara, 1991]. Both findings have been used to suggest that different disease processes may involve different prognoses.

Use of claims data for the study of back disorders

Because of the huge cost burden due to work-related back problems, there is increasing interest in methods to monitor this public health problem. There are no standardized methods with which to define disease, and medical exam findings are frequently negative even among those with symptoms. For these reasons, administrative data may be a very reasonable step in the study of these problems - to survey problems reported by a worker or health care provider as being related to work, to provide data on trends which can be used to assess the effect of interventions on claims, and to provide direction for more explicit research.

Workers' compensation records have been used for the study of low back pain. Early research was done by Leavitt [1971], in which he took a sample of cases from the largest carrier in California to evaluate patterns of care, and to assess the prognostic value of patient data available early in a case. The study was descriptive and no information about the population from which the claims arose was presented. Federspeil [1989] attempted to analyze differences in expenditures for back injuries compared to injuries to the extremities using Tennessee compensation files. The Minnesota Department of Labor and Industries compared costs for treatment of back pain and other musculoskeletal conditions treated through the compensation system to those treated through Blue-Cross [Zaidman, 1990]. Webster [1990] used claims data from Liberty Mutual to estimate the cost of compensable low back pain. These studies largely described the cost burden of compensation cases and explored economic variability. A recent descriptive study of construction workers' claims resulting in work disability through one large insurance carrier was conducted by researchers at Liberty Mutual documenting low back pain as the most frequently occurring condition among these workers [Courtney, 2003].

There is both biologic and epidemiologic evidence that low back pain can be associated with cumulative trauma. Ailments that arise gradually and chronic conditions, which

back pain often is, are less likely to be recognized through the compensation system than events resulting from acute trauma [Blessman, 1991]. In these cases, the demarcation between work-related and non work-related is unclear – and can result in contentious situations and/or bleed over of coverage into private insurance [Ramsey and Rosenstock, 1994]. This makes those claims a potentially important source of information about this group of disorders.

Summary and rationale for work

Back disorders are the most commonly reported occupational disorder among construction workers. A small proportion of claims are responsible for the bulk of the costs, yet surprising little is known about these high cost episodes. Few risk factors for recurrence, other than history of a prior event, have been identified, perhaps, in part, due to failure to appropriately characterize incident events. There is no standard nosology for describing low back disorders, and there is no agreement over whether the majority of reported occupational back problems are related to acute or cumulative injury or even both. Within the limits of knowledge about back pain and the confines of variables available in a workers' compensation database, there is a clear challenge in classifying back pain events in a manner which will make the data more revealing.

The interest in how existing data might be utilized for the study of this problem seems particularly relevant to the study of construction workers with high rates of compensation claims, known exposure to risk factors for occupational back pain, and little opportunity for light duty work. There are also practical problems that make surveillance of construction workers difficult including frequently changing work sites and even employers, irregular and temporary employment, and often small, dispersed work sites. Methods currently used by BLS to count workplace injuries and illnesses do not differentiate initial events from recurrent ones. Information on the rates of incident and recurrent claims could provide an important benchmark with which to measure change over time and the effects of potential interventions. More clearly defining the hazard function for these claims may also provide information about time windows when interventions might be most effective. "The dynamic nature of this health problem... seems perfectly fit for more aggressive secondary prevention interventions to reduce the number and duration of recurrences in individuals who have already suffered back problems.." [Rossignol, 1993].

Union carpenters, unlike many non-union construction workers, have health insurance coverage through jointly trusteed health and welfare funds developed through collective bargaining processes. Contractors hiring union labor pay into the trusts based on the hours worked by the workers they hire, with funds used to support health insurance coverage. In Washington State the coverage to the carpenter is free. Eligibility is based on working a required number of hours each quarter, and once they initially meet the requirement workers are allowed to “bank” hours to extend their coverage at times when work may not be steady. Coverage includes chiropractic care; an important element to include in understanding health care delivery for this group of disorders which is not collected through national surveys, such as the National Ambulatory Medical Care Survey.

With these things in mind we studied back disorders among union carpenters using existing administrative data. The data included information provided by the union allowing us to update a cohort of carpenters we have previously enumerated, their work hours each month, their periods of eligibility for health insurance coverage through the union and their private health insurance claims. We obtained their workers' compensation records from the Washington State Dept of Labor and Industries. As one of six state administered workers' compensation funds, they are able to provide not only the records of work-related injuries and illnesses, but also the records for medical care, including the actual line items billed by providers with attached diagnosis codes. Using techniques previously described [Lipscomb and Dement, 1996; 1997; 1998; 1999], we were able to link these data on an individual basis without using personal identifiers and create event histories for a 15 year time period for a large cohort of union carpenters.

SPECIFIC AIMS

The original specific aims of this project included the following:

- Update our Washington carpenter data to allow definition of a 15-year historical cohort, their hours worked, workers' compensation claims and associated medical care, private health insurance claims, and months of eligibility for private insurance coverage.
- Identify and describe claims for work-related back disorders, including incident and recurrent claims, in terms of nature and mechanism of injury; paid lost time from work; and ICD-9 diagnoses.
- Define costs for medical care, indemnity, and impairment for work-related back disorders and examine patterns over this 15 year period of time.
- Evaluate care received for back disorders in private union insurance before and after work-related back injuries, including the calculation of utilization rates and payments involved.
- Calculate rates of incident and recurrent work-related back injuries and explore whether the risk of recurrence is different for different definitions of the incident case.
- Using survival techniques and time window analyses, identify whether there are periods of time when risk of recurrent injury is greater following return to work from a back injury.
- Using a case-control approach, contrast work-related back injuries that result in prolonged loss of time from work with those resulting in more rapid return.
- Conduct a series of focus groups to inform these results and provide qualitative data on factors related to return to work after injury not available through administrative data.

Due to economic decline in the U.S. in late 2008, the resulting effects on construction employment and changes in local union leadership, we were not able to generate adequate support for recruitment of focus group participants. Consequently, the last specific aim was not completed. All other aims were met and additional analyses were undertaken to evaluate costs associated with medical care for musculoskeletal back disorders through the Carpenters Trusts of Western Washington and relationships between medical care and paid lost days from work after work-related back injury.

RESEARCH DESIGN AND METHODOLOGY
Specific Analyses

Work-related back injuries among union carpenters in Washington State, 1989-2003

Events of interest and diagnoses

For these analyses we wanted to identify all workers' compensation records for back injuries among the cohort. We first identified records with an American National Standards Institute (ANSI) code of '420,' '400,' or '600' representing a primary injury to the back, trunk, or the back and neck. We then identified any additional events that had a back specific ICD-9 code assigned for medical treatment of the injury; relevant ICD-9 codes were selected by a review of all ICD-9 codes for musculoskeletal and nervous system disorders, as well as acute injury and poisoning codes. To be included in our analyses claims without an ANSI code, designating a back injury, had to have at least two different medical visits with a back pain diagnosis in the workers' compensation treatment files. This process captured claims in which the body part code indicated multiple injuries as well as claims that may have had some other body part designated as the primary injury when first reported, while avoiding claims that may have been identified because of a single miscoded ICD-9 diagnosis.

To assign a medical diagnosis to groups of medical claims, reflecting both inpatient and outpatient care an injured carpenter received, a priori, ICD-9 codes were placed in groups felt to represent similar disorders. This was done in conjunction with an occupational medicine physician with particular expertise in musculoskeletal problems. A particular attempt was made to separate more acute trauma from injuries resulting from overexertion or bodily motion. Individuals who had a diagnosis of a spinal fracture or cord injury were assigned that designated diagnosis regardless of any other codes they may have been assigned. An attempt was next made to separate diagnoses which based on the face value of the ICD-9 code represent acute events (contusions, dislocations, sprains, root injuries) from those which may be more likely to be the result of more chronic exposures. Dislocations, which are not fractures, and low back sprain/strains should theoretically represent acute events. The category 'degenerative spine pain' was used for codes which have been used by others to potentially represent the result of cumulative trauma [Park et al., 1992]. Non-specific back codes (lumbago, unspecified back pain) were classified together as symptom descriptors. Individuals who had codes from more than one of these designated categories were assigned a mixed diagnosis code. [See appendix for codes used]

Time at Risk

After the claims of interest were identified, event histories were created for each individual. Person-hours of work as a union carpenter were used as the measurement of time at risk. The carpenters were considered to be at risk of injury at any time they were working union hours beginning in the first month they met the cohort entry criteria. The occurrence of one injury did not remove the worker from the risk set for a new event as long as he/she was working. Although person-hours were used as the measurement of time at risk, the person-month was effectively the unit of analysis since we do not know

when the hours in any given month were accumulated. All hours in months in which an injury occurred were counted as time at risk for that injury. Only injuries which occurred in a month that the individual worked union hours were counted so that events and time at risk were counted on the same basis for rate calculations.

Analyses

Descriptive statistics were generated on age, gender, time in the union, predominant type of work, and hours worked by the cohort. Carpenters typically spend four years in apprenticeship; strata were constructed to assess risk in each year of this training and at two-year intervals afterwards. The union local affiliation was the only surrogate available for characterizing the work done by cohort members. The locals represented by the cohort members were grouped into categories based on the predominant type of carpentry work done by the locals. Assignments of predominant type of work from earlier work with this cohort [Lipscomb et al., 1997; Lipscomb et al., 2003a] were updated through interviews with business agents for each union local.

These categories included light commercial, heavy commercial, drywall, millwrighting, piledriving, residential carpentry, and a mixed category. Light commercial work involved construction on projects two to three stories. Heavy commercial work involved high-rise buildings and interstate, freeway and bridge work. Millwrights are carpenters who work in industry and are often involved in repair and maintenance of heavy machinery. Drywall carpenters in Washington State hang drywall, but they do not tape or finish, in residential or commercial settings. We were unable to identify the type of work of carpenters affiliated with a local outside of the State of Washington; for this reason they were combined for the analyses.

Back injuries were described in terms of the ANSI nature and type (mechanism) of injury codes, type of medical care received and diagnoses assigned. Crude and stratified incidence density rates were calculated per 200,000 hours worked (the equivalent of 100 carpenters working full-time for one year). Age and time in the union were both treated as time-varying variables with time at risk accumulating in the appropriate strata over the 15-year period. Poisson regression was used to calculate crude rates and rate ratios and adjusted rate ratios [Nizim, 2000] because of its utility in the analyses of longitudinal data for a dynamic cohort, such as this one, since it allows maximal use of available data for each individual [Checkoway et al., 1989]. Claims for back injuries that did and did not result in paid lost time from work were analyzed separately and contrasted, and those that resulted from overexertion were compared to more acute traumatic events. All analyses were conducted using SAS Version 8.2 [SAS Institute, Inc., 1999].

Incident and recurrent back injuries

Events of Interest

Workers' compensation claims for back injuries were identified by body part codes designating an injury to the back, trunk or back and neck as well as by medical claims for a back specific ICD-9 code assigned for treatment of the injury. This process captured claims in which the body part code indicated multiple injuries as well as claims that may have had some other body part code designated as the primary injury when first reported. To avoid claims that may have been identified by a single miscoded ICD-9 diagnosis, at least 2 claims for a back specific diagnosis were required if the body part code did not designate a back injury. Details on the process and specific codes used have been previously described. Up to two injuries were included per carpenter, with incidence approximated by the first back injury claim identified.

Time at Risk

Person-time began accumulating for the first back injury when the individual met cohort entry criteria. After an injury, person-time at risk of a second event began accumulating in the next month in which union hours appeared. All person-hours were counted in any month in which an injury occurred. Although time at risk was counted in terms of person-hours, the person-month was effectively the unit of analysis, since it is unknown where in any given month the work hours fell.

Classification of Back Injury Claims

Each of the previously described classification schemes were used to explore whether the risk of a second back injury, based on different definitions of the incident event, differed from the risk of filing the first claim for a back disorder. It was hypothesized that individuals with degenerative diagnoses, including disc disorders, would be at greater risk of recurrence. In contrast, we felt that those who required only first aid, and those who sustained sprains, that should be self-limiting injuries, should not be at greater risk for a recurrent injury. However, we suspected that the ANSI code classifications of injury nature would prove too crude to detect meaningful differences.

Analyses

Kaplan-Meier survival curves were constructed to compare incident and recurrent claims. Incident and recurrent back injuries were described, separately, by each of the classification schemes. Crude and stratified incidence rates were calculated per 200,000 hours worked, or the equivalent of 100 carpenters working full-time for one year. Age and time in the union were both treated as time-varying variables, with events and time at risk accumulating in the appropriate strata over time. Poisson regression was used to calculate crude rates and rate ratios as well as adjusted rate ratios [Nizim, 2000] because of its utility in the analyses of longitudinal cohort data such as these, allowing maximal use of available data [Checkoway, et al., 1989]. Claims for the first back injury identified for each carpenter were analyzed separately from second events.

Next, each of the classification schemes were used in separate models to explore whether the risk of recurrence, based on different definitions of the incident back injury, differed from the risk of filing an incident claim for a back disorder. In each case those with no

prior claim served as the referent group. Second injuries that resulted from acute trauma (falls, struck by) were excluded from these latter analyses since we saw no biologically plausible reason that a prior injury should contribute to subsequent acute trauma. Lastly, injury rates (and 95% CI) were calculated in windows of time representing 1000-2000 hour increments of cumulative hours at risk following return to work. This analysis was done to explore whether periods of time could be identified when carpenters were at greater risk for a second back injury after they returned to work. All analyses were conducted with SAS Version 8.2 [SAS Institute, Inc., 1999].

Health care utilization for musculoskeletal back disorders, Washington State union carpenters, 1989-2003

In the United States, health care delivery for working individuals is theoretically covered by two different insurance systems – private insurance, most often provided through an employer or union, and workers' compensation (WC). Although in theory the systems are separate, and in combination they should provide comprehensive coverage, there are potential overlaps and gaps between them. If a worker is injured on the job or has a work-related condition, he or she must submit a claim through their employer or WC carrier. If the claim is approved, medical care should be paid for by the compensation carrier until it is determined that the person requires no additional care or they have reached a point of maximum medical improvement.

In addition to medical care, workers' compensation provides partial salary reimbursement when loss of time from work is required and payment for permanent impairment which may result from the work-related injury or illness. Further complicating coverage issues, these benefits are sometimes viewed as incentives for workers to seek care through WC. In addition, there is conflicting literature on the potential significance of cost-shifting practices on the part of providers and insurers [Ducatman, 1986; Zwerling, 1991; Buter, 1997] related to the diagnosis of conditions as occupationally related and, consequently, to the per capita costs associated with conditions labeled work-related.

We identified significant declines in work-related musculoskeletal back injury rates due to overexertion type activities among this cohort of union carpenters. To explore the potential for cost-shifting across payment systems, we examined outpatient utilization rates for back disorders of a musculoskeletal nature over the same 15-year period among this large cohort of union construction workers. Members of construction trade unions have health insurance coverage, in most cases, through participation in jointly trusteed health and welfare funds. These funds developed through the collective bargaining process over a period of years in different local areas and in different industries and trades.

We combined data from their health care trust with workers' compensation records to allow us to assess whether a contrasting pattern was seen for treatment of back disorders among these carpenters through their health care trust during the same time period, and to explore whether health care utilization for musculoskeletal back problems increased through the trust after having experienced a work-related injury.

Definitions of outcomes and time at risk

The primary outcome of interest in these analyses was private outpatient health care utilization through the CTWW for musculoskeletal back diagnoses (see Table 1 for codes used) based on a primary ICD-9 code diagnosis assigned to the claim by the provider as a requirement for billing purposes. Time at risk for health care claims was based on months in which each carpenter was eligible for insurance coverage through the trust. Utilization was defined as one visit per provider in any given day. A given carpenter might see a physician and a physical therapist on the same day counting as two visits for example; however, if the carpenter saw the same provider for an exam, x-ray, and laboratory study, the encounter was considered as only one visit. In order to define time at risk and events of interest on the same basis for rate calculations, visits were limited to those occurring in months of insurance eligibility.

Covariates of interest

We were interested in whether the history of a prior work-related back injury would influence health care utilization for back diagnoses of a musculoskeletal nature through their private insurance coverage. We were also interested in whether utilization varied based on the time since the work injury. Work-related back injuries and the dates of injury were previously identified using workers' compensation records [Lipscomb, 2008]. Other covariates of interest included age and gender; both are associated with health care utilization in other populations [Bertakis, 2000; Ladwig, 2000]. We were also interested in time in the union and predominant type of work which we have found to be associated with the risk of work-related back injury in this cohort [Lipscomb, 2008].

Analyses

The frequency of diagnoses and the number of carpenters with each diagnosis were identified. Descriptive statistics were generated on age, gender, time in the union, predominant type of work, and months of insurance eligibility of the cohort. Overall private outpatient health care utilization rates for musculoskeletal back disorders were calculated per 100 person-years (or 1200 months) of insurance eligibility by year as were private outpatient utilization rates for all other diagnoses. The private utilization rates for back disorders were compared to rates of WC claims filed for back disorders by the cohort in the same 15 year period.

Time at risk and events (health care visits for back disorders in CTWW) were stratified by time before and after a work-related injury as well as by gender, categories of age and time in the union. Age, time in the union, prior work-related back injury status and calendar time since work injury were all treated as time-varying variables with time at risk accumulating in the appropriate strata over the 15 year period. All time at risk for individuals who did not file a work-related claim was assigned to the time before injury category.

The distribution of the utilization data was highly skewed due to a significant proportion of the population who never sought care. Therefore negative binomial models were used to calculate stratified rates and rate ratios [Byers, 2003]. To account for the correlation

of health care visits within subjects generalized estimating equations were used in the multivariate modeling of these longitudinal data[Zeger, 1988]. The initial multivariate model explored risk factors for private health care utilization based on age, gender, time in the union, and predominant type of work. We evaluated the effect of having had a prior work-related back injury and the time that transpired since that injury adjusting for the above factors. While the number of work-related back injuries could have been treated as a time-varying covariate, the latter model excluded individuals who had multiple work-related injuries due to interpretive difficulties related to defining time before and after injuries. We did evaluate private utilization based on the number of compensation injuries during the 15 year period.

Compensation costs of work-related back disorders among union carpenters, Washington State 1989-2003

Workers' compensation records are a valuable source of information on injuries reported by workers, employers or health care providers as being related to work, and they provide a way to capture the associated medical care, indemnity and impairment costs of these injuries. Analyses of such costs can provide an estimate of injury severity as well as economic burden, not discernible in injury-rate data [Rice, 2000]. However, workers' compensation coverage is provided in most states by multiple carriers, making access to claims data for large groups of workers difficult to obtain, particularly over an extended period of time. Furthermore, workers' compensation data alone typically fail to provide information on the population at risk.

The goal of these analyses was to measure the resources used to provide medical care and to estimate lost productivity represented by payments for lost work time or impairment for back injuries among this large cohort of union carpenters over a15-year period, 1989 to 2003. By analyzing these data we also sought to evaluate sub-groups of injured carpenters whose injuries were responsible for higher costs as well as to estimate costs associated with injury based on hours worked by the cohort.

Adjustment for inflation and discounting

Our cost data spanned 15 years. To compare costs incurred during different years and express them in constant dollars, it is necessary to adjust them for inflation and discount them. We used the Consumer Price Index (CPI) for the nation, adjusting all costs (medical, indemnity, impairment) for inflation to the year 2006. Medical costs were adjusted using the CPI for medical care. Those adjusted costs were then discounted by 3 percent per year to account for changes in the time value of money over the study period. These procedures account for differences in the values of services received or payments made at different time periods, yielding the present value of each cost stream or grouping thereof [Drummond, 1999]. These two adjustments resulted in all costs being expressed in constant dollars as of the year 2006. All WC costs were assigned to the year in which the injury occurred. In the event a workers' compensation claim was still open, projected claim reserve costs were used.

Analyses

Using previously identified work-related back injuries among this cohort [Lipscomb et al., 2008], the distribution of cost was examined separately for medical care, indemnity and impairment. Mean and median costs (payments) per claim were calculated by year and by whether the claim was the first back injury for the carpenter or a subsequent injury. Payments associated with back injuries resulting from acute trauma (falls, struck by, etc.) were analyzed separately from those associated with overexertion injuries (lifting, pushing, pulling, manual materials handling, etc.).

Negative binomial regression was used to model payments and adjusted payment ratios allowing us to assess risk of higher costs among the injured carpenters. The use of generalized linear models in analyses of medical care costs has been previously described to accommodate factors that are typical of cost data, including highly skewed distributions, and the variability that often increases as mean costs increase rather than having a constant variance (homoscedasticity). [Blough and Ramsey, 2000]. Finally, payment rates expressed as dollars per hours worked for the entire cohort were calculated by year to assess trends in overall cost burden of back injuries among these construction workers. All analyses were conducted using SAS Version 8.2 [SAS Institute, Inc., 1999].

Health care costs for musculoskeletal back disorders through their health and welfare fund, Washington State union carpenters, 1989-2003

While many construction workers do not have private insurance coverage [CPWR, 2007], members of construction trade unions have health insurance coverage, in most cases, through participation in jointly trusteed (labor and management) health and welfare funds. These funds developed through the collective bargaining process over a period of years. We previously identified significant declines in work-related musculoskeletal back injury rates due to overexertion among a large cohort of union carpenters in Washington State between 1989 and 2003 as well as increasing health care utilization through their health and welfare fund during the same time period [Lipscomb et al., 2009]. Their workers' compensation costs declined substantially largely due to declining rates of injury rather than any substantive changes in costs per claim [Lipscomb et al., 2009 in review American Journal of Industrial Medicine]. We explored the medical costs for musculoskeletal back disorders paid by these carpenters' health and welfare fund during this time period.

Definitions of outcomes and time at risk

The primary outcome of interest in these analyses was outpatient health care costs paid through the CTWW for musculoskeletal back diagnoses based on a primary ICD-9 code diagnosis assigned to the claim by the provider as a requirement for billing purposes. These codes have been described previously [Lipscomb et al; 2009]. Time at risk for health care costs was based on months in which each carpenter was eligible for insurance coverage through the trust. For these analyses payments were defined as dollars paid for outpatient care for musculoskeletal back disorders in months of insurance eligibility. We

were interested in whether having a history of a prior work-related back injury would influence health care costs for musculoskeletal back disorders through the workers' health insurance plan. We were also interested in whether payments for medical care varied according to the length of time that had elapsed since the date of the work injury.

To compare costs incurred during different years and express them in constant dollars, costs were adjusted for inflation and discounted. Using the Consumer Price Index (CPI) medical component for the nation, we adjusted costs for inflation to the year 2006. Those adjusted costs were then discounted by 3 percent per year to account for changes in the time value of money over the study period. This procedure accounts for differences in the values of services received or payments made at different time periods, yielding the present value of each cost stream [Drummond, 1999]. These two adjustments resulted in all costs being expressed in constant 2006 dollars.

Covariates of interest

Age and gender are associated with health care utilization in other populations [Bertakis, 2000; Ladwig, 2000] as well as in this one [Lipscomb et al., 2009], and both were covariates of interest. We were also interested in length of union membership and predominant type of work which are both associated with health care utilization and the risk of work-related back injury in this cohort [Lipscomb et al; 2009].

Carpenters typically spend four years in apprenticeship; strata were constructed to assess risk in each year of this training and at two-year intervals afterwards. The union local affiliation was the only surrogate available for characterizing the work done by cohort members. The locals represented by the cohort members were grouped into categories based on the predominant type of carpentry work done by the locals. Assignments of predominant type of work from earlier work with this cohort [Lipscomb et al; 1997; Lipscomb et al;, 2000; Lipscomb et al, 2003] were updated through interviews with business agents for each union local. The categories included light commercial, heavy commercial, drywall, millwrighting, piledriving, residential carpentry, and a mixed category. We were unable to identify the type of work performed by carpenters affiliated with locals outside of the State of Washington; consequently, data for workers in these locals were combined for the analyses.

Analyses

Using previously identified line items associated with outpatient health insurance claims [Lipscomb et al., 2009] for musculoskeletal back disorders through the trust, payments were identified, adjusted and discounted. Payment, as well as charge, rates for musculoskeletal back disorders were calculated per 100 person-years (or 1200 months) of insurance eligibility by year as were payment rates for all other diagnoses for comparison. The private cost rates for back disorders were compared to rates of WC claims filed for back disorders [Lipscomb et al., 2008] as well as to the cost rates associated with these work-related claims based on hours of work in the same 15-year period [Lipscomb et al. , 2009].

Time at risk and events of interest (health care costs for back disorders in CTWW) were stratified by time before and after a work-related injury as well as by gender, categories of age, time in the union, and type of work. Age, time in the union, prior work-related back injury status and calendar time since work injury were all treated as time-varying variables with time at risk accumulating in the appropriate strata over the 15-year study period. All time at risk for individuals who did not file a work-related claim was assigned to the time before injury category.

The distribution of medical cost data was highly skewed; costs among users were highly variable and a significant proportion of the population never sought care for back pain. Negative binomial models were used to calculate stratified rates and rate ratios [Byers; 2003]. To account for multiple observations per person and the correlation of health care visits and associated costs within subjects, generalized estimating equations were used in the multivariate modeling of these longitudinal data [Zeger et al; 1988]. The initial multivariate model explored health care payments based on categories of age, gender, time in the union, and predominant type of work. We evaluated the effect of having had a work-related back injury and the time that transpired since that injury, adjusting for the above factors. The latter models excluded individuals who had multiple work-related injuries due to interpretive difficulties in defining time before and after injuries. We did evaluate payment costs through the health care trust based on the number of compensation injuries during the 15-year period including a variable for calendar time in the model as well.

Predictors of delayed return to work after back injury: A case control analysis

Delayed return to work after a work-related back injury is associated with high medical cost and high paid lost days. Researchers have summarized the evidence regarding delayed return to work [Krause, et al. 2001, Turner, et al. 2000] and report associations [increased risk] with older age [Cheadle, et al. 1994, Oleinick, et al. 1996], female gender [Cheadle, et al. 1994, Gatchel, et al. 1995, Volinn, et al. 1991], small firm size [Cheadle, et al. 1994, Infante-Rivard and Lortie 1996], falls [Hogg-Johnson, et al. 1994], lifting [Tate, et al. 1999], shorter employment duration [Infante-Rivard and Lortie 1996], greater time between injury and rehabilitative treatment [Infante-Rivard and Lortie 1996, McIntosh, et al. 2000], and construction work [Cheadle, et al. 1994, Hogg-Johnson, et al. 1994, McIntosh, et al. 2000]. Since back injury claims for carpenters were responsible for the greatest total cost and the greatest total number of paid lost days from work [Lipscomb, et al. 1996], it is important to identify risk factors for delayed return to work specific for this working population. When carpenters are injured, there is little opportunity for light duty or modified work, potentially requiring workers to be out longer or to return to work prematurely increasing the risk for further injury.

Previous studies have used hospitalization as a marker of severity for disability following work related back injury [Cheadle, et al. 1994]. Carpenters with prolonged work loss or hospitalization from their first injury were significantly more likely to experience recurrence than those with shorter absences or requiring outpatient care [Lipscomb, et al. 2008]. However, “severe” or hospitalized injuries were not responsible for the majority

of injuries resulting in paid lost time: 75% of impaired carpenters at six months post injury had only outpatient care [Waller, et al. 1989].

With this in mind, we used a case control approach to contrast work-related back injuries that resulted in prolonged loss of time from work with those resulting in more rapid return in a cohort of union carpenters. We were interested in the effect of age, gender, time in the union, and predominant type of work on delayed return to work following a work-related back injury. In addition, to help target cases for secondary prevention efforts, we were interested in whether the nature or mechanism of injury (ANSI codes from workers' comp) or ICD-9 diagnoses help distinguish cases that resulted in delayed return to work. We want to explore whether ICD-9 code assigned for medical care of work-related back injuries or time to seek medical care for injury influences return to work. Lastly, does prior history of paid time off back claim predict delayed return to work?

Health insurance eligibility files from the Carpenters Trusts of Western Washington were used to identify a cohort of 20,642 active union carpenters who worked at least three months from 1989 to 2003 [Lipscomb, et al. 1997, Lipscomb, et al. 1996]. No restriction was placed on minimum number of hours worked per month and the three months did not have to be consecutive. Entrances and exits were allowed throughout the 15 year period. Individuals did not have to have any additional observation time after injury so the cohort is larger than those used in earlier analyses.

Back Injury Claims, Cases, and Controls

For these analyses, back claims of interest were identified by American National Standards Institute (ANSI) codes (back "420", trunk "400", or back and neck"600") or by International Classification of Disease (ICD-9) codes relevant to medical care for claims consistent with a back injury (i.e. lumbar sprain, spondylosis, lumbar spinal cord injury). All codes have been previously described in published work [Lipscomb, et al. 2008]. Since the ANSI body part code identifies only cases where the back or back and neck were thought to be most severely involved at the time of the initial injury report, the use of ICD-9 codes identified back injuries and disorders for which a peripheral body part or a non-specific region (multiple, musculoskeletal, nervous) were reported. Claims for which the ANSI code for body part was missing were identified as a back injury by at least two different medical visits with an ICD-9 coded back pain diagnosis.

In Washington State, an injured worker receives payment for lost time after three days of missed work. The claim rather than worker was the unit of analysis; individuals with multiple claims could serve as both a case and a control during the 15 year period. Cases were defined as back injury claims with more than 90 days of paid lost time or delayed return to work (RTW). Controls were defined as back injury claims resulting in more rapid return to work or return within 30 days. We excluded claims with 31-90 paid lost days to highlight potential differences.

Covariates

Covariates considered in this analysis based on associations in previous delayed RTW research included age, sex, time in the union, predominant type of carpentry work, history of a previous paid time off back injury claim, and delay to medical care (<30 days versus ≥30 days). No race or ethnicity information was available from these data sources. Time in the union was dichotomized at four years to separate apprentices from journeymen carpenters. Typically, an inexperienced carpenter must be in the union at least four years and complete appropriate training to reach journeyman status. Since 1997 Standardized Industry Classification (SIC) codes were replaced by North American Industry Classification System (NAICS) codes. This transition is still in process with these data and NAICS codes were missing for 23% (332/1437). Therefore, SIC codes were used to determine the type of work performed at the time of the claim.

ANSI codes are provided for the body part injured, the nature of the injury (e.g. sprain, fracture), the mechanism of injury (e.g. fall), and the source (substance or object associated with the injury). Diagnosis (ICD-9) groupings for each claim were catagorized for all claims as: contusion, spinal fracture, spinal cord injury, non-fracture dislocation (common diagnosis associated with chiropractic care), low back sprain or strain, symptom descriptor (i.e. lumbago, back pain), degenerative (i.e. spondylosis, spinal stenosis), first aid only, no back ICD-9/ANSI back, other (i.e. sacral instability), mixed diagnosis (i.e. two or more ICD-9 codes), and unknown (employers' self-insurance). Multiple claims in addition to two ICD-9 codes per claim were available for injury coding.

Analysis

Descriptive frequencies and univariate statistics were calculated by worker and claim. Distribution of claims was examined from 1989 to 2003 to identify any yearly variation in claim reporting. ICD-9 codes were compared with ANSI nature of injury codes. Logistic regression models estimated odds ratios (OR) and 95% confidence intervals (95% CI) for the odds of a delayed return to work back injury claim compared to more rapid return. Age and time in the union were treated as time varying covariates. Potential confounders in univariate analyses with an odds ratio of either 1.20 or greater or 0.80 or less were included in multivariate models. Confidence limit ratios (CLR, calculated as the upper confidence limit divided by the lower confidence limit) were produced to quantify precision for all estimates [Poole 2001].

Relationships between medical care and paid lost days from work after work-related back injury among Washington State union carpenters

The relationship between physical treatments and return to work has been identified as a priority research area [Pransky et al., 2005]. Much of previous research on care patterns and delayed return to work has been done on occupational low back pain using workers' compensation data in cohorts of workers in the US and Canada. Delays to care [Cote et al., 2005, Kominski et al., 2008], and more specifically delays to physical therapy [Cote et al., 2005, Ehrmann-Feldman et al., 1996, Gross and Battie 2005, Infante-Rivard and Lortie 1996, Kominski et al., 2008], were associated with delayed return to work. Not

surprisingly, being referred to a specialist was also related to delayed return to work [Kominski et al., 2008]. In light of our previous work and studies of others, we examined relationships between medical care provided for work-related musculoskeletal back injuries due to overexertion and bodily reaction and time off work among a cohort of carpenters, as well as care received for similar diagnoses through their private insurance.

Back injury workers' compensation claim identification

All work-related back injury claims were identified by American National Standards Institute (ANSI) body part codes (back "420", trunk "400", or back and neck"600") or by International Classification of Disease (ICD-9) codes relevant to medical care for claims consistent with a back injury (i.e. lumbar sprain, spondylosis, lumbar spinal cord injury). Since the ANSI body part code identifies only cases where the back or back and neck were thought to be most severely involved at the time of the initial injury report, the use of ICD-9 codes identified back injuries and disorders for which a peripheral body part or a non-specific region (multiple, musculoskeletal, nervous, missing) were reported. Claims for which the ANSI code for body part was missing were identified as a back injury by at least two different medical encounters with an ICD-9 coded back pain diagnosis. These procedures and claims have been previously described [Lipscomb et al., 2008].

Workers' compensation injuries of interest for this analysis were those reported to result from overexertion or bodily reaction based on ANSI mechanism of injury codes. Overexertion events included injuries resulting from actions such as pushing, pulling, lifting, and materials handling. Bodily reaction events were defined as cases involving musculoskeletal or internal injury or illness resulting from the assumption of an unnatural position or from voluntary movements like climbing, or involuntary motions induced by sudden noise, flight or efforts to recover from slips or loss of balance (not resulting in falls). Traumatic injuries resulting from direct trauma such as falls or being struck by something were excluded. The claim rather than worker was the unit of analysis; individuals with multiple claims could be found more than once during the 15 year period. In Washington State an injured worker receives payment for lost time after three days of missed work. Number of paid lost days was categorized as follows: no paid lost days, 1 to 30 paid lost days, 31 to 90 paid lost days, and greater than 90 paid lost days.

Treatment for musculoskeletal back pain

In both care systems, we identified health care utilization for back disorders for each carpenter. We were interested in the influence of previous care for any back injury through either the workers' compensation or private health care systems. Hypothesizing that some carpenters may circumvent or supplement the workers' compensation system and receive care from their private health care providers, receipt of any private health care within 90 days of the date of the workers' compensation injury claim was also examined.

Health Care Providers

Medical providers were classified as primary care providers (osteopath, physician assistant, nurse practitioner, clinic, family medicine, internal medicine, pediatric), occupational medicine, other specialist, chiropractor, physical therapy, mental health provider, hospital/ER, other provider, or unknown. Occupational and massage therapists care was included with physical therapy. Other included any otherwise non-classifiable provider or treatment. Utilization was defined based on one outpatient visit per day per provider. For example, a worker who saw their family medicine physician and then an orthopedist on the same day had two provider encounters: 1 specialist and 1 general. Similarly a worker who saw a chiropractor and then went to physical therapy on the same day had two provider encounters: 1 chiropractic and 1 physical therapy encounter.

Covariates

Covariates considered in this analysis based on associations in previous research included age, gender, time in the union, and history of a previous work-related back injury claim. No race or ethnicity information was available from these data sources. Time in the union was dichotomized at four years to separate apprentices from journeymen carpenters. Typically, an inexperienced carpenter must be in the union at least four years and complete appropriate training to reach journeyman status.

The nature of the work-related injury was assigned based on the ANSI nature of injury codes provided in the workers' compensation data (e.g. sprain, fracture) as well as diagnoses based on groupings of ICD-9 codes which included: contusion, spinal fracture or cord injury, non-fracture dislocation (common diagnosis associated with chiropractic care), sprain or strain, symptom descriptor (i.e. lumbago, back pain), degenerative diagnoses (i.e. herniated nucleous pulposus, spondylosis, spinal stenosis), other (i.e. sacral instability), and mixed back diagnoses (i.e. two or more ICD-9 codes) [Lipscomb et al., 2008].

Analysis

First we described the characteristics of the injured carpenters and their work-related injuries stratified by length of time they were out of work. Next, we described the medical care received for work-related injuries including the number of medical encounters, and the type and number of different types of medical care providers. Descriptive frequencies and univariate statistics were calculated by provider and each covariate for claims overall and stratified by the four categories of paid lost days from work: no paid lost days, 1 to 30 days, 31 to 90 days, or >90 days. Statistical differences between ordinal column categories for the stratification variable were tested using the Mantel-Haenszel Chi-Square statistic ("Row Mean Scores Differ") at 0.05 level of significance. This allowed us to explore patterns and trends by time loss for providers seen (e.g. general practitioner, chiropractor, specialist, physical therapy) and specifically whether the receipt or timing of physical therapy was related to paid lost days.

We were also interested in health care received for similar diagnoses through the Carpenter Trust payment system in the immediate 90 days following their work-related

injury and whether this was related to paid lost days. Overlap between the two systems was examined with Venn diagrams. Looking at the opposite end, history of previous care through workers' compensation or Carpenter Trust payment in the one, three, or five years prior to the back injury claim was also examined by paid lost days.

RESULTS

Work-related back injuries among union carpenters in Washington State, 1989-2003

Cohort

We identified a dynamic, retrospective cohort of 20,642 carpenters who worked at least three months in the State of Washington between 1989 and 2003. Of these, 18,768 worked hours after they met cohort entry criteria. Mean time the carpenters were observed over the 15 years was 45 months (median 23.0). The cohort was predominantly male (n=17,879; 97.4%), and relatively young at first observation (range from 17 to 76 years, mean 35 years, median 34 years). Time in the union at first entry into the cohort ranged from less than one year to 48 years (mean 6.1 years; median 1 year).

Identification and description of claims

A total of 4,138 workers' compensation claims for back injuries were identified in months of union work by cohort members in 15 years; these injuries accounted for 19% of all workers' compensation claims filed. We identified 3,590 back injuries using an ANSI body part code. An additional 548 injuries, or 13.2% of the total, were identified using ICD9 diagnoses on claims for medical care. The latter included 372 claims in which another body part had been coded as the more significant injury, 167 claims that had an ANSI body part code of 'multiple,' and nine claims in which the body part code was missing.

Just over 5% of the claims had no associated medical costs (n=215) and 91% (3,764) had only outpatient care; 3.8% (n=159) required hospitalization. The injuries occurred among 3,037 different carpenters or 16% of the cohort. The number of back injury claims among the injured ranged from 1-7; 73% had only one injury. Forty percent (40%) of the back injuries (n=1681) resulted in paid lost time from work.

Based on ANSI coding, the majority of the PLT and non-PLT claims were both classified as resulting from overexertion and they were most commonly coded as sprains (Table 1). Proportionately more of the PLT claims were identified by an ICD9 code on a claim for actual medical care rather than an ANSI code designating a back injury. More pronounced differences were apparent when comparing the ICD-9 medical diagnosis groupings. Notably, more of the non-PLT injuries were coded as sprains and, the largely chiropractic diagnosis, dislocations without fractures. Other striking differences include proportionately more fractures and symptom descriptor diagnoses among the PLT claims, as well as the high proportion of claims that had mixed diagnoses.

Injury rates and risk factors

The number of carpenters observed each year, their hours worked, injuries, and crude injury rates are presented in Table 2. In the 15 years between 1989 and 2003, the overall back injury rate was 6.2 (95% CI 5.8, 6.6) per 200,000 hours worked. Overall back injury rates declined 54.8% between 1989 and 2003. Back injuries that resulted in PLT, which occurs after the third lost day in Washington State, and those that did not result in PLT both decreased over time (Figure 1); the decrease in claims without lost time was 50%, while those with PLT time decreased 62%. There was a marked decrease in the

rate of back injury claims associated with overexertion; there was a 66% decline from the high of 6.9/200,000 hours worked in 1990 and 1991 to 2.3/200,000 hours worked in 2003. Over the 15 year period, there was a less substantive decline (32%) in rates of injuries associated with more acute traumatic events (Figure 2).

The distribution of time at risk, back injury frequencies, as well as the unadjusted rates and rate ratios are presented by strata of age, gender, union tenure, and predominant type of work for injuries that did and did not result in paid lost time from work (Table 3). Unadjusted rates of injury decreased with increasing age and increasing time in the union. Individuals affiliated with locals that perform residential carpentry or drywall installation were at higher risk for both non-PLT and PLT injuries than their counterparts doing other types of construction work. Women had higher rates of PLT claims than men, but this is based on a small number of events. These patterns remained in the fully adjusted models.

Similar patterns of risk were seen for overexertion injuries and injuries resulting from more acute trauma by age and gender (Table 4). Rates of overexertion injuries decreased 30%, and remained so, after four years of time in the union, while back injuries associated with acute trauma did not decline substantially until the eighth year of union tenure. Drywall and residential carpenters were at greater risk for overexertion injuries; they were also at greater risk for back injuries from acute trauma, as were millwrights.

Table 1. Nature and mechanism of injury and medical diagnoses by whether back injury resulted in paid lost time from work, union carpenters, Washington State, 1989-2003

	No paid lost time (n=2457) Frequency (%)	Paid lost time (n=1681) Frequency (%)
Mechanism of injury		
Overexertion	1632 (66.5)	1078 (64.1)
Bodily reaction	209 (8.5)	123 (7.3)
Fall from elevation	186 (7.6)	183 (10.9)
Same level fall	140 (5.7)	105 (6.3)
Struck by	134 (5.5)	91 (5.4)
Struck against	64 (2.6)	25 (1.5)
MVA	18 (0.73)	13 (0.77)
Caught	10 (0.41)	5 (0.30)
Explosion	1 (0.04)	--
Abraded	1 (0.04)	--
NEC/Unknown	58 (2.6)	58 (3.5)
Nature of injury		
Sprain	1973 (80.3)	1101 (65.5)
Ill-defined symptoms	148 (6.0)	121 (7.2)
Contusion	56 (2.3)	24 (1.4)
Dislocation/herniated disc	29 (1.2)	46 (2.7)
Fracture	7 (0.28)	27 (1.6)
Nervous system	5 (0.20)	7 (0.42)
Multiple injuries	4 (0.16)	4 (0.24)
Scratches	1 (0.04)	--
Amputation	--	1 (0.1)
Unclassified	10 (0.41)	26 (1.6)
ID by ICD9	224 (9.3)	324 (19.3)
Medical diagnoses		
First aid (no diagnosis)	101(4.1)	114 (6.8)
Sprain	839 (34.2)	374 (22.2)
Dislocation without fracture	519 (21.1)	171 (10.2)
Degenerative condition	82 (3.3)	96 (5.7)
Symptom descriptor	65 (2.6)	70 (4.2)
Contusion	51 (2.1)	12 (0.71)
Fracture/cord or injury	4 (0.16)	24 (1.4)
Nerve injury	1 (0.04)	--
Mixed diagnoses	432 (17.6)	703 (41.8)
Unknown diagnosis	358 (14.7)	117 (7.0)

Table 2. Number of carpenters observed, hours worked, back injuries, and rates of injury by year: Union Carpenters, Washington State, 1989-2003

Year	# Observed[1]	Hours worked	# Injuries	Rate[2] (95% CI)
1989	6,190	6,070,969	254	8.4 (7.4, 9.5)
1990	7,298	7,955,039	367	9.2 (8.3, 10.3)
1991	7,616	8,503,453	389	9.2 (8.3, 10.2)
1992	8,024	9,103,418	369	8.1 (7.3, 9.0)
1993	7,898	8,512,786	318	7.5 (6.7, 8.4)
1994	7,553	8,018,041	276	6.9 (6.1, 7.8)
1995	7,195	8,062,927	247	6.1 (5.4, 6.9)
1996	7,328	8,165,628	243	6.0 (5.3, 6.8)
1997	7,552	8,718,329	250	5.7 (5.0, 6.5)
1998	8,049	9,291,889	246	5.3 (4.7, 6.0)
1999	9,305	10,618,931	287	5.4 (4.8, 6.1)
2000	9,961	11,514,489	288	5.0 (4.5, 5.6)
2001	9,846	10,618,931	246	4.6 (4.1, 5.2)
2002	9,173	9,748,095	181	3.7 (3.2, 4.3)
2003	8,856	9,357,906	177	3.8 (3.3, 4.4)
TOTAL	18,768	134,199,443	4138	6.2 (5.8, 6.6)

[1] Not mutually exclusive each year, so sum of observations does not equal total observed.
[2] Rates are per 200,000 hours worked

Table 3. Stratified time at risk, frequency of back injuries, crude rates and rate ratios, and adjusted rate ratios, by indemnity, Washington carpenters 1989-2003

		Non-paid lost time (n=2457)				**Paid lost time** (n=1681)			
	Time at risk	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)
Age									
< 20	543,786	14	5.5 (3.3, 9.3)	2.2 (1.2, 4.0)	1.5 (0.89, 2.5)	12	4.3 (2.4, 7.8)	2.2 (1.1, 4.5)	1.1 (0.61, 2.1)
20- < 30	22,001,842	494	4.4 (4.0, 4.9)	1.8 (1.5, 2.1)	1.4 (1.2, 1.6)	273	2.4 (2.1, 2.7)	1.2 (0.97, 1.5)	0.73 (0.59, 0.90)
30- < 40	47,457,445	996	4.2 (3.9, 4.4)	1.7 (1.5, 2.0)	1.5 (1.3, 1.7)	712	2.9 (2.7, 3.2)	1.5 (1.2, 1.8)	1.1 (0.96, 1.3)
40- < 50	41,745,886	667	3.2 (2.9, 3.4)	1.3 (1.1, 1.5)	1.2 (1.1, 1.4)	459	2.2 (1.9, 2.4)	1.1 (0.91, 1.3)	0.99 (0.84, 1.2)
50+	22,288,337	281	2.5 (2.2, 2.8)	1	1	221	2.0 (1.7, 2.2)	1	1
Gender									
Female	2,260,386	48	4.2 (3.1, 5.5)	1.0 (0.72, 1.5)	1.2 (0.88, 1.5)	44	3.8 (2.8, 5.1)	1.6 (1.2, 2.1)	1.6 (1.2, 2.0)
Male	131,773,547	2402	3.6 (3.5, 3.8)	1	1	1631	2.4 (2.3, 2.5)	1	1
Time in the union									
< 1 year	8,083,156	209	5.0 (4.3, 5.8)	1.7 (1.4, 2.0)	1.3 (1.1, 1.6)	141	3.4 (2.9, 4.1)	1.7 (1.4, 2.1)	1.7 (1.4, 2.1)
1-< 2 years	9,100,638	208	4.7 (4.1, 5.4)	1.6 (1.4, 1.9)	1.3 (1.1, 1.5)	161	34 (2.9, 4.0)	1.7 (1.4, 2.1)	1.7 (1.4, 2.1)
2- <3 years	7,921,782	181	4.5 (3.8, 5.2)	1.5 (1.2, 1.8)	1.2 (1.0, 1.4)	126	3.1 (2.6, 3.7)	1.5 (1.3, 1.9)	1.6 (1.3, 1.9)
3- <4 years	6,966,498	168	4.7 (4.0, 5.5)	1.6 (1.3, 2.0)	1.3 (1.1, 1.5)	106	2.9 (2.4, 3.5)	1.5 (1.2, 1.8)	1.5 (1.2, 1.8)
4-<6 years	11,659,061	229	3.9 (3.4, 4.4)	1.2 (1.0, 1.4)	1.1 (0.93, 1.2)	162	2.7 (2.4, 3.2)	1.4 (1.1, 1.6)	1.4 (1.1, 1.6)
6-<8 years	9,409,159	172	3.6 (3.1, 4.2)	1.1 (0.90, 1.3)	1.0 (0.86, 1.2)	147	3.0 (2.6, 3.4)	1.5 (1.3, 1.8)	1.5 (1.2, 1.8)
8-<10 years	8,843898	168	3.8 (3.2, 4.4)	1.2 (1.0, 1.5)	1.1 (0.90, 1.2)	101	2.3 (1.9, 2.2)	1.1 (0.93, 1.4)	1.1 (0.88, 1.3)
10 years and over	72,203,905	1,122	3.1 (2.9, 3.3)	1	1	737	2.0 (1.9, 2.2)	1	1

Table 3. (cont)

		Non-paid lost time (n=2457)				**Paid lost time** (n=1681)			
Predominant work	Time at risk	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)
Drywall	24,129,911	646	5.4 (5.0, 5.8)	1.8 (1.5, 2.0)	1.5 (1.4, 1.7)	463	3.8 (3.5, 4.2)	1.7 (1.4, 2.0)	1.7 (1.4, 2.0)
Residential	1,675,730	47	5.7 (4.3, 7.6)	1.8 (1.3, 2.6)	1.5 (1.2, 2.0)	38	4.6 (3.3, 6.3)	2.0 (1.4, 2.8)	1.7 (1.2, 2.4)
Millwright	2,549,160	50	3.9 (3.0, 5.2)	1.1 (0.73, 1.5)	1.2 (0.94, 1.6)	32	2.5 (1.8, 3.6)	1.1 (0.76, 1.6)	1.1 (0.77, 1.6)
Pile driver	8,171,203	81	2.0 (1.6, 2.5)	0.61 (0.46, 0.81)	0.62 (0.50, 0.78)	36	0.88 (0.64, 1.2)	0.38 (0.27, 0.55)	0.40 (0.28, 0.56)
Out of Washington	1,826,138	29	3.2 (2.2, 4.6)	0.97 (0.62, 1.5)	0.93 (0.65, 1.3)	27	3.0 (2.0, 4.3)	1.3 (0.87, 1.9)	1.3 (0.85, 1.9)
Mixed commercial	58,917,900	882	3.0 (2.8, 3.2)	0.96 (0.62, 1.1)	0.91 90.81, 1.0)	594	2.0 (1.9, 2.2)	0.88 (0.76, 1.0)	0.89 (0.77, 1.0)
Light commercial	14,919,760	322	4.3 (3.9, 4.8)	1.4 (1.1, 1.6)	1.3 (1.1, 1.5)	195	2.6 (2.3, 3.0)	1.1 (0.94, 1.4)	1.1 (0.95, 1.4)
Heavy commercial	20,253,804	339	3.3 (3.0, 3.7)	1	1	232	2.3 (2.0, 2.6)	1	1

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[1] Rates are per 200,000 hours worked
[2] Poisson regression models
[3] Scaled deviance in adjusted models

Table 4. Stratified time at risk, frequency of back injuries, crude rates and rate ratios, and adjusted rate ratios, by injury mechanism, Washington carpenters 1989-2003

		Overexertion injuries (n=3042)				**Traumatic injuries** (n=1095)			
	Time at risk	Injuries	Crude Rate[1] (95% CI)	Crude RR (95% CI)	Adjusted RR[2] (95% CI) [3]	Injuries	Crude Rate[1] (95% CI)	Crude RR (95% CI)	Adjusted RR[2] (95% CI) [3]
Age									
< 20	543,786	18	6.7 (4.1, 10.7)	2.1 (1.2, 3.8)	1.3 (0.78, 2.1)	8	3.1 (1.6, 6.3)	2.5 (1.3, 5.1)	1.5 (0.79, 2.8)
20- < 30	22,001,842	571	5.1 (4.7, 5.5)	1.6 (1.4, 1.9)	1.1 (0.98, 1.3)	196	1.7 (1.5, 1.9)	1.4 (1.1, 1.7)	0.90 (0.73, 1.1)
30- < 40	47,457,445	1282	5.3 (4.7, 5.5)	1.7 (1.4, 1.9)	1.4 (1.2, 1.6)	426	1.8 (1.6, 1.9)	1.4 (1.2, 1.7)	1.1 (0.96, 1.4)
40- < 50	41,745,886	799	3.8 (3.5, 4.1)	1.2 (1.0, 1.4)	1.1 (0.97, 1.3)	327	1.6 (1.4, 1.7)	1.3 (1.0, 1.5)	1.2 (0.97, 1.4)
50- < 60	22,288,337	363	3.2 (2.9, 3.5)	1	1	139	1.2 (1.1, 1.5)	1	1
Gender									
Female	2,260,386	65	5.6 (4.4, 7.2)	1.3 (0.98, 1.6)	1.3 (1.0, 1.6)	27	2.3 (1.6, 3.4)	1.5 (1.0, 2.2)	1.5 (1.1, 2.1)
Male	131,773,547	2965	4.4 (4.3, 4.6)	1	1	1068	1.6 (1.5, 1.7)	1	1
Time in the union									
< 1 year	8,083,156	259	6.2 (5.4, 7.0)	1.6 (1.4, 19)	1.4 (1.2, 1.7)	91	2.2 (1.8, 2.7)	1.6 (1.3, 2.7)	1.6 (1.3, 1.9)
1-< 2 years	9,100,638	274	6.0 (5.3, 6.8)	1.6 (1.4, 1.8)	1.4 (1.2, 1.6)	95	2.1 (1.7, 2.5)	1.5 (1.2, 1.9)	1.5 (1.2, 1.8)
2- <3 years	7,921,782	228	5.6 (4.9, 6.4)	1.5 (1.3, 1.7)	1.3 (1.1, 1.5)	79	2.0 (1.6, 2.5)	1.5 (1.1, 1.90	1.4 (1.2, 1.8)
3- <4 years	6,966,498	213	6.0 (5.2, 6.8)	1.6 (1.4, 1.8)	1.4 (1.2, 1.6)	61	1.6 (1.3, 2.1)	1.2 (0.92, 1.6)	1.2 (0.93, 1.5)
4-<6 years	11,659,061	268	4.6 (4.1, 5.2)	1.2 (1.1, 1.4)	1.1 (0.95, 1.2)	123	2.0 (1.7, 2.4)	1.5 (1.2, 1.9)	1.5 (1.2, 1.8)
6-<8 years	9,409,159	224	4.7 (4.1, 5.3)	1.3 (1.1, 1.4)	1.1 (0.95, 1.3)	95	2.0 (1.6, 2.4)	1.5 (1.2, 1.9)	1.4 (1.2, 1.7)
8-<10 years	8,843898	205	4.6 (4.0, 5.3)	1.2 (1.1, 1.4)	1.1 (0.93, 1.3)	64	1.5 (1.1, 1.9)	1.1 (0.83, 1.4)	1.0 (0.83, 1.3)
10 years and over	72,203,905	1371	3.8 (3.6, 4.0)	1	1	488	1.3 (1.2, 1.5)	1	1

Table 4. (cont)

		Overexertion injuries (n=3042)				**Traumatic injuries** (n=1095)			
	Time at risk	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)
Predominant work									
Drywall	24,129,911	837	6.9 (6.5, 7.4)	1.7 (1.5, 1.9)	1.7 (1.5, 1.9)	272	2.3 (2.0, 2.5)	1.4 (1.2, 1.7)	1.4 (1.2, 1.6)
Residential	1,675,730	59	7.1 (5.5, 9.2)	1.8 (1.4, 2.3)	1.6 (1.2, 2.0)	26	3.1 (2.1, 4.6)	1.9 (1.3, 2.9)	1.7 (1.2, 2.4)
Millwright	2,549,160	50	3.9 (3.0, 5.2)	0.98 (0.73, 1.3)	1.0 (0.78, 1.4)	32	2.5 (1.8, 3.6)	1.6 (1.1, 2.3)	1.6 (1.1. 2.2)
Pile driver	8,171,203	87	2.1 (1.7, 2.6)	0.53 (0.42, 0.67)	0.56 (0.45, 0.69)	30	0.73 (0.51, 1.1)	0.45 (0.31, 0.67)	0.47 (0.34, 0.65)
Out of Washington	1,826,138	38	4.2 (3.0, 5.7)	1.0 (0.74, 1.4)	1.0 (0.74, 1.4)	18	2.0 (1.2, 3.1)	1.2 (0.75, 2.0)	1.2 (0.79, 1.8)
Mixed commercial	58,917,900	1098	3.7 (3.5, 4.0)	0.93 (0.83, 1.0)	0.95 (0.85, 1.1)	378	1.3 (1.2, 1.4)	0.79 (0.66, 0.95)	0.80 (0.69, 0.94)
Light commercial	14,919,760	374	5.0 (4.5, 5.6)	1.3 (1.1, 1.4)	1.3 (1.1, 1.5)	143	1.9 (1.6, 2.3)	1.2 (0.95, 1.5)	1.2 (0.98, 1.4)
Heavy commercial	20,253,804	407	4.0(3.6, 4.4)	1	1	164	1.6 (1.4, 1.9)	1	1

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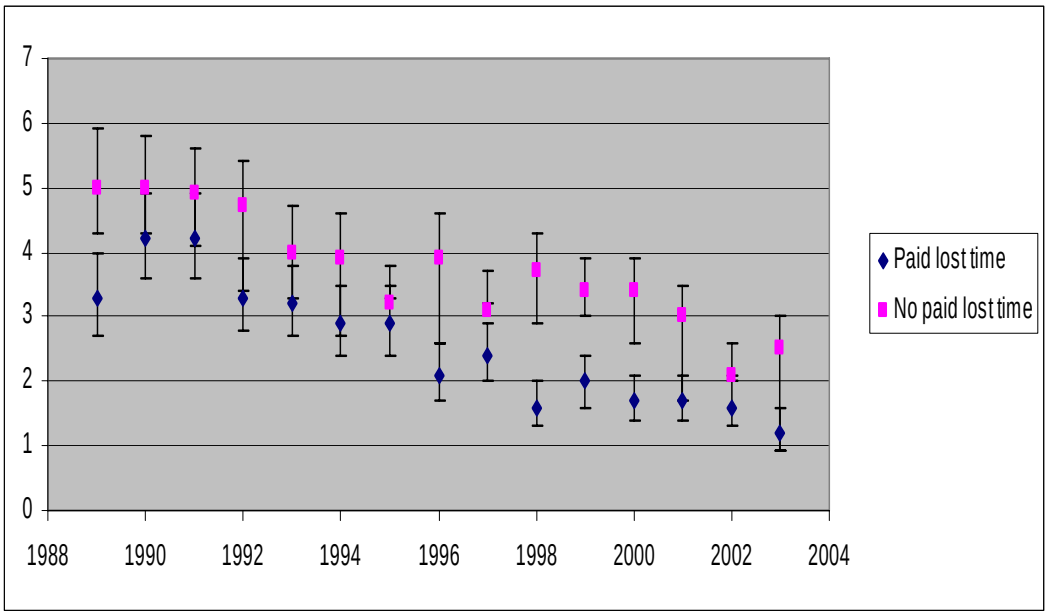
[1] Rates are per 200,000 hours worked
[2] Poisson regression models
[3] Scaled deviance in adjusted models

Figure 1. Back Injury Rates (per 200,000 hours worked) by Paid Lost Time from Work, Union Carpenters, Washington State, 1989-2003



Incident and recurrent back injuries

Using our case definitions, 3037 incident and 751 recurrent back injury claims were identified. The distribution of the incident and recurrent injuries are remarkably similar by mechanism and nature of injury, medical diagnoses assigned for their treatment, type of medical care received, and associated paid lost time from work (Table 5). The mean difference in time lost from work was slightly higher for recurrent than for incident injuries (126 vs 110 days).

There were 151 individuals who were never observed working union hours again after their first back injury, leaving 2886 carpenters in the risk pool for a second event. Excluding 22 individuals who filed their initial claims in 2003, who may have returned to work after our observation period, 74% (n=117) of those who never returned to work had paid lost time of over 60 days. These individuals were more likely to be assigned a degenerative diagnosis (7%;n=9), fracture (4%; n=5), or mixed diagnoses (40%; n=52) than individuals who returned to work and their injuries were more likely to have resulted from a fall from elevation (n=25;19%). Thirty-five (27%) sustained injuries to other body parts as well. However, only 8.5% (n=11) received hospital care for their injury. Consistent with this, the majority were coded as having resulted from overexertion or bodily motion (63%; n=81).

Injury rates and risk factors

Incident injuries occurred at an overall rate of 5.4 per 200,000 hours worked; recurrent events occurred at a rate of 9.5 per 200,000 hours worked (RR=1.8). Kaplan–Meier curves demonstrating the survival functions for incident and recurrent claims are presented in Figure 2. Although the survival curves for incident and recurrent injuries are significantly different from each other (log-rank test $p<0.001$), the patterns of relative risk are fairly similar for incident and recurrent back injuries (Table 6). Because the youngest and oldest work groups are small, and consequently the least stable, age 30-<40 years was chosen as the reference cell. Crudely, the youngest workers were at greatest risk of both incident and recurrent back injury, but this did not remain the case when adjusting for gender, time in the union and predominant type of work. Women had higher rates of incident events, and slightly lower recurrent events. Overall back injury risk declined with increasing time in the union. Individuals who work predominantly in drywall were at consistently higher risk than their union counterparts doing other types of work.

Crude rates and rate ratios of a second back injury resulting from overexertion or bodily motion are presented in Table 7 for each of the different classification schemes for incident cases, as are the adjusted rate ratios. Overall, these subsequent back injuries of a musculoskeletal nature occurred at a rate of 6.8 (95% CI 6.3, 7.9) per 200,000 hours worked; this is 30% higher than rates of initial back injuries. Minimal differences in risk of second injury were observed based on the mechanism of the first back injury. The few carpenters whose nature of injury had been coded as a fracture were at particularly high risk of a second back injury when compared to those with no prior history, but their fractures were not confirmed by appropriate ICD9 codes. Individuals with a medical diagnosis of degenerative conditions or mixed diagnoses, those who required inpatient care for their first injury, and those who were out of work a month or longer with their initial event were at greater risk of reporting a second work-related back injury of a musculoskeletal nature. The parameters estimates for age, gender, and predominant type of work were not significantly different in these models and they are not presented here.

Of note, is the higher rate of injury between 1000 and 1500 hours after return to work (Figure 3). Other than in this period, the rate of second injuries decreased slowly over the first 6000 hours after return to work (representing 3-4 years of fulltime work among this cohort) and then declined rather dramatically.

Table 5. Nature and mechanism, paid lost time, medical diagnoses, and hierarchy of care for back injury claims, Washington Carpenters, 1989-2003

	Incident (n= 3037) Frequency (%)	Recurrent (n=751) Frequency (%)
Mechanism of injury		
Overexertion	1965 (64.7)	510 (67.9)
Bodily reaction	240 (7.9)	65 (8.7)
Fall from elevation	284 (9.4)	60 (8.0)
Same level fall	185 (6.1)	36 (4.8)
Struck by	174 (5.7)	37 (4.9)
Struck against	65 (2.1)	16 (2.1)
MVA	22 (0.72)	8 (1.1)
Caught	10 (0.33)	2 (0.27)
Explosion	1 (0.03)	--
Abraded	1 (0.03)	--
NEC/Unknown	90 (3.0)	13 (1.7)
Nature of injury		
Sprain	2262 (74.5)	553 (73.6)
Ill-defined symptoms	194 (6.4)	48 (6.4)
Contusion	63 (2.1)	14 (1.9)
Dislocation	54 (1.8)	16 (2.1)
Fracture	26 (0.86)	7 (0.93)
Nervous system	9 (0.30)	2 (0.27)
Multiple injuries	6 (0.20)	2 (0.27)
Scratches	1 (0.03)	--
Unclassified	26 (0.86)	4 (0.53)
ID by ICD9	395 (13.0)	105 (14.0)
Medical diagnoses		
First aid (no diagnosis)	163 (5.4)	36 (4.8)
Sprain	930 (30.6)	191 (25.4)
Dislocation without fracture	507 (16.7)	125 (16.6)
Degenerative condition	113 (3.7)	42 (5.6)
Symptom descriptor	98 (3.2)	24 (3.2)
Contusion	48 (1.6)	13 (1.7)
Fracture/cord or injury	14 (0.46)	5 (0.67)
Nerve injury	1 (0.03)	1 (0.13)
Mixed diagnoses	802 (26.4)	227 (30.2)
Unknown diagnosis	353 (11.6)	87 (11.6)

Table 5. (cont)

	Incident (n=3037) Frequency (%)	Recurrent (n=751) Frequency (%)
Hierarchy of medical care		
First aid only	163 (5.4)	36 (4.8)
Outpatient care	2771 (91.3)	682 (90.8)
Inpatient care	103 (3.4)	33 (4.4)
Paid lost time from work		
None	1839 (60.6)	429 (57.1)
Up to 2 weeks	336 (11.1)	70 (9.3)
2 weeks to 1 month	123 (4.1)	36 (4.8)
1-3 months	173 (5.7)	52 (6.9)
>3 months	566 (18.6)	64 (21.8)

Table 6. Stratified time at risk, frequency of back injuries, crude rates and rate ratios, and adjusted rate ratios, incident and recurrent claims, Washington carpenters 1991-2003

	Incident (n= 3037)					**Recurrent** (n=751)				
	Time at risk	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)	Time at risk	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)
Age										
< 20	530,900	25	9.6 (6.5, 14.4)	1.6 (0.98, 2.5)	1.0 (0.71, 1.5)	12,339	1	16.8 (2.4, 119.3)	1.4 (0.23, 12.9)	0.88 (0.16, 4.8)
20- < 30	19,871,546	655	6.4 (5.9, 6.9)	1.0 (0.93, 12)	0.85 (0.78, 0.94)	1,857,725	89	9.4 (7.6, 11.6)	0.80 (0.64, 1.0)	0.63 (0.51, 0.78)
30- < 40	39,872,789	1243	6.1 (5.8, 6.5)	1	1	5,728,404	341	11.7 (10.5, 13.0)	1	1
40- < 50	33,818,763	756	4.4 (4.1, 4.8)	0.72 (0.65, 0.80)	0.82 (0.75, 0.89)	5,705,218	232	8.1 (7.1, 9.2)	0.69 (0.59, 0.81)	0.79 (0.68, 0.92)
50-<60	15,969,901	313	3.8 (3.4, 4.3)	0.63 (0.54, 0.73)	0.77 (0.68, 0.87)	2,279,633	85	7.4 (6.0, 9.1)	0.63 (0.50, 0.79)	0.78 (0.63, 0.96)
60+	2,833,793	36	2.6 (1.9, 3.6)	0.42 (0.28, 0.62)	0.53 (.39,0.72)	295,298	3	2.0 (0.65, 6.3)	0.17 (0.06, 0.50)	0.21 (0.08, 0.56)
Gender										
Female	1,935,818	73	7.2 (5.7, 9.1)	1.4 (1.0, 1.9)	1.3 (1.1, 1.7)	266,718	12	9.0 (5.1, 15.9)	0.97 (0.55, 1.7)	0.91 (0.56, 1.5)
Male	110,959,277	2952	5.2 (5.0, 5.4)	1	1	15,611,134	738	9.3 (8.7, 10.0)	1	1
Time in the union										
< 1 year	7,936,623	340	8.3 (7.4, 9.3)	2.0 (1.7, 2.3)	1.7 (1.5, 1.9)	143,936	10	13.5 (7.0, 25.9)	1.7 (0.91, 3.2)	1.7 (0.97, 3.1)
1-< 2 years	8,648,889	337	7.7 (6.9, 8.6)	1.8 (1.6, 2.1)	1.6 (1.4, 1.8)	428,328	31	14.9 (10.5, 21.2)	1.9 (1.3, 2.7)	1.9 (1.4, 2.6)
2- <3 years	7,263,326	257	6.8 (6.0, 7.7)	16 (1.4, 1.9)	1.4 (1.2, 1.6)	607,917	40	13.3 (9.8, 18.3)	1.7 (1.3, 2.3)	1.7 (1.3, 2.3)
3- <4 years	6,199,130	201	6.3 (5.5, 7.3)	1.5 (1.3, 1.8)	1.3 (1.2, 1.6)	671,684	61	16.9 (13.0, 21.9)	2.1 (1.6, 2.8)	2.1 (1.7, 2.8)
4-<6 years	9,951,689	294	5.8 (5.2, 6.5)	1.4 (1.2, 1.6)	1.2 (1.1, 1.4)	1,396,611	70	9.9 (7.8, 12.6)	1.3 (0.99, 1.6)	1.2 (0.98, 1.5)
6-<8 years	7,654,640	214	5.5 (4.8, 6.3)	1.3 (1.1, 1.6)	1.2 (1.0, 1.3)	1,384,801	78	11.0 (8.8, 13.8)	1.4 (1.1, 1.8,)	1.3 (1.1, 1.7)
8-<10 years	7,023,305	168	4.7 (14.1, 5.5)	1.1 (0.95, 1.4)	1.0 (0.86, 1.2)	1,355,887	64	9.5 (7.4, 12.1)	1.2 (0.93, 1.5)	1.1 (0.89, 1.4)
10 years and >r	58,368,968	1226	4.2 (3.9, 4.4)	1	1	9,891,378	397	7.9 (7.2, 8.7)	1	1

Table 6. (cont)

	Incident (n=3037)					**Recurrent** (n=751)				
	Time at risk	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)	Time at risk	Injuries	Crude Rate (95% CI)	Crude RR (95% CI)	Adjusted RR (95% CI)
Predominant work										
Drywall	18,584,830	724	7.8 (7.3, 8.4)	1.6 (1.4, 1.9)	1.5 (1.4, 1.7)	3,704,563	234	12.6 (11.1, 14.4)	1.3 (1.1, 1.6)	1.3 (1.1, 1.6)
Residential	1,439,915	69	9.7 (7.7, 12.3)	2.0 (1.5, 2.7)	1.7 (1.3, 2.2)	189,935	12	12.6 (7.2, 22.2)	1.3 (0.75, 2.3)	1.0 (0.61, 1.7)
Millwright	2,091,624	58	5.5 (4.3, 7.2)	1.2 (0.86, 1.6)	1.2 (0.94, 1.6)	336,429	16	9.5 (5.8, 15.5)	0.98 (0.76, 1.3)	1.1 (0.69, 1.7)
Pile driver	7,302,610	99	2.7 (2.2, 3.3)	0.57 (0.45, 0.72)	0.60 (0.49, 0.74)	756,049	14	3.7 (2.2, 6.3)	0.38 (0.23, 0.65)	0.41 (0.26, 0.66)
Non-Washington	1,675,735	51	6.0 (4.5, 7.9)	1.3 (0.90, 1.7)	1.2 (0.93, 1.6)	133,426	5	7.5 (3.1, 18.0)	0.38 (0.23, 0.65)	0.70 (0.33, 1.5)
Mixed commercial	50,431,010	1127	4.5 (4.2, 4.7)	0.93(0.82, 1.1)	0.96 (0.86, 1.1)	6,625,257	260	7.9 (7.0, 8.9)	0.81 (0.66, 1.0)	0.83 (0.69, 1.00
Light commercial	12,586,487	413	6.2 (5.6, 6.8)	1.3 (1.1, 1.5)	1.3 (1.2, 1.5)	1,788,993	85	9.5 (7.7, 11.8)	0.98 (0.76, 1.3)	1.0 (0.80, 1.3)
Heavy commercial	17,278,765	390	4.8 (4.3, 5.3)	1	1	2,279,369	110	9.7 (8.0, 11.6)	1	1

[1] Rates are per 200,000 hours worked
[2] Poisson regression models
[3] Scaled deviance in adjusted models

Table 7. Crude rates and rate ratios, adjusted rate ratios of subsequent musculoskeletal back injuries based on definition of incident injury, Washington Carpenters, 1989-2003

Definition of incident injury	Time at risk	Injuries	Crude rate	Crude rate ratio	Adjusted rate ratios[1]
Mechanism of injury					
Incident (no prior injury)	113,057,915	3037	5.3 (5.1, 5.5)	1	1
Overexertion	11,171,118	392	6.8 (6.2, 7.5)	1.3 (1.2, 1.4)	1.3 (1.2, 1.4)
Bodily reaction	1,477,561	35	4.8 (3.4, 6.7)	0.91 (0.69, 12)	1.4 (1.3, 1.5)
Fall from elevation	1,400,817	56	7.7 (5.9, 10.1)	1.5 (12, 1.8)	0.98 (0.75, 1.3)
Same level fall	1,030,261	32	6.2 (4.4, 8.8)	1.2 (0.89, 1.5)	1.5 (1.2, 1.9)
Struck by/against	1,295,957	41	6.2 (4.5, 8.4)	1.2 (0.91, 1.5)	1.3(1.0, 1.7)
MVA	112,169	4	7.1 (12.7, 19.0)	1.4 (0.60, 3.1)	1.3 (0.55, 3.1)
Caught	40,745	0	--	--	--
NEC/Unknown	388,883	15	1.5 (0.96, 2.2)	1.5 (0.96, 2.2)	--[2]
Nature of injury					
Incident (no prior injury)	113,057,915	3037	5.3 (5.1, 5.5)	1	1
Sprain	12,967,053	452	5.8 (4.1, 8.3)	1.1 (0.82, 1.5)	1.3 (0.99, 1.7)
Ill-defined symptoms	388,883	15	6.8 (6.2, 7.5)	1.3 (1.2, 1.4)	1.3 (1.2, 1.5)
Contusion	405, 545	33	5.9 (3.4, 10.4)	1.1 (0.70, 1.8)	1.2 (0.74, 1.8)
Dislocation	317,615	12	3.1 (1.3, 7.6)	0.60 (0.29, 1.2)	0.75 (0.38, 15)
Fracture	83,030	5	9.7 (3.6, 25.7)	1.8 (0.81, 4.1)	2.5 (1.2, 5.4)
Nervous system	39,139	4	5.1 (0.72, 36.3)	0.97 (0.19, 4.9)	0.95 (0.21, 4.3)
Multiple injuries	1,792,172	1	7.3 (5.7, 9.3)	1.4 (1.1, 1.7)	1.4 (1.2, 1.7)
Unclassified/ID by ICD9	242,405	66	1.7 (0.41, 6.6)	0.31 (0.10, 0.99)	--[2]
Medical diagnoses					
Incident (no prior injury)	113,057,915	3037	5.3 (5.1, 5.5)	1	1
First aid (no diagnosis)	1,190,434	30	5.1 (3.5, 7.2)	0.96 (0.72, 1.3)	1.3 (0.98, 1.7)
Sprain	5,353,432	154	5.7 (4.8, 6.7)	1.1 (0.95, 1.2)	1.1 (0.96, 1.2)
Dislocation without fracture	2,979,704	106	7.0 (5.7, 8.4)	1.3 (1.1, 1.5)	1.4 (1.2, 1.6)
Degenerative condition	684,061	31	9.1 (6.4, 12.9)	1.7 (1.3, 2.3)	2.0 (1.5, 2.6)
Symptom descriptor	394,386	12	6.2 (3.5, 10.9)	1.2 (0.75, 1.8)	1.1 (0.71, 1.7)
Contusion	317,307	1	0.63 (0.09, 4.5)	0.12 (0.03, 0.57)	0.14 (0.03, 0.61)
Fracture/cord or injury	48,570	0	--	--	--
Mixed diagnoses	4,076,261	179	1.6 (1.4, 1.8)	1.6 (1.4, 1.8)	1.7 (1.5, 1.9)
Unknown diagnosis	1,873,357	62	6.2 (4.8, 8.1)	1.2 (1.0, 1.4)	--[2]

	Time at risk	Injuries	Crude rate	Crude rate ratio	Adjusted rate ratios
Medical care					
Incident (no prior injury)	113,057,915	3037	5.3 (5.1, 5.5)	1	1
First aid only	1,190,434	30	5.0 (3.5, 7.2)	0.96 (0.21,1.3)	1.3 (0.97, 1.7)
Outpatient care	15,266,201	526	6.7 (6.2, 7.4)	1.3 (1.2, 1.4)	1.3 (1.2, 1.1)
Inpatient care	460,876	19	7.4 (4.6, 11.9)	1.4 (0.94, 2.1)	1.6 (1.1, 2.3)
Paid lost time from work					
Incident (no prior injury)	113,057,915	3037	5.3 (5.1, 5.5)	1	1
None	11,267,523	340	6.0 (5.4, 6.6)	1.1 (1.0, 1.2)	1.2 (1.1, 1.3)
1-<2 weeks	2,065,501	54	5.1 (3.9, 6.7)	0.96 (0.72, 1.2)	1.1 (0.87, 1.3)
2-<4 weeks	770,843	26	6.5 (4.4, 9.6)	1.2 (0.89, 1.7)	1.3 (0.99, 1.8)
1-3 months	962,436	40	8.1 (5.9, 11.1)	1.5 (1.2, 2.0)	1.8 (1.4, 2.3)
>3 months	1,851,207	115	11.8 (9.8, 14.3)	2.3 (1.9, 2.6)	2.3 (2.0, 2.7)

[1] Adjusted for age, gender, time in the union, and predominant type of work
[2] Missing or unknown omitted from adjusted models; no significant change in other parameter estimates

Figure 2. Kaplan-Meier survival curves for incident and recurrent back injuries, Washington carpenters, 1989-2003

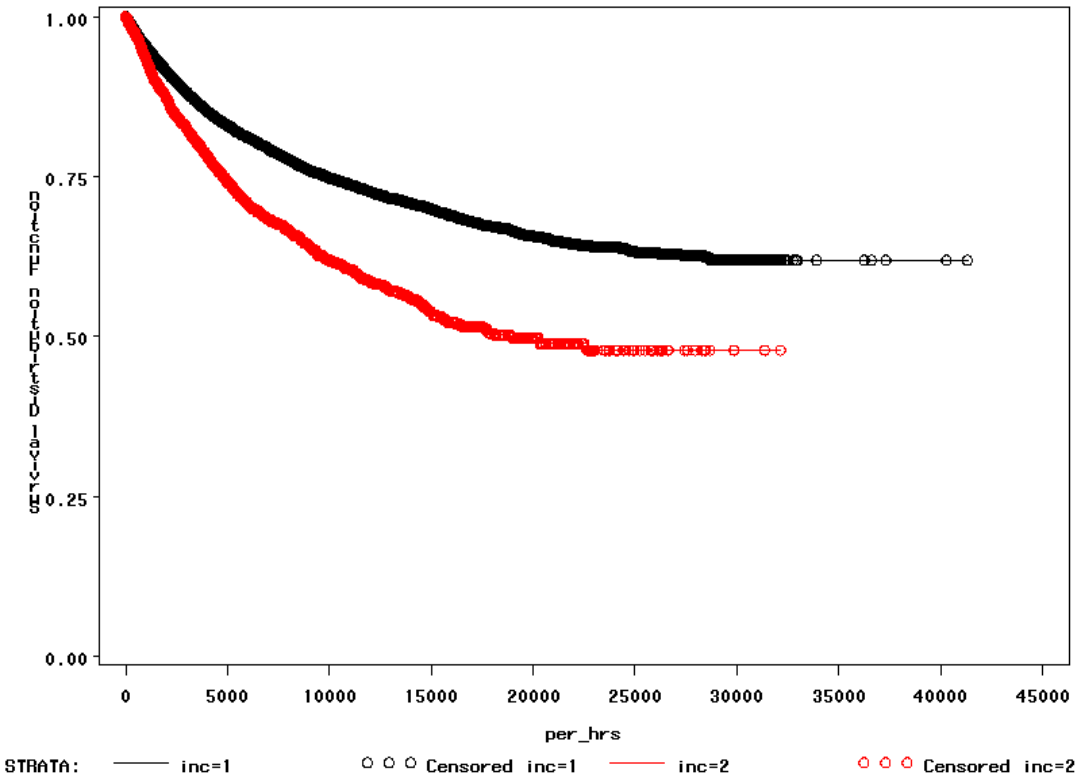
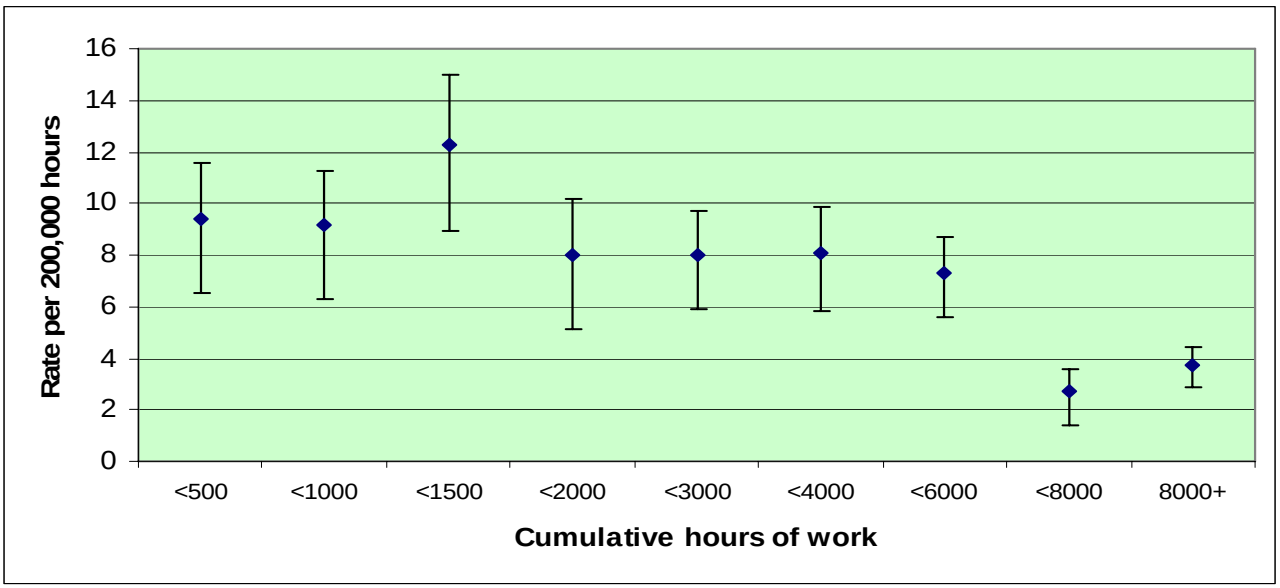


Figure 3. Rates of next back injury in different windows of time after return to work, Washington Carpenters, 1989-2003.



NOTE: Second injuries limited to events resulting from overexertion or bodily motion.

Health care utilization for musculoskeletal back disorders, Washington State union carpenters, 1989-2003

Health care utilization for back disorders

Sixty percent (n=11,217) of the cohort did not seek medical care for back disorders through either the workers' compensation system or through their private union-provided insurance (Table 8); 10% (n=1,819) sought care in both systems. Through the private health care trust 6,333 carpenters (33.7%) had 120,907 different health care visits out of a total of 565,726 overall outpatient healthcare visits (18.1%). The most common diagnosis was 'ill-defined dislocations' (ICD-9 839) (Table 9). This diagnosis code accounted for nearly half of visits and was most frequently assigned by chiropractors. This was followed by unspecified back disorders (739) and sprains and strains (846 and 847). Together these three diagnoses represented 82% of all back diagnoses assigned. Disc disorders and root lesions were relatively rare diagnoses. During the same 15 year period, 3,037 (16.2%) different carpenters filed 4,138 claims for work-related back injuries/disorders; these injuries have previously been described.

The pattern of yearly health care utilization for back disorders of a musculoskeletal nature through their health care trust by cohort members are contrasted to their previously identified pattern of work-related back injuries of a musculoskeletal nature due to overexertion type activities (lifting, carrying, pushing, etc.) in Figure 4 (Lipscomb, 2008). Private outpatient utilization rates for all other diagnoses are presented in Figure 5. [Of note, in both figures, the contrasting rates are presented separately on the two y-axes. Work-related back injury rates are based on hours of work while private utilization rates are based on months of health insurance eligibility.] There was a fairly steady decline in the rate of work-related back injuries due to overexertion over time resulting in a rate that was 62% lower in 2003 compared to 1989. In contrast, private health care utilization for musculoskeletal back diagnoses increased 108% over the 15 years, most notably after 1999. Private outpatient utilization rates for other diagnoses also markedly increased, but in a different pattern than for the back diagnoses.

Utilization rates were lower among younger carpenters and women had 64% higher rates of health care utilization through the trust compared to male carpenters (Table 10). Carpenters in the first three years of their apprenticeship had higher utilization rates than their more seasoned peers. Particularly high rates of utilization for back disorders were observed among carpenters whose locals did predominantly residential construction.

Health care utilization for back diagnoses through private insurance coverage was higher among carpenters with more work-related back injuries (Table 11). Following the first work-related back injury, private utilization rates were 36% higher (RR 1.36; 95% CI 1.20, 1.53); rates were nearly 3 times higher (RR 2.75; 95% CI 1.94, 3.91) among individuals who experienced four or more work-related back injuries during the observation period. In analyses limited only to individuals who ever used the workers' compensation system (data not shown), the pattern was the same. Private health care utilization was highest in the first year after overexertion work injuries but highest one to three years following acute work-related back injury (Table 12).

Table 8. Medical care for back disorders through workers' compensation and private insurance, union carpenters Washington State, 1989-2003

Source of care	Frequency (% of cohort)
Only Workers' Compensation System	1218 (6.5)
Only Private Insurance System	4514 (24.1)
Both (WC and Private)	1819 (9.7)
Neither, no care for back disorders	11217 (59.8)

Table 9. Frequency of primary diagnoses assigned to private outpatient health care claims for back problems of a musculoskeletal nature, Carpenters Trusts of Western Washington, 1989-2003

Primary ICD-9 diagnosis	Frequency (%)	# different carpenters with diagnosis
353 Nerve root and plexus disorders Limited to lumbosacral (353.1, 353.4)	97 (0.08)	17 (0.15)
355 Mononueritis of lower limb) Limited to sciatic nerve lesions (355.0)	30 (0.02)	4 (0.04)
721 Spondylosis and allied disorders	2872 (2.4)	225 (2.1)
722 Intervertebral disc disorders	6805 (5.6)	1142 (10.4)
724 Other /unspecified back disorders	20477 (16.9)	2728 (24.9)
738.4 Acquired spondylolisthesis	116 (0.10)	37 (0.34)
739 Nonallopathic lesions Limited to LS (739.3, 739.4)	12227 (10.1)	938 (8.6)
839 Ill-defined dislocations (chiropractic diagnosis)	59674 (49.3)	3419 (31.2)
846 Sprain/strains sacroiliac region	4882 (4.0)	659 (6.1)
847 Sprains/strains other parts of back (limited to lumbar and sacral)	13727 (11.4)	1801 (16.4)
TOTAL	120907 (100.0)	6,333*

* 6333 different carpenters were treated for ms back diagnoses (33.7% of cohort); some had > 1 diagnosis assigned

Table 10. Stratified time at risk, health care visits, utilization rates and adjusted rate ratios, union carpenters Washington State, 1989-2003

	Months of insurance Eligibility	Visits	Stratified utilization rate[1,2] (95% CI)	Adjusted RR[3] (95% CI)
Age				
< 20	5107	257	53.75 (42.48, 68.00)	0.36 (0.19, 0.68)
20- < 30	173565	17529	100.66 (97.13, 104.32)	0.76 (0.60, 0.97)
30- < 40	356530	40913	112.67 (110.06, 115.55)	0.99 (0.85, 1.15)
40- < 50	311613	35634	115.03 (112.07, 118.07)	1.01 (0.88, 1.15)
50+	267576	26528	109.65 (106.46, 112.93)	1
Gender				
Female	19594	3171	158.69 (143.46, 75.53)	1.64 (0.86, 3.11)
Male	1094582	117690	109.69 (108.15, 111.25)	1
Time in the union				
< 1 year	74182	8305	122.97 (115.96, 130.40)	1.16 (0.86, 1.56)
1-< 2 years	77403	14030	186.33 (176.90, 196.26)	1.88 (1.16, 3.03)
2- <3 years	63286	8120	124.70 (117.80, 132.00)	1.25 (1.03, 1.51)
3- <4 years	54404	5832	102.20 (96.10, 108.69)	1.09 (0.91, 1.30)
4-<6 years	89002	8997	95.99 (91.49, 100.71)	1.02 (0.87, 1.19)
6-<8 years	70016	6479	89.11 (84.37, 94.11)	0.94 (0.81, 1.08)
8-<10 years	64850	5952	90.29 (85.24, 95.63)	0.94 (0.82, 1.06)
10 years and over	624023	63190	106.58 (104.59, 108.60)	1
Predominant work				
Residential	14557	4558	324.68 (289.48, 364.16)	3.40 (1.03, 11.22)
Light commercial	131645	13281	101.60 (97.55, 105.83)	0.92 (0.73, 1.15)
Drywall	190994	20570	106.09 (102.66, 109.63)	0.96 (0.77, 1.20)
Millwright	21371	2141	101.14 (91.53, 111.760	0.85 (0.60, 1.22)
Pile driver	63905	5528	91.41 (86.12, 92.02)	0.82 (0.64, 1.07)
Mixed commercial	491135	52381	110.85 (108.55, 113.20)	1.01 (0.82, 1.24)
Out of Washington	18193	1893	100.35 (90.28, 111.56)	0.90 (0.65, 1.25)
Heavy commercial	163058	17878	113.26 (109.27, 117.39)	1

[1] Rates are per 100 person- years of insurance eligibility
[2] Negative binomial regression model
[3] Negative binomial regression model with generalized estimating equations

Table 11. Private outpatient utilization rates and adjusted rate ratios for musculoskeletal back diagnoses by the number of work-related claims, union carpenters Washington State, 1989-2003

Number of WC Claims	Rate of private utilization[1] (95% CI)	Adjusted Rate Ratio[2] (95% CI)
None	100.29 (98.68, 101.93)	1
One	129.34 (125.15, 133.68)	1.36 (1.20, 1.53)
Two	157.28 (147.97, 167.18)	1.66 (1.41, 1.95)
Three	165.05 (148.93, 182.92)	1.74 (1.37, 2.20)
Four or more	246.70 (214.13, 284.24)	2.75 (1.94, 3.91)

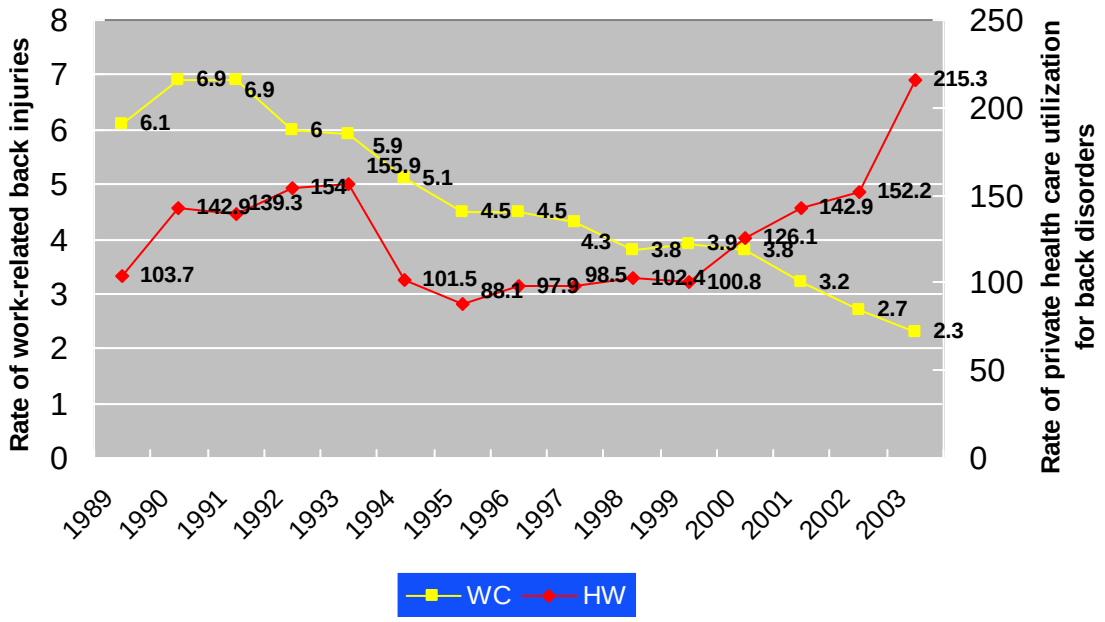
[1] Rates are per 100 person- years of insurance eligibility
[2] Adjusted for age, gender, time in the union, and predominant type of work; negative binomial regression with generalized estimating equations.

Table 12. Stratified utilization rates and adjusted rate ratios based on calendar time since work injury and cause of work injury, union carpenters Washington State, 1989-2003

	Straftified rate[1] of utilization (95% CI)	Adjusted RR[2] (95% CI)
	Overexertion Injury	
Time since work injury		
Less than 1 year	162.08 (154.94, 169.94)	1.53 (1.21, 1.94)
1-<3 years	125.16 (120.07, 130.47)	1.23 (1.01, 1.50)
3-<5 years	124.87 (118.95, 131.09)	1.24 (0.98, 1.56)
5+ years	110.10 (105.90, 114.46)	1.11 (0.89, 1.38)
No prior work injury	102.87 (102.20, 103.94)	1
	Acute trauma	
Time since work injury		
Less than 1 year	134.47 (123.70, 146.18)	1.22 (0.85, 1.76)
1-<3 years	157.03 (147.45, 167.23)	1.48 (1.02, 2.13)
3-<5 years	93.32 (84.74, 102.76)	0.93 (0.62, 1.38)
5+ years	99.48 (92.84, 106.54)	1.01 (0.66, 1.55)
No prior work injury	101.49 (100.81, 102.18)	1

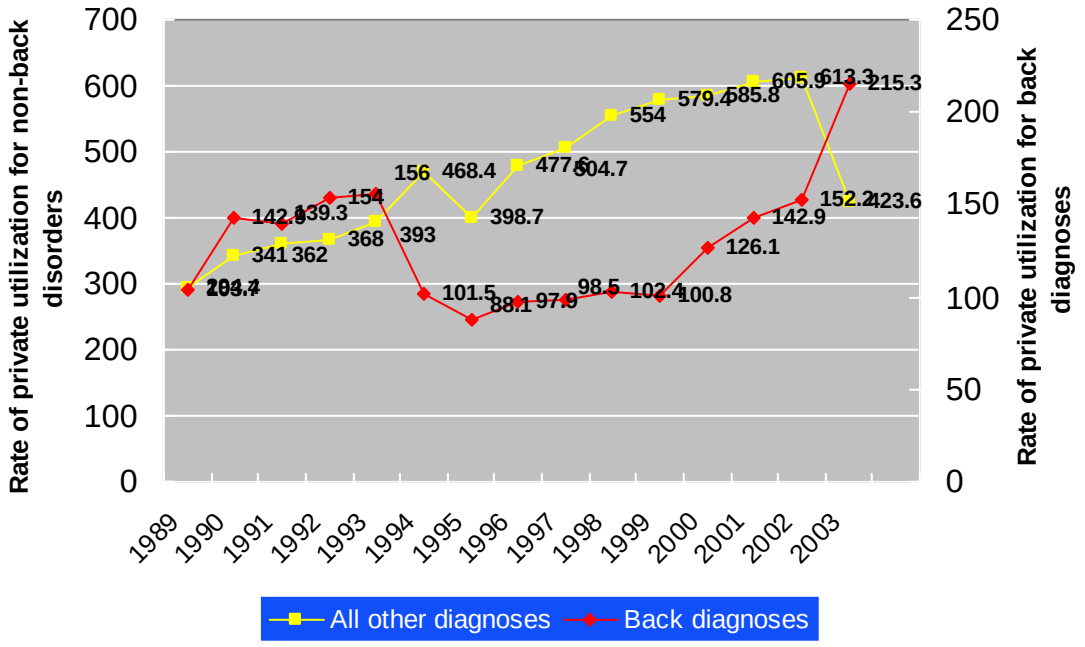
[1] Rates are per 100 person- years of insurance eligibility
[2] Adjusted for age, gender, time in the union, and predominant type of work; negative binomial regression with generalized estimating equations.

Figure 4. Outpatient health care utilization rates for musculoskeletal back diagnoses through the Carpenters Trusts of Western Washington compared to workers' compensation injury rates for overexertion back disorders, 1989-2003



WC=overexertion injury rates per 100 person years (200,000 hrs worked)
HW=User rates for back care of MS nature per 100 person years of insurance eligibility; limited to one visit per day per person

Figure 5. Outpatient private health care utilization rates[1] for musculoskeletal back diagnoses and all other diagnoses, Carpenters Trusts of Western Washington, 1989-2003



[1] Rates are per 100 person-years of insurance eligibility (1200 person-months)

Compensation costs of work-related back disorders among union carpenters, Washington State 1989-2003

Total costs incurred for back injuries/disorders including medical care, indemnity payments for lost time, and impairment for this cohort of carpenters were $128,358,522, representing $0.97 for each hour of work. This figure includes estimated costs for 5% of claims that were not closed when the data were downloaded; less than one percent of claims from 1989 were still open compared to 22% of those from 2003. Indemnity payments were responsible for the largest proportion of costs followed by medical care for both overexertion injuries and those caused by acute trauma (Table 13). Cost per claim was significantly higher for injuries resulting from acute trauma ($45.6 thousand; 95% CI, 40.7, 51.0) than for those resulting from overexertion ($25.0 thousand; 95% CI, 23.3, 26.8); traumatic injuries were responsible for 26% of claims and 39% of total costs.

While costs of work-related back injuries ended slightly lower in 2003 than in 1989, there was significant variability over the 15-year period with no discernable trend. Lower acute injury costs were responsible for this slight decline in costs over time (not at a level of statistical significance); no change in costs of overexertion injuries was observed (Figure 6). In each year, indemnity payments were consistently responsible for the largest proportion of costs associated with these injuries (Figure 7). The data were highly skewed with median costs for indemnity and impairment zero in each year; median medical costs ranged from a high of $1700 in 1990 to a low of $1050 in 1998, but ended in 2003 at $1600 as they were in 1989.

Costs and adjusted cost ratios for overexertion and acute back injuries followed similar patterns with costs increasing with increasing age (Table 14). It is of note that similar patterns were seen for both indemnity and medical costs, although the cost ratios were slightly higher for indemnity (data not shown). Costs for women were higher than costs for men for both overexertion and acute injuries, but these estimates were based on few observations and are consequently unstable. Minimal differences were observed based on predominant type of work with the exception of relatively low costs for overexertion injuries among pile drivers.

For overexertion injuries particularly, payments tended to increase as the number of back injuries experienced increased up to the third injury (Table 15) after adjusting for calendar time as well as age, gender, tenure, and type of work. This pattern of increasing cost is even more pronounced when analyses are limited to individuals who had a subsequent injury (Table 16). Among the 233 carpenters who experienced three back injuries mean medical and impairment costs were over 3 times higher for the third injury than the first and indemnity costs were over 7 times higher.

Although mean costs for back injuries changed relatively little over 15 years, payment rates based on dollars spent per 200,000 hours (or 100 fulltime carpenters working 2000 hours per year) decreased markedly over time (Figure 8). Dollars spent on back injuries per hour of carpenter work decreased 24% from a high of $1.61 per hour in 1990 to $0.39 per hour in 2003.

Table 13 Distribution of hours worked, overexertion and acute back injuries by age, gender, union tenure and predominant type of work, Union Carpenters, Washington State 1989-2003

	Hours worked	Overexertion	Acute trauma
Age			
< 30	22,545,628	589	204
30- < 40	47,457,445	1282	426
40- < 50	41,745,886	799	327
50- < 60	22,288,337	363	139
Gender			
Male	131,773,547	2965	1068
Female	2,260,386	65	27
Time in the union			
< 2 years	17,183,794	533	186
2- <4 years	14,888,280	441	140
4-<6 years	11,659,061	268	123
6-<8 years	9,409,159	224	95
8-<10 years	8,843898	205	64
10 years and over	72,203,905	1371	488
Predominant work			
Heavy commercial	20,253,804	407	164
Drywall	24,129,911	837	272
Residential	1,675,730	59	26
Millwright	2,549,160	50	32
Pile driver	8,171,203	87	30
Out of Washington	1,826,138	38	18
Mixed commercial	58,917,900	1098	378
Light commercial	14,919,760	374	143

Table 14. Distribution of workers' compensation payments for back injuries by injury type among union carpenters, Washington State, 1989-2003, expressed in 2006 dollars

	Overexertion (n=3042)	Acute (n=1096)	Overall (n=4138)
Medical			
Total	27,501, 931 (35.3%)	18,254,797 (36.2%)	45,756,728
Mean	9,041	16,656	11,058
Median	1,231	1,885	1,373
Indemnity[1]			
Total	43,283,694 (55.6%)	26,784,073 (53.1%)	70,067,767
Mean	35,333	77,872	41,023
Median	4,156	55,454	6,180
Impairment[2]			
Total	7,116,554 (9.1%)	5,417,481 (10.7%)	12,534,026
Mean	18,876	23,152	13,377
Median	18,538	20,074	18,971
Overall			
Total	77,902,170 (100%)	50,456,351 (100%)	128,358,522
Mean	25,608	46,037	31,019
Median	1,669	2,497	1,864

[1] Limited to 1708 or 41.3% of claims with paid lost time
[2] Limited to 611 or 14.8% of claims with impairment

Table 15. Payments[1] and adjusted payment ratios[2] for overexertion and acute back injuries (among the injured), union carpenters, Washington State, 1989-2003

	Overexertion injuries		Acute traumatic injuries	
	Payments[1] in $1000's per injury (95% CI)	Adjusted Payment Ratio (95% CI)[2]	Payments[1] in $1000's per injury (95% CI)	Adjusted Payment Ratio (95% CI)[2]
Age				
< 30	16.6 (14.2, 19.4)	1	31.8 (24.2, 41.7)	1
30- < 40	24.4 (23.8, 29.4)	1.62 (1.29, 2.05)	39.9 (33.3, 47.9)	1.24 (0.82, 1.88)
40- < 50	26.1 (22.8, 29.8)	1.71 (1.31, 2.23)	48.3 (39.3, 59.4)	1.64 (1.03, 2.62)
50- < 60	31.3 (25.5, 38.7)	2.11 (1.49, 3.00)	78.7 (56.4, 109.9)	2.76 (1.51, 5.05)
Gender				
Male	24.9 (23.2, 26.7)	1	45.3 (40.3, 50.9)	1
Female	28.6 (17.8, 46.1)	1.23 (0.69, 2.19)	57.7 (27.7, 120.0)	1.62 (0.65, 4.00)
Time in the union				
< 2 years	20.1 (17.0, 23.8)	1	40.1 (30.2, 53.2)	1
2- <4 years	19.3 (16.1, 23.1)	0.92 (0.71, 1.19)	31.0 (22.4, 42.9)	1.21 (0.76, 1.92)
4-<6 years	27.7 (22.1, 34.8)	0.92 (0.70, 1.20)	39.5 (27.9, 42.9)	0.70 (0.44, 1.12)
6-<8 years	32.3 (25.1, 41.6)	1.33 (0.97, 1.81)	47.2 (32.1, 69.2)	1.10 (0.67, 1.81)
8-<10 years	30.1 (23.2, 39.0)	1.54 (1.10, 2.17)	50.5 (31.5, 80.8)	1.15 (0.68, 1.92)
10 years and over	26.1 (23.5, 28.9)	1.28 (0.91, 1.80)	52.3 (44.0, 62.1)	1.29 (0.68, 2.44)
Predominant work				
Heavy commercial	26.6 (22.1, 32.0)	1	47.8 (35.7, 64.1)	1
Drywall	25.1 (22.1, 28.5)	0.92 (0.71, 1.20)	39.1 (31.1, 49.1)	0.94 (0.60, 1.47)
Residential	26.9 (16.5, 43.8)	0.93 (0.50, 1.71)	21.3 (10.1, 44.9)	0.50 (0.19, 1.35)
Millwright	30.3 (17.8, 51.3)	0.95 (0.49, 1.82)	54.0 (28.0, 104.4)	1.46 (0.59, 3.58)
Pile driver	16.3 (10.9, 24.5)	0.52 (0.30, 0.87)	34.8 (17.6, 68.80	0.91 (0.37, 2.24)
Out of Washington	26.3 (14.3, 48.2)	0.92 (0.44, 1.93)	37.1 (15.0, 91.8)	0.88 (0.28, 2.72)
Mixed commercial	23.8 (21.2, 26.7)	0.88 (0.68, 1.13)	51.5 (42.5, 62.5)	1.21 (0.80, 1.85)
Light commercial	27.3 (22.7, 31.2)	1.03 (0.75, 1.41)	45.5 (33.2, 62.2)	0.86 (0.51, 1.44)

[1] Dollars (in 2006 dollar value) modeled as counts using negative binomial regression
[2] Adjusted for age, gender, tenure, and type of work; scaled deviance

Table 16. Paymentss[1] and adjusted payment ratios[2] for overexertion and acute back injuries (among the injured), by the number of claims of the worker, union carpenters, Washington State, 1989-2003

	Overexertion injuries		Acute traumatic injuries	
	Payments[1] in $1000's per injury (95% CI)	Adjusted Payment Ratio (95% CI) [2]	Payments[1] in $1000's per injury (95% CI)	Adjusted Payment Ratio (95% CI) [2]
Count of claims				
First claim	22.3 (20.5, 24.2)	1	44.7 (39.1, 51.0)	1
Second Claim	30.5 (26.1, 35.6)	1.27 (1.02, 1.59)	50.2 (37.6, 67.1)	1.39 (0.92, 2.11)
Third Claim	38.1 (28.5, 50.9)	1.88 (1.30, 2.22)	52.6 (32.4, 85.6)	1.27 (0.68, 2.37)
Fourth Claim +	29.9 (20.1, 44.4)	1.43 (0.87, 2.36)	28.4 (13.4, 50.0)	0.53 (0.20,1.38)

[1] Dollars (in 2006 dollar value) modeled as counts using negative binomial regression
[2] Adjusted for age, gender, tenure, type of work, and calendar time; scaled deviance

Table 17. Mean payments [1] (and standard errors) by order of injury occurrence, work-related back injuries union carpenters Washington State, 1989-2003

	First injury (n=3037)	Second injury (n=751)	Third injury (n=233)
	Payments (SE)	Payments (SE)	Payments (SE)
Medical	10470 (532)	12456 (1155)	14875 (1907)
Indemnity	15682 (854)	19420 (1935)	25325 (3937)
Impairment	2989 (1433)	3130 (308)	3604 (598)

Limited to those who had subsequent injury

751 carpenters who had at least two back injuries

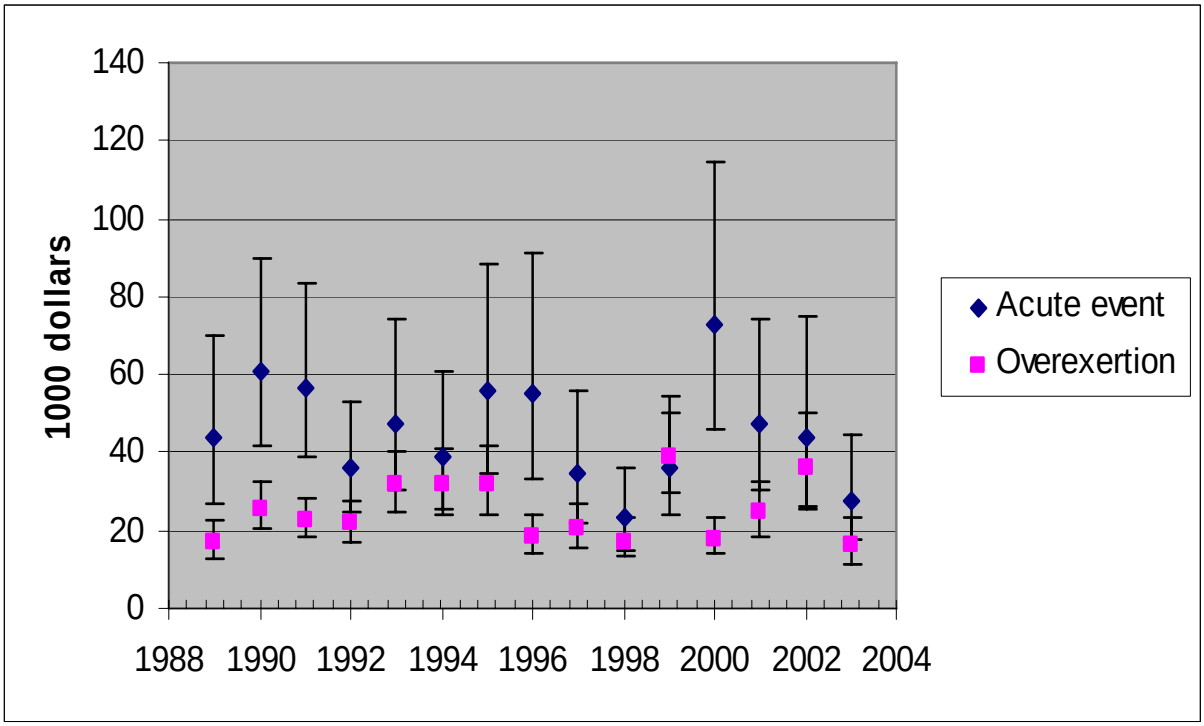
	First injury	Second injury
Medical	4118 (401)	12456 (1155)
Indemnity	3932 (1155)	19420 (1935)
Impairment	1062 (647)	3130 (308)

233 carpenters who had at least 3 back injuries

	First injury	Second injury	Third injury
Medical	4015 (567)	9021 (1996)	14875 (1907)
Indemnity	3207 (753)	10753 (2423)	25325 (3937)
Impairment	1056 (288)	1538 (412)	3604 (598)

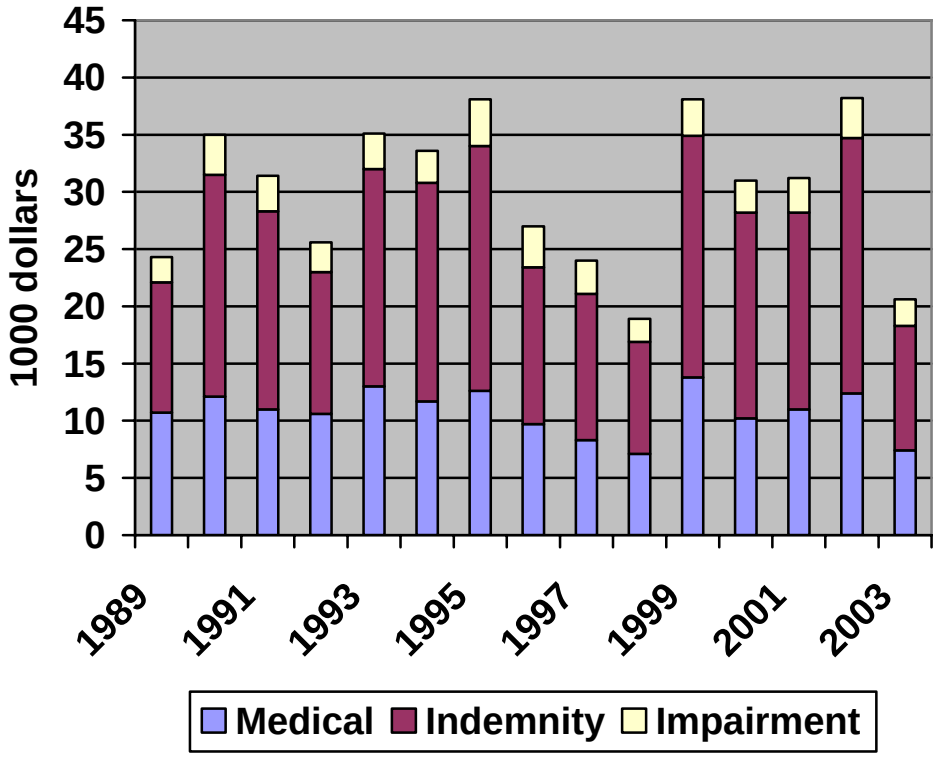
[1] Dollars in 2006 value

Figure 6. Yearly mean workers' compensation payments [1] and 95% confidence limits for back injuries attributed to overexertion and acute trauma among union carpenters, Washington State, 1989-2003



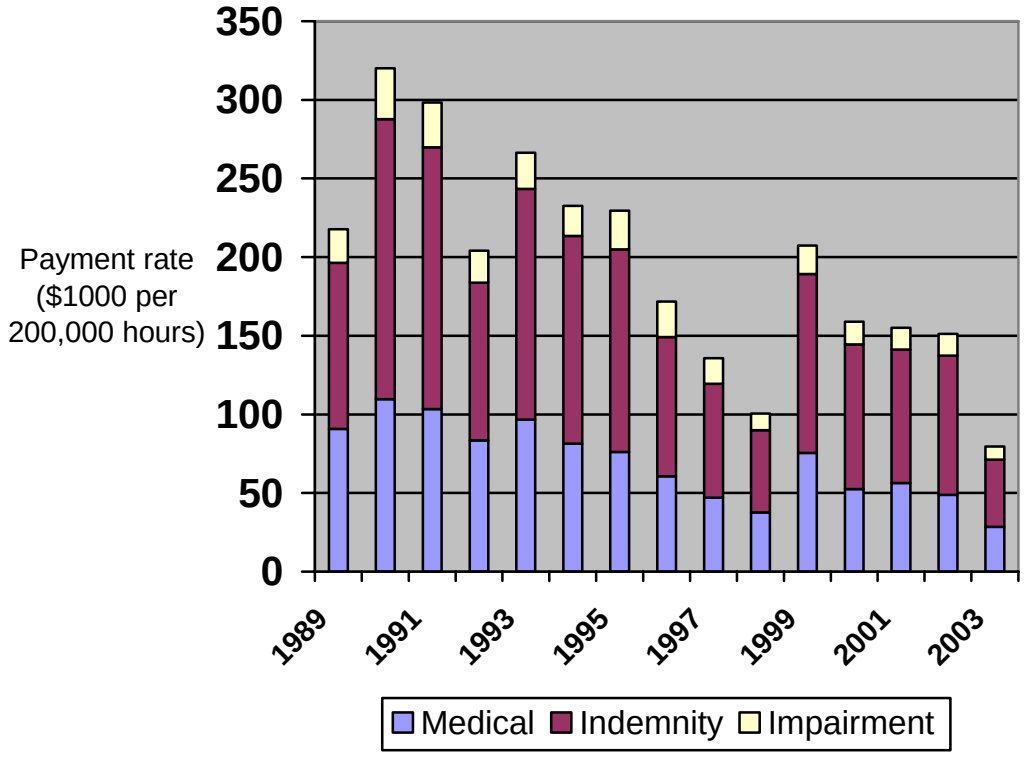
[1] Dollars in 2006 value

Figure 7. Workers' compensation payments [1] for work-related back injuries (n=4138) among union carpenters in Washington State, 1989-2003 expressed in 2006 dollars



[1] Dollars in 2006 value

Figure 8. Yearly workers' compensation payment rates [1] based on hours worked among union carpenters, Washington State, 1989-2003



[1] Dollars in 2006 value

Predictors of delayed return to work after back injury: A case control analysis

Characteristics of case and control back injury claims

Of the 3093 union carpenters with a back injury claim, 40% reported 1699 claims resulting in paid time off over a 15 year period: 738 claims had over 90 days delayed return to work (cases, range 91 to 3774 days, median 465) and 699 claims returned to work within 30 days (controls, range 1 to 30 days, median 8). Nineteen percent of the injured carpenters had multiple back injury claims: 15% had one previous, 3% had two previous, and 1% had three previous claims. Time between claims ranged from 3 to 4453 days (median 746); few had 3 to 20 days between claims (1%).

The proportion of back injury claims with delayed return to work was lowest in year 1989 and in year 1997 (31%) and highest from years 2000 to 2003 (54%, 56%, 59%, and 52% respectively). Delayed return to work back claims occurred more frequently among carpenters 45 and over, journeymen (four or more years union experience), and those who's previous claim was a paid time off back injury claim (Table I). Claims among individuals working for residential operative builders were more frequently delayed return to work; claims among individuals working for non-residential general contractors were more frequently rapid return to work (Table I). Of the few females, twice as many claims were delayed return to work claims.

Thirty percent of case claims and 8% of control claims were identified by an ICD-9 code (ANSI body code was missing, n=3, or multiple injuries were sustained, n=281). Delayed return to work most often occurred for claims with multiple body parts involved including upper and lower extremities, multiple injury types, dislocations (herniated nucleus pulposus), and fractures (Table II, Note: ANSI dislocation of back is used to code herniated nucleus pulposus). Traumatic events such as falls and being struck were more often delayed return claims. Injury claims to the back only, sprains and strains, and overexertion injuries were more likely to have a rapid return to work. ICD-9 code groupings for spinal fracture, spinal cord injury, symptom descriptor (e.g. "lumbago", "back pain"), degenerative, and mixed back diagnoses occurred more often in delayed return claims. Sprains and strains and non-fracture dislocations were predominantly rapid return claims. The top four sources of back injury claims for cases and controls included timber or slab (10% cases; 13% controls), sheetrock (9% cases; 9% controls), bodily motion, (7% cases; 8% controls), and work surface (8% cases; 5% controls).

Inpatient hospital care was predominantly for delayed return claims (18% vs. 1%) whereas outpatient care (90% vs. 77%) or first aid (9% vs. 5%) was more common for rapid return claims. For most injured carpenters we could identify medical care received within 30 days of the injury claim date; however, delayed return claims were more likely to be seen after 30 days (9%) compared to rapid return claims (3%).

Predictors of delayed return to work

Delayed return to work after back injury claim was associated with being female, age 30 to 44 and age over 45, journeyman status (four or more years union experience), previous claim was a paid time off back injury claim, and a 30 day delay to medical care (Table III). There was a positive and statistically significant linear trend for age and delayed return to work (p for trend

<0.05). In multivariate analyses all associations remained except for the positive association with increasing age attenuated as a result of the positive correlation (0.68) between age and union experience (Table III).

For other predictors, the unadjusted estimates were identical to adjusted estimates, therefore we present adjusted estimates in Tables IV and V. Standard Industry Classification codes for heavy construction and residential operative building industries were associated with delayed return to work compared to non-residential general contractors (Table IV).

Evidence of more acute trauma was associated with delayed return to work and included being struck against or by an object or person, a fall from elevation or the same level, and motor vehicle crashes (Table IV). When compared to ANSI classified strains and sprains, dislocations (herniated nucleus pulposus), fractures, and multiple injury types were associated with delayed return to work. ICD-9 code groupings for symptom descriptor, degenerative, mixed back diagnoses, and spinal fracture or cord injury were associated with delayed return to work compared to sprains and strains. Unlike ANSI injury type dislocations which represent disc herniations, ICD-9 coded dislocations were associated with a rapid return to work.

There is a suggestion of a linear trend between increasing years between paid time off back injury claims and increased odds of delayed return to work (Table V). Previous care for back injury prior to the back injury claims, through private insurance or workers' comp, was associated with delayed return to work (Table V).

Table 18. Demographic characteristics of case and control back injury claims among Washington State Union Carpenters, 1989-2003

	Cases (claims with over 90 paid lost days)		Controls (claims with 1 to 30 paid lost days)		Total	
	n	%	n	%	n	%
Gender						
Male	709	96.5%	686	98.4%	1395	97.4%
Female	26	3.5%	11	1.6%	37	2.6%
Unknown	*3*		*2*		*5*	
Age at injury date						
Under 30	101	13.7%	141	20.2%	242	16.8%
30 to 44	435	58.9%	419	59.9%	854	59.4%
45 and over	202	27.4%	139	19.9%	341	23.7%
Union experience						
Apprentice (<4 years)	180	24.4%	238	34.0%	418	29.1%
Journeyman (>=4 years)	558	75.6%	461	66.0%	1019	70.9%
SIC codes						
Non-residential general contractor[a]	183	24.8%	212	30.3%	395	27.5%
Residential operative builder[b]	154	20.9%	110	15.7%	264	18.4%
Heavy construction[c]	54	7.3%	31	4.4%	85	5.9%
Specialty contractor[d]	135	18.3%	122	17.5%	257	17.9%
Drywall[e]	142	19.2%	134	19.2%	276	19.2%
All others	60	8.1%	80	11.4%	140	9.7%
Missing	*10*	*1.4%*	*10*	*1.4%*	*20*	*1.4%*
History of previous paid time off back injury claim						
No	618	83.7%	633	90.6%	1251	87.1%
Yes	119	16.3%	66	9.4%	185	12.9%
TOTAL	**738**		**699**		**1437**	

Note: Individual carpenters can be a case or a control during the 15 year period.
[a]SIC codes: 1541, 1542
[b]SIC codes: 1521, 1522, 1531
[c]SIC codes: 1611, 1622, 1623, 1629
[d]SIC codes: 1711, 1721, 1741, 1751, 1752, 1761, 1771, 1791, 1793, 1794, 1796, 1799
[e]SIC codes: 1742

Table 19. Characteristics for case and control back injury claims among Washington State Union Carpenters, 1989-2003

	Cases (claims with over 90 paid lost days)		Controls (claims with 1 to 30 paid lost days)		Total	
	n	%	n	%	n	%
Claim identified as back by ICD-9 code						
No	515	70%	641	92%	1156	80%
Yes	223	30%	58	8%	281	20%
Grouped by part[a]						
Neck	23	3%	5	1%	28	2%
Neck/Back	65	9%	71	10%	136	9%
Back	431	58%	560	80%	991	69%
Head/face	5	1%	0	0%	5	0%
Chest/abdomen	9	1%	9	1%	18	1%
Trunk multiple	19	3%	10	1%	29	2%
Multiple body parts	60	8%	21	3%	81	6%
Upper Extremity	76	10%	12	2%	88	6%
Lower Extremity	47	6%	11	2%	58	4%
Unclassified	2	0%	0	0%	2	0%
Missing	*1*	*0%*	*0*	*0%*	*1*	*0%*
Nature of Injury (ANSI coded)						
Sprain or strain	395	54%	553	79%	948	66%
Contusion	4	1%	12	2%	16	1%
Dislocation (herniated nucleus pulposus)	32	4%	7	1%	39	3%
Fracture	15	2%	6	1%	21	1%
Ill-defined symptoms	49	7%	50	7%	99	7%
Multiple injury types	226	31%	59	8%	285	20%
Other	5	1%	0	0%	5	0%
Missing	*12*	*2%*	*12*	*2%*	*24*	*2%*
Mechanism of injury (ANSI coded)						
Overexertion	419	57%	502	72%	921	64%
Bodily reaction	52	7%	58	8%	110	8%
Fall from elevation	102	14%	53	8%	155	11%
Fall from same level	54	7%	36	5%	90	6%
Struck against object	12	2%	8	1%	20	1%
Struck by object or person	52	7%	23	3%	75	5%
Motor vehicle crash	10	1%	1	0%	11	1%
Other	17	2%	2	0%	19	1%
Missing	*20*	*3%*	*16*	*2%*	*36*	*3%*

Table 19. (continued)

	Cases (claims with over 90 paid lost days)		Controls (claims with 1 to 30 paid lost days)		Total	
	n	%	n	%	n	%
ICD-9 grouping						
Sprain or strain	96	13%	223	32%	319	22%
Contusion	4	1%	8	1%	12	1%
Dislocation - not fracture[b]	26	4%	130	19%	156	11%
Symptom descriptor[c]	48	7%	17	2%	65	5%
Degenerative	50	7%	24	3%	74	5%
Company self-insured claim	34	5%	60	9%	94	7%
No back ICD-9/ANSI back	27	4%	64	9%	91	6%
Mixed back diagnoses[d]	426	58%	168	24%	594	41%
Other	4	1%	1	0%	5	3%
Spinal fractures	18	2%	1	0%	19	1%
Spinal cord injury	5	1%	0	0%	5	0%
First aid only	0	0%	3	0%	3	0%
TOTAL	**738**		**699**		**1437**	

ICD-9, International Classification of Disease; ANSI, American National Standards Institute
[a]Primary body part injured from ANSI or ICD-9 code
[b]Common diagnosis for chiropractic care
[c]Symptom descriptors include lumbago, back pain, etc.
[d]Mixed back diagnoses includes two or more ICD-9 codes

Table 20. Odds ratios (OR) and 95% confidence intervals (95% CI) for predictors of back injury claims with delayed return to work among Washington State Union Carpenters, 1989-2003

	Cases n=738	Controls n=699	OR	95% CI	CLR†	Adjusted OR*	95% CI	CLR†
Gender								
Male	709	686	**1.0**			**1.0**		
Female	26	11	**2.3**	1.1, 4.7	4.2	**2.7**	1.3, 5.5	4.3
Age at injury date								
Under 30	101	141	**1.0**			**1.0**		
30 to 44	435	419	**1.5**	1.1, 1.9	1.8	**1.2**	0.9, 1.7	1.9
45 and over	202	139	**2.0**	1.5, 2.8	2.0	**1.6**	1.1, 2.3	2.1
Union experience								
Apprentice (<4 years)	180	238	**1.0**			**1.0**		
Journeyman (>= 4 years)	558	461	**1.6**	1.3, 2.0	1.6	**1.4**	1.1, 1.8	1.7
Previous claim was paid time off back claim								
No	618	633	**1.0**			**1.0**		
Yes	119	66	**1.9**	1.3, 2.6	1.9	**1.8**	1.3, 2.5	1.9
Delay to medical care								
<30 days	668	679	**1.0**			**1.0**		
30 days or more	70	20	3.6	2.1, 5.9	2.8	**3.6**	2.1, 6.1	2.9

†CLR, Confidence Limit Ratio = upper confidence limit divided by the lower confidence limit [Poole, 2001]
*Multivariate model adjusted for all other variables in the table.
Note: Adjusted model n=1431: 5 missing values for sex, 1 missing value for history of back claim

Table 21. Odds ratios (OR) and 95% confidence intervals (95% CI) for predictors of back injury claims with delayed return to work among Washington State Union Carpenters (n=), 1989-2003

	Cases n=738	Controls n=699	Adjusted OR	95% CI	CLR†
SIC Codes*					
Non-residential general contractor[a]	183	212	**1.0**		
Residential operative builder[b]	154	110	**1.6**	1.1, 2.2	1.9
Heavy construction[c]	54	31	**2.0**	1.2, 3,2	2.7
Specialty contractor[d]	135	122	**1.3**	0.9, 1.7	1.9
Drywall[e]	142	134	**1.3**	0.9, 1.7	1.9
All others	60	80	**0.8**	0.6, 1.3	2.2
Missing	*10*	*10*			
Mechanism of injury (ANSI coded)*					
Overexertion	419	502	**1.0**		
Bodily reaction	52	58	**1.1**	0.7, 1.7	2.2
Struck against object	12	8	**1.8**	0.7, 4.7	6.5
Struck by object or person	52	23	**2.9**	1.7, 4.8	2.8
Fall from elevation	102	53	**2.7**	1.8, 3.8	2.1
Fall from same level	54	36	**1.7**	1.1, 2.8	2.5
Motor vehicle crash	10	1	**13.9**	1.7, 110.3	63.2
Other or missing	37	18	**2.5**	1.4, 4.6	3.3
Nature of Injury (ANSI coded)*					
Sprain or strain	395	553	**1.0**		
Ill-defined symptoms	49	50	**1.2**	0.8, 1.9	2.4
Contusion	4	12	**0.6**	0.2, 2.0	10.1
Dislocation (herniated nucleus pulposus)	32	7	**6.3**	2.7, 14.5	5.4
Fracture	15	6	**3.9**	1.5, 10.3	7.1
Multiple injury types	226	59	**5.4**	3.9, 7.4	1.9
Other and missing	17	12	**1.5**	0.7, 3.3	4.9

Table 21. (continued)

	Cases n=738	Controls n=699	Adjusted OR	95% CI	CLR†
ICD-9 Grouping*					
Sprain or strain	96	223	**1.0**		
Contusion	4	8	**1.5**	0.4, 5.0	11.8
Dislocation - not fracture	26	130	**0.5**	0.3, 0.8	2.7
Symptom descriptor	48	17	**5.8**	3.1, 10.7	3.4
Degenerative	50	24	**4.4**	2.5, 7.7	3.0
Company self-insured claim	34	60	**1.0**	0.6, 1.7	2.8
No back ICD9/ANSI=back	27	64	**0.9**	0.5, 1.6	2.9
Mixed back diagnoses	426	168	**5.8**	4.2, 7.8	1.8
Other	4	1	**7.5**	0.8, 73.5	96.3
Spinal fracture or cord injury	23	1	**55.8**	7.4, 420.8	56.9
First aid only	0	3	**No estimate**		

ICD-9, International Classification of Disease; ANSI, American National Standards Institute
†CLR, Confidence Limit Ratio = upper confidence limit divided by the lower confidence limit [Poole, 2001]
*Adjusted for gender, age, experience, previous claim was paid time off claim, and ≥30 day delay to care
[a]SIC codes: 1541, 1542
[b]SIC codes: 1521, 1522, 1531
[c]SIC codes: 1611, 1622, 1623, 1629
[d]SIC codes: 1711, 1721, 1741, 1751, 1752, 1761, 1771, 1791, 1793, 1794, 1796, 1799
[e]SIC codes: 1742

Table 22. Previous back injury claim and medical care as predictors of delayed return to work back injury claim

	Cases n=738	Controls n=699	Adjusted OR	95% CI	CLR†
Years between paid time off claims*					
4 or more	35	17	**1.8**	1.0, 3.3	3.3
3 to <4 years	15	5	**3.1**	1.1, 8.6	7.7
2 to <3 years	21	9	**2.3**	1.0, 5.1	4.9
1 to <2 years	18	11	**1.8**	0.8, 3.8	4.6
up to 1 year	30	24	**1.3**	0.7, 2.2	3.1
Zero	618	633	**1.0**		
Days lost in previous paid time off claim*					
90 or more days	46	7	**6.4**	2.9, 14.4	2.3
30 to 90 days	19	17	**1.0**	0.5, 2.0	3.9
1 to 30 days	54	42	**1.3**	0.9, 2.0	5.0
No paid lost days	618	633	**1.0**		
Previous recent care from private health insurance*					
Care in the previous year	174	121	**1.4**	1.1, 1.8	1.7
Care beyond 1 year	131	128	**0.9**	0.7, 1.2	1.8
No recent care	433	450	**1.0**		
Previous recent care from workers' comp*					
Care in the previous year	113	78	**1.5**	1.1, 2.1	1.9
Care beyond 1 year	127	99	**1.2**	0.9, 1.7	1.8
No recent care	498	522	**1.0**		

†CLR, Confidence Limit Ratio = upper confidence limit divided by the lower confidence limit [Poole, 2001]
*Adjusted for gender, age, experience, and ≥30 day delay to care

Figure 9. Proportion of delayed return to work (>90 days) back injury claims for Washington State Union Carpenters (1699 claims), 1989-2003

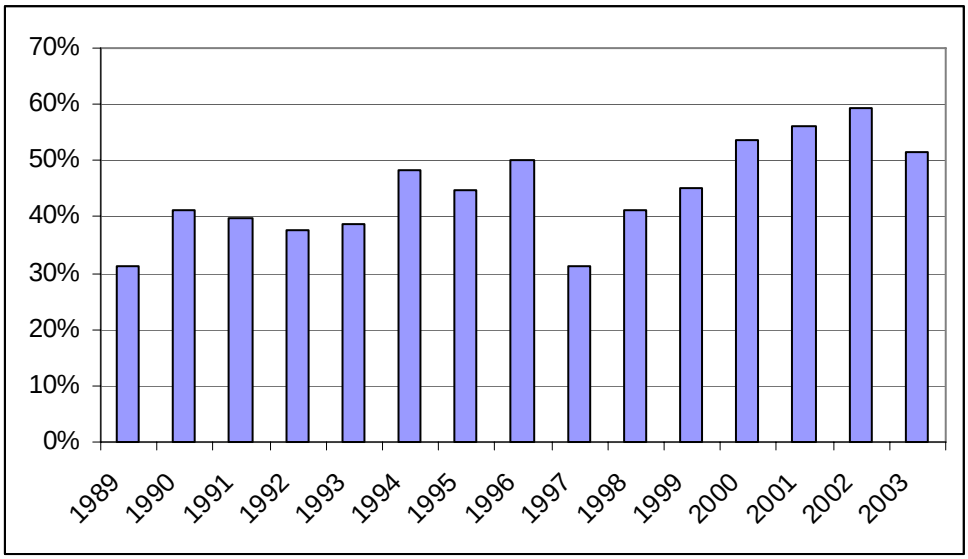


Figure 10. Days off work due to back injury claim for Washington State Union Carpenters (1699 claims), 1989-2003

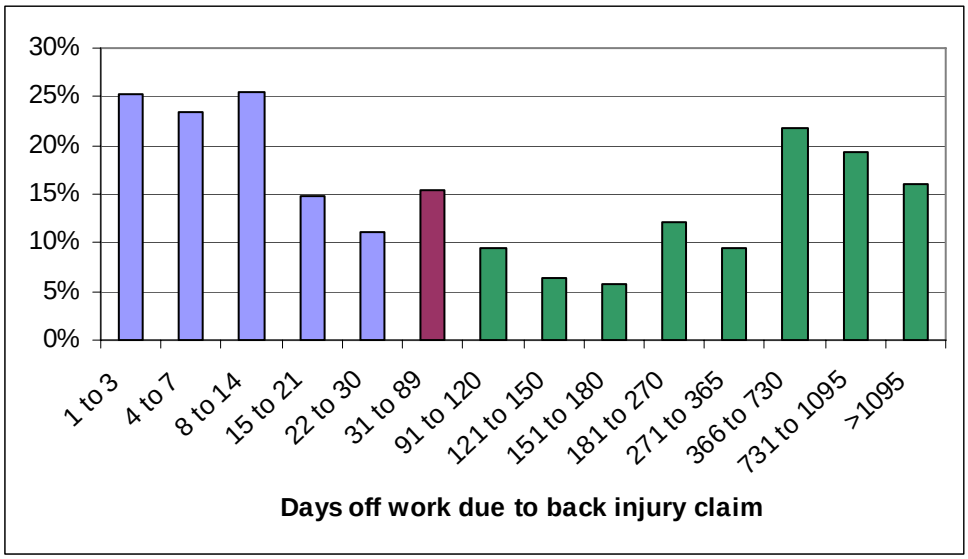
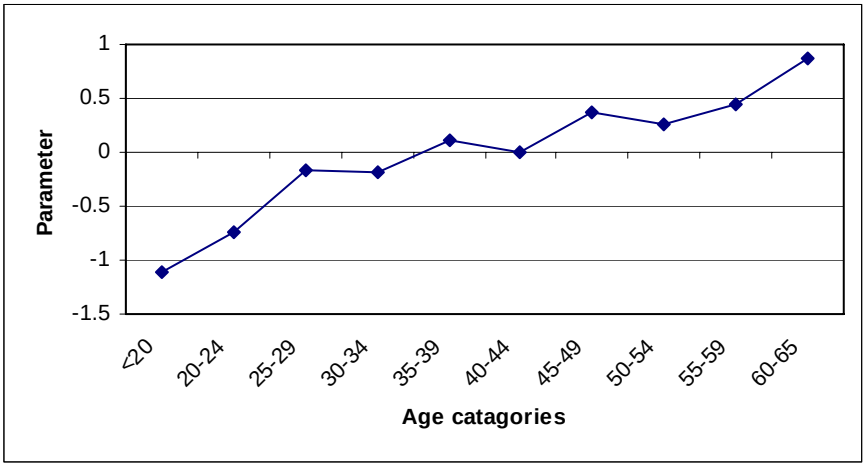


Figure 11. Linear trend for logistic regression parameters by 5-year age catagories



Health care costs for musculoskeletal back disorders, Washington State union carpenters, 1989-2003

Musculoskeletal back disorders accounted for $6,439, 909 in outpatient payments in 1,117,250 months of insurance eligibility. The overall payment rate was $6917 per 100 person-years of insurance eligibility (or $69 for every year of insurance eligibility). This represented 8.2% of outpatient payments for all conditions among cohort members over 15 years. The proportion of payments for back disorders varied some by year, ranging from a low of 6.5% in 2001 to a high of 10.8% in 1990, 1992, and 1993.

The pattern of yearly health care payments associated with musculoskeletal back disorders through their health care trust by cohort members is contrasted to their previously identified pattern of work-related back injuries of a musculoskeletal nature due to overexertion type activities (lifting, carrying, pushing, etc.) in Figure 12 (Lipscomb et al; 2008). As work-related back injuries declined steadily over 15 years, medical payment rates declined until 1995 after which time they gradually increased. However, payment rates for outpatient musculoskeletal back disorders were 16% lower in 2003 than in 1989. Examination of charges reveals a pattern very similar to that seen in Figure 4 for utilization. Overall outpatient cost rates for all conditions increased 9.7% over this 15-year period. Workers' compensation payment rates for overexertion back injuries, influenced by occasional very high costs cases, were less stable than injury rates, but they also declined over the 15-year period (Figure 13). [Note: In both figures, the two y axes show different scales pertinent to the sets of rates. Work-related back injury payment rates are based on hours of work while trust payment rates are based on months of health insurance eligibility.]

Payment rates for musculoskeletal back disorders for older individuals (over 30) and women were higher than for other workers. Payment rates for back disorders were lower among carpenters affiliated with locals whose members worked predominantly in residential or light construction, drywall installation and millwrighting compared with those in heavy commercial work (Table 23).

Health care payments for back diagnoses covered through trust insurance coverage increased among carpenters with each work-related back injuries (Table 24). The health insurance payment rates for workers with one work-related injury were 40% higher than for those with no history of work injury, while payment rates for those with 4 or more work-related injuries were nearly three times the payment rate for those with no prior work injury. Following the first work-related back injury claim, medical costs covered by health insurance increased 19% in the first year and 30% for each year thereafter (Table 25).

Table 23. Months of insurance eligibility, health insurance payments, payment rates and adjusted rate ratios, union carpenters Washington State, 1989-2003

	Months of insurance eligibility	Payments	Univariate payment rate[1,2] models (95% CI)	Multivariate adjusted RR[3] (95% CI)
Age				
< 20	5107	9,294	1971 (1269, 3162)	0.47 (0.29, 0.76)
20- < 30	173565	816,175	4610 (4290, 4954)	0.97 (0.82, 1.17)
30- < 40	356530	2,327,793	6512 (6197, 6841)	1.21 (1.05, 1.39)
40- < 50	311613	1,890,206	6104 (5788, 6436)	1.08 (0.94, 1.23)
50+	216410	1,341,323	5741 (5408, 6095)	1
Gender				
Female	19594	180,449	9096 (7373, 11220)	1.62 (1.16, 2.26)
Male	1043416	6,204,340	5846 (5681, 6017)	1
Time in the union				
< 1 year	74168	267,751	4034 (3577, 4552)	0.65 (0.54, 0.77)
1-< 2 years	77374	446,489	5910 (5297, 6595)	0.92 (0.78, 1.09)
2- <3 years	63253	360,222	5497 (4890, 6180)	0.85 (0.72, 1.00)
3- <4 years	54380	287,740	4896 (4323, 5547)	0.75 (0.65, 0.88)
4-<6 years	88948	475,988	5112 (4640, 5630)	0.79 (0.69, 0.91)
6-<8 years	69945	402,054	5548 (4974, 6188)	0.84 (0.71, 1.00)
8-<10 years	64755	362,243	5464 (4871, 6130)	0.82 (0.70, 0.95)
10 years and over	573177	3,784,083	6449 (6207, 6700)	1
Predominant work				
Residential	14394	71,156	5090 (3973, 6520)	0.98 (0.68, 1.41)
Light commercial	125004	645,991	4909 (4521, 5331)	0.83 (0.70, 0.98)
Drywall	188316	1,087,227	5627 (5264, 6015)	0.87 (0.75, 1.01)
Millwright	20781	93,991	4462 (3647, 5460)	0.65 (0.49, 0.88)
Pile driver	60430	345,033	5764 (5116, 6494)	0.90 (0.71, 1.14)
Mixed commercial	462806	2,904,370	6219 (5959, 6490)	1.01 (0.88, 1.14)
Out of Washington	17065	125,816	6746 (5449, 8354)	1.20 (0.88, 1.63)
Heavy commercial	155290	988,519	6323 (5878, 6803)	1

[1] Rates are per 100 person- years of insurance eligibility
[2] Negative binomial regression model
[3] Negative binomial regression model with generalized estimating equations

Table 24. Health insurance outpatient payment rates and adjusted rate ratios for musculoskeletal back diagnoses by the number of work-related claims, union carpenters Washington State, 1989-2003

Number of WC Claims	Payment rate[1] (95% CI)	Adjusted Rate Ratio[2] (95% CI)
None	5158 (4992, 5330)	1
One	7296 (6817, 7808)	1.40 (1.26, 1.55)
Two	9145 (8052, 10386)	1.68 (1.41, 2.00)
Three	10362 (8358, 12847)	1.92 (1.51, 2.44)
Four or more	15164 (11210, 20514)	2.93 (2.06, 4.17)

[1] Rates are dollars per 100 person- years of insurance eligibility; negative binomial regression.
[2] Adjusted for age, gender, time in the union, predominant type of work; negative binomial regression with generalized estimating equations.

Table 25. Stratified health insurance payment rates and adjusted rate ratios based on calendar time since work-related back injury, union carpenters Washington State, 1989-2003

	Stratified rate[1] of utilization (95% CI)	Adjusted RR[2] (95% CI)
Time since work injury		
Less than 1 year	8030 (6589, 9787)	1.19 (0.99, 1.43)
1-<3 years	8892 (7592, 10414)	1.30 (1.08, 1.58)
3-<5 years	9365 (7797, 11248)	1.33 (1.05, 1.70)
5+ years	9035 (7877, 10363)	1.32 (1.04, 1.68)
No prior work injury	5501 (5338, 5670)	1

[1] Rates are per 100 person- years of insurance eligibility
[2] Adjusted for age, gender, time in the union, predominant type of work, and calendar time; negative binomial regression with generalized estimating equations.

Figure 12a. Outpatient health insurance payment rates for musculoskeletal back diagnoses paid through the Carpenters Trusts of Western Washington compared with workers' compensation injury rates for overexertion back disorders, 1989-2003

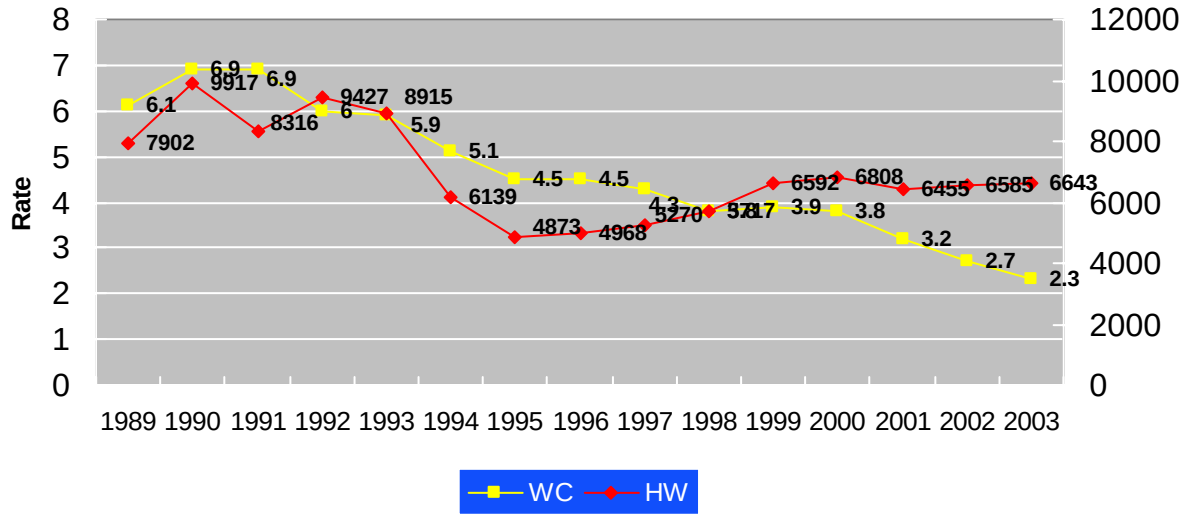
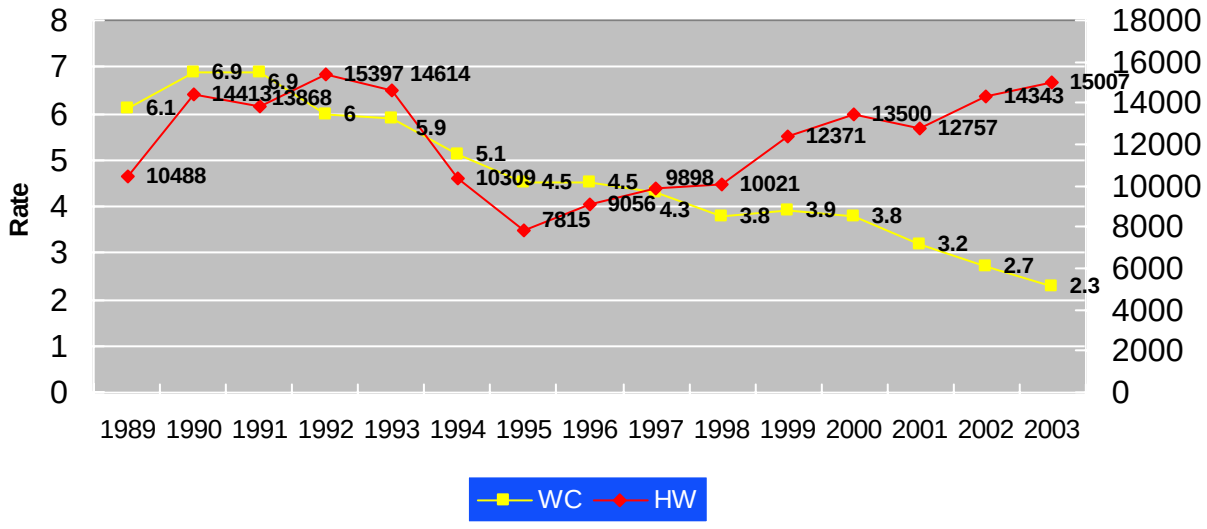
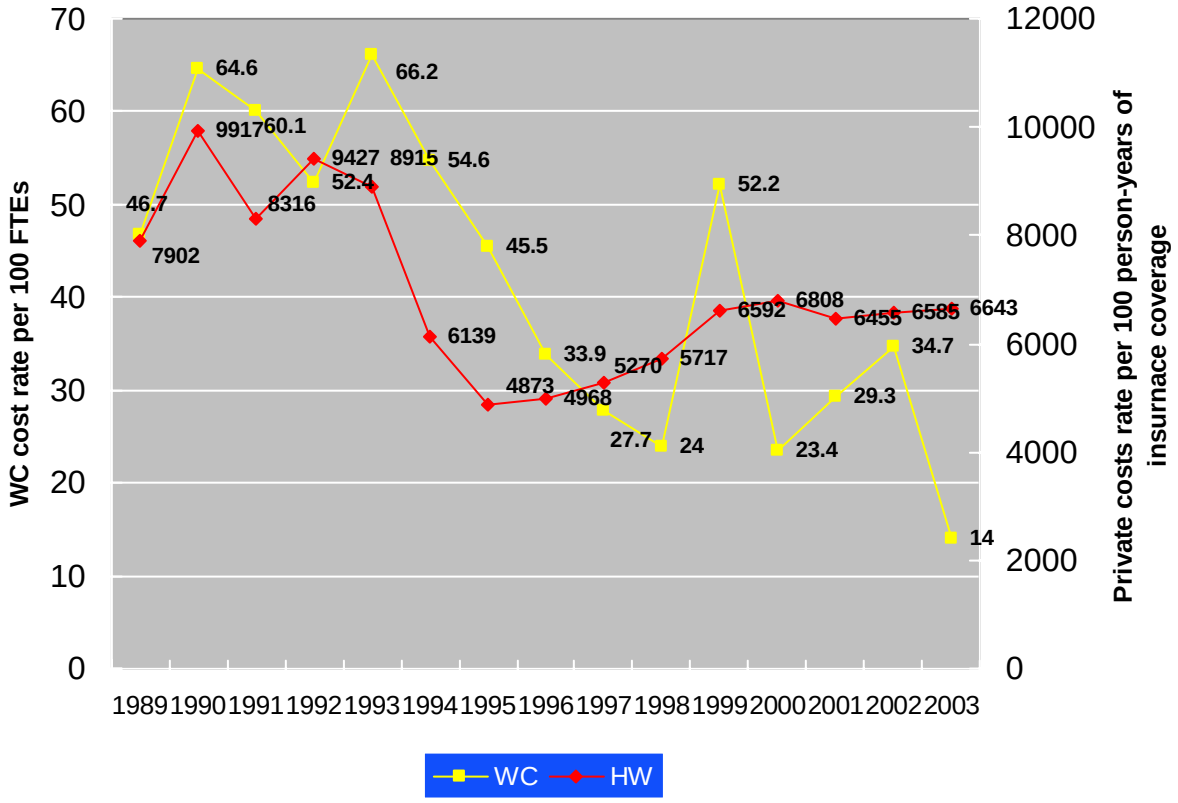


Figure 12b. Outpatient health insurance <u>charge rates</u> for musculoskeletal back diagnoses, Carpenters Trusts of Western Washington compared with workers' compensation injury rates for overexertion back disorders, 1989-2003



WC=overexertion injury rates per 100 person years (200,000 hrs worked)
HW=User rates for back care of MS nature per 100 person years of insurance eligibility; limited to one visit per day per person

Figure 13. Outpatient health insurance payment rates for musculoskeletal back diagnoses paid through the Carpenters Trusts of Western Washington compared with workers' compensation costs payment rates for overexertion back disorders, 1989-2003



Relationships between medical care and paid lost days from work after work-related back injury among Washington State union carpenters

Characteristics of work-related injuries and injured workers

A total of 2959 musculoskeletal back injury claims were filed over the 15 year period by 2287 different carpenters; these represented 74% of all work-related back injury claims filed for the cohort. The majority of carpenters reported only one overexertion/bodily reaction claim (77%); 16% reported two claims, 5% reported three claims, and 2% reported four or more claims. Most work-related musculoskeletal back injuries resulted in no paid lost work days (62%); 17% had 1 to 30 work days off, 6% missed 31 to 90 work days, and 15% missed over 90 work days.

The majority of work-related musculoskeletal back injury claims were among carpenters over age 30 (80%) and those with four or more years experience (71%) carpenters (Table 26). Overall, the proportion of claims with a previous history of back injury claim increased as paid lost days increased (Table 26, $p<0.05$).

In 8% of the work-related injuries we could identify other injured body parts besides the back; this percentage tended to increase as number of paid lost days increased (Table 27, $p<0.05$). ANSI nature of injury included predominantly strains and sprains, multiple injuries, and ill-defined symptoms. ICD-9 coded injury types included strain/sprain, mixed diagnosis, non-fracture dislocations, and claims with no back ICD-9 but identified as back in ANSI. A greater number of paid lost days from work were observed among those with mixed and degenerative diagnoses (Table 27). The opposite pattern was observed for strains/sprains and non-fracture dislocations.

Workers' compensation care for the back injury claims

2938 out of 2959 overexertion/bodily reaction claimants (99%) received medical treatment through the workers' compensation system for their injury (Table 28) for a total of 74,013 back injury provider encounters. Over the entire period of workers' compensation treatment, about half of injured carpenters received care from multiple providers (1617/2938). The most common combinations included: general, specialist, and physical therapy (18%); general and specialist (11%); general, specialist, chiropractor, and physical therapy (10%); and general and physical therapy (10%).

The first day of workers' compensation care after injury there were 3750 provider encounters; 80% (2351/2938) had only one provider encounter on the first day. Encounters on the first day included predominantly chiropractors (31%) and general practitioners (29%) followed by specialist (12%), hospital or ER (11%), other (10%), physical therapy (2%), and occupational medicine (1%) (Table 28). Twenty-one percent received x-rays on the first day of workers' compensation care. Within specialist category, encounters with radiology (54%) and orthopedics (24%) were most common, followed by physical medicine and rehab (7%), general surgery (7%), neurology or neurosurgeon (4%), sports medicine (2%), OB/GYN (2%), and other (1%).

For the first 30 days after the claim date, the mean number of encounters per provider type increased with increasing paid time loss category – no PLD, 1 to 30 PLD, 31 to 90 PLD, and >90 PLD: specialists (0.3, 0.4, 1.1, 1.4), general practitioners (0.8, 1.1, 1.7, 1.5), and physical therapy (0.4, 1.0, 2.4, 1.8).

Provider encounters by ICD-9 diagnosis: A majority of strains/sprains (67%) were ever seen by general practitioners, the majority of symptom descriptors (55% and 58%) and degenerative conditions (57% and 58%) were ever seen by either general practitioners or specialists, and almost all non-fracture dislocations (99%) were ever seen by chiropractors. Spinal fracture/cord injury, other ICD-9 coded injuries, and mixed back diagnosis injuries had the highest median (54, 48, and 30 visits) and mean (53, 48, and 48 visits) number of total provider encounters. Mixed back diagnoses were first diagnosed most often as sprain/strain (45%), non-fracture dislocation (19%), or symptom descriptor (10%).

Delays to care: The majority of injured carpenters received treatment for work-related injury by a workers' compensation provider within 7 days (82%) – 95% within 30 days. For the 5% with >30 days to provider treatment, paid lost days increased with the proportion of delayed care (Table 29).

Physical therapy: Mean and median days to physical therapy within the first year after the injury date indicate that as the number of paid lost days increased the mean and median days to physical therapy increased (Table 29). Similarly, the proportion of claims with a delay to physical therapy increased as the amount of paid lost days increased (Table 29). Specifically, among those out of work the longest (>90 paid lost days), physical therapy after the first 30 days was one and a half times as prevalent as physical therapy within the first 30 days (prevalence ratio, (43% / 29%) = 1.5). A substantial number of claims never received physical therapy: 38% of claims with 31 to 90 paid lost days and 27% of claims with >90 paid lost days.

Carpenter Trust payment for a back injury post back injury claim

Eleven percent (340/2959) of claimants had a Carpenter Trust payment health care visit for a musculoskeletal back injury within 90 days after the claim injury date; of these, the majority had their first visit within 30 days (73%). Of the 369 initial Carpenter Trust payment provider encounters, most were to a chiropractor (41%), followed by general practitioners (24%), specialists (11%), hospital/ER (8%), physical therapists (1%), or other (1%) (Table 28). The proportion of claims with Carpenter Trust payment visits within 90 days increased as paid lost time increased (9% no PLD, 10% 1-30 PLD, 14% 31-90 PLD, and 22% >90 PLD).

Venn diagrams were used to illustrate potential overlap in the two care systems during the first year after the injury date. Comparing the first 90 days to the period of 91 to 365 days after the injury date, workers' compensation care only was more prevalent during the first 90 days (81% versus 64%) while Carpenter Trust payment care only (0.2% versus 3%) and care in both systems (19% versus 33%) was more prevalent after the first 90 days (Figure 14). Overlap between care systems did not differ substantially by categories of paid lost days except for claims with >90 days of paid lost days (Table 30). Among claims with at least one paid lost day

from work, contrasting care overlap before and after return to work (RTW) indicates increased prevalence of Carpenter Trust payment care only and care from both systems after RTW (Figure 15).

History of Workers' Compensation or Carpenter Trust payment for Back Injury

Roughly one third of claims had a previous history of back injury care (28% workers' compensation and 36% Carpenter Trust payment) totaling 23,689 outpatient workers' compensation medical visits and 16,077 Carpenter Trust payment visits. We examined workers' compensation or Carpenter Trust payment utilization in the prior one, three, or five years overall and stratified by provider type (Table 31 and 32).

Any workers' compensation (Table 31) or Carpenter Trust payment (Table 32) care in the previous year was associated with an increased number of paid lost days. The proportion with prior physical therapy through workers' compensation increased as paid lost days increased for all three categories. Cell sizes for physical therapy through Carpenter Trust payment were too sparse to examine. The proportion of workers' compensation specialist encounters increased as paid lost days increased in the prior 5 years but not for 1 or 3 years. Conversely, we observed a significant difference for Carpenter Trust payment specialist encounters in prior one and three years but not for five years. No differences were observed for chiropractor encounters in either payment system.

Table 26. Demographic characteristics of work-related musculoskeletal back injury claimants by categories of resulting paid lost days from work, Washington State Union Carpenters, 1989 to 2003 (n=2959)

	No PLD		PLD 1 to 30		PLD 31 to 90		PLD >90		TOTAL	
	n	%	n	%	n	%	N	%	n	%
Total	1832		511		169		445		2959	
Age										
under30	401	**22%**	101	**20%**	30	**18%**	58	**13%**	590	**20%**
30 to 44	1061	**58%**	314	**61%**	102	**60%**	272	**61%**	1749	**59%**
>=45	369	**20%**	96	**19%**	37	**22%**	115	**26%**	617	**21%**
Gender										
Male	1795	**98%**	500	**98%**	163	**97%**	429	**97%**	2889	**98%**
Female	30	**2%**	9	**2%**	5	**3%**	14	**3%**	58	**2%**
Unknown									12	
Apprentice	535	**29%**	168	**33%**	41	**24%**	108	**24%**	852	**29%**
Journeyman	1297	**71%**	343	**67%**	128	**76%**	337	**76%**	2107	**71%**
History of work-related back injury										
Yes	489	**27%**	130	**25%**	58	**34%**	160	**36%**	837	**28%**
No	1343	**73%**	381	**75%**	111	**66%**	285	**64%**	2122	**72%**

Table 27. Characteristics of the work-related musculoskeletal back injuries by categories of resulting paid lost days from work among Washington State Union Carpenters, 1989 to 2003 (n=2959)

	No PLD		PLD 1 to 30		PLD 31 to 90		PLD >90		TOTAL	
	n	%	n	%	n	%	N	%	n	%
Body Part										
Back	1516	**83%**	437	**86%**	137	**81%**	317	**71%**	2407	**81%**
Back/neck	216	**12%**	47	**9%**	14	**8%**	34	**8%**	311	**11%**
Other body part*	99	**5%**	27	**5%**	18	**11%**	94	**21%**	238	**8%**
ANSI Nature										
Sprain/strain	1622	**89%**	446	**87%**	131	**78%**	294	**66%**	2493	**84%**
Ill-defined symptoms	101	**6%**	32	**6%**	14	**8%**	32	**7%**	179	**6%**
Contusion	1	**0%**	2	**0%**	0	**0%**	0	**0%**	3	**0%**
Dislocation (HNP)	23	**1%**	5	**1%**	4	**2%**	26	**6%**	58	**2%**
Fracture	0	**0%**	1	**0%**	0	**0%**	2	**0%**	3	**0%**
Multiple injuries and ICD9 ID	79	**4%**	25	**5%**	17	**10%**	85	**19%**	206	**7%**
Other	6	**0%**	0	**0%**	3	**2%**	6	**1%**	15	**1%**

Table 27 (cont)

ICD-9 Diagnosis										
Nerve injury	1	**0%**	0	**0%**	0	**0%**	0	**0%**	1	**0%**
Contusion	3	**0%**	0	**0%**	0	**0%**	0	**0%**	3	**0%**
Dislocation not fracture	428	**23%**	112	**22%**	11	**7%**	11	**2%**	562	**19%**
Strain/sprain	685	**37%**	175	**34%**	32	**19%**	56	**13%**	948	**32%**
Symptom descriptor	32	**2%**	7	**1%**	4	**2%**	22	**5%**	65	**2%**
Degenerative	63	**3%**	21	**4%**	11	**7%**	32	**7%**	127	**4%**
First aid only	18	**1%**	3	**1%**	0	**0%**	0	**0%**	21	**1%**
No back ICD9, ANSI=back	252	**14%**	53	**10%**	13	**8%**	21	**5%**	339	**11%**
Mixed diagnosis	348	**19%**	139	**27%**	97	**57%**	298	**67%**	882	**30%**
Other	2	**0%**	1	**0%**	0	**0%**	2	**0%**	5	**0%**
Spinal fracture or cord injury	0	**0%**	0	**0%**	1	**1%**	3	**1%**	4	**0%**

Table 28. First health care provider encounters after work-related musculoskeletal back injury claim by categories of resulting paid lost days from work, Washington State Union Carpenters, 1989 to 2003 (2959 claims)

	Workers' Compensation		Carpenter Trust payment within 90 days after work-related injury claim**	
	n	**%**	**n**	**%**
Claims with no care	21	**0.7%**	1437+1182	**49+40%**
Claims with care	2938	**99.3%**	340	**11%**
Provider Grouped				
Number of visits first day*	3750	**100%**	369	**100%**
General	1073	**29%**	89	**24%**
Occupational Medicine	54	**1%**	0	**0%**
Specialty	456	**12%**	42	**11%**
Chiropractor	1165	**31%**	153	**41%**
Physical Therapy	58	**2%**	4	**1%**
Hospital or ER	425	**11%**	31	**8%**
Other	382	**10%**	3	**1%**
Unknown	-	**-**	37	**10%**
Missing	126	**3%**	10	**3%**

*Note: Claimant could see more than one provider on the first day.
**Note: n=1182 received Carpenter Trust payment care >90 days after the work-related injury claim

Table 29. Delays to care and physical therapy after workers' compensation injury stratified by categories of resulting paid lost days from work, Washington State Union Carpenters, 1989 to 2003 (2959 claims)

	No PLD		**PLD 1 to 30**		**PLD 31 to 90**		**PLD >90**		**Total**		**P value**
	n	**%**	n	**%**	N	**%**	n	**%**	n	**%**	P
Days to first workers' comp care*											
No comp care	16		3		2		0		23		
0 days	544	30%	144	28%	44	26%	95	21%	827	28%	
1 to 7 days	956	53%	318	63%	92	55%	208	47%	1574	54%	
8 to 30 days	237	13%	39	8%	22	13%	90	20%	388	13%	
>30 days	79	4%	7	1%	9	5%	52	12%	147	5%	<.0001
Days to first workers' comp care*											
Mean (SD)	7.6 (19.7)		3.8 (11.3)		7.9 (20.5)		21.7 (77.5)		8.5 (35.0)		
Range	0 to 366		0 to 177		0 to 145		0 to 837		0 to 837		
Median	1		1		2		3		2		
Delay to first therapy*											
no therapy	1552	85%	388	76%	64	38%	122	27%	2125	72%	
0 to 30 days	183	10%	99	19%	67	40%	131	29%	480	16%	
>30 days	97	5%	24	5%	38	22%	192	43%	352	12%	<.0001
Days to first therapy											
Mean (SD)	40.6 (57.8)		24.9 (47.1)		38.8 (49.3)		75.4 (82.7)		51.7 (69.4)		
Range	0 to 310		0 to 313		1 to 312		0 to 362		0 to 362		
Median	14.5		9		21		44		21		

PLD, paid lost days from work, Note: Chi-square p-value tests location shifts or trends by categories of paid lost time (Row Mean Scores Differ), *n=2 missing claim date

Table 30. Overlap in claims with workers' compensation and Carpenter Trust payment care during 1 year period after the claim stratified by paid lost day status, Washington State Union Carpenters, 1989 to 2003

	No PLD days		**PLD 1 to 30**		**PLD 31 to 90**		**PLD >90**	
Overlap in care	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Both systems	437	**24%**	130	**26%**	43	**26%**	146	**33%**
Workers' compensation only	1380	**76%**	378	**74%**	124	**74%**	294	**67%**
Carpenter Trust payment only	4	**0%**	0	**0%**	1	**1%**	0	**0%**
TOTAL	**1821**		**508**		**168**		**440**	

Table 31. Previous Workers' Compensation back injury care: provider encounters in the previous 1, 3, and 5 years stratified by categories of resulting paid lost days from work, Washington State Union Carpenters, 1989 to 2003 (2959 claims)

	No PLD		PLD 1 to 30		PLD 31 to 90		PLD >90		Total		P value
	N	%	n	%	N	%	n	%	n	%	P
Any comp											
Past 1 year?	193	**11%**	57	**11%**	30	**18%**	67	**15%**	347	**12%**	0.0014
Past 3 years?	348	**19%**	96	**19%**	51	**30%**	113	**25%**	608	**21%**	0.0003
Past 5 years?	409	**22%**	113	**22%**	57	**34%**	138	**31%**	717	**24%**	<0.0001
Therapy											
Past 1 year?	29	**2%**	9	**2%**	9	**5%**	23	**5%**	70	**2%**	<0.0001
Past 3 years?	65	**4%**	19	**4%**	13	**8%**	44	**10%**	141	**5%**	<0.0001
Past 5 years?	80	**4%**	27	**5%**	13	**8%**	55	**12%**	175	**6%**	<0.0001
Chiropractor											
Past 1 year?	99	**5%**	29	**6%**	11	**7%**	23	**5%**	162	**5%**	0.98
Past 3 years?	189	**10%**	55	**11%**	22	**13%**	41	**9%**	307	**10%**	0.79
Past 5 years?	236	**13%**	65	**13%**	26	**15%**	51	**11%**	378	**13%**	0.65
Specialist											
Past 1 year?	55	**3%**	14	**3%**	19	**11%**	27	**6%**	115	**4%**	<0.0001
Past 3 years?	115	**6%**	25	**5%**	28	**17%**	61	**14%**	229	**8%**	<0.0001
Past 5 years?	144	**8%**	32	**6%**	29	**17%**	78	**18%**	283	**10%**	<0.0001

Note: Chi-square p-value tests location shifts or trends by categories of paid lost time (Row Mean Scores Differ)

Table 32. Previous Carpenter Trust payment care for back injury: provider encounters for back related care in the past 1, 3, and 5 years stratified by categories of resulting paid lost days from work, Washington State Union Carpenters, 1989 to 2003 (2959 claims)

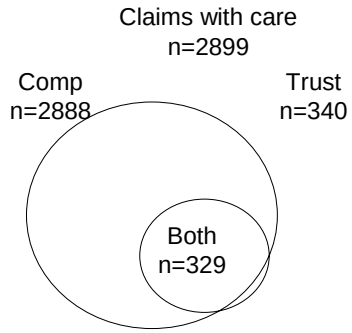
	No PLD		**PLD 1 to 30**		**PLD 31 to 90**		**PLD >90**		**Total**		**P value**
	n	**%**	n	**%**	n	**%**	n	**%**	n	**%**	P
Carpenter Trust payment care											
Past 1 year?	296	**16%**	83	**16%**	34	**20%**	107	**24%**	520	**18%**	0.0001
Past 3 years?	499	**27%**	129	**25%**	52	**31%**	142	**32%**	822	**28%**	0.052
Past 5 years?	573	**31%**	147	**29%**	58	**34%**	158	**36%**	936	**32%**	0.10
Therapy											
Past 1 year?	6	**0%**	2	**0%**	0	**0%**	5	**1%**	13	**0%**	0.06
Past 3 years?	16	**1%**	4	**1%**	2	**1%**	11	**2%**	33	**1%**	0.008
Past 5 years?	24	**1%**	5	**1%**	3	**2%**	14	**3%**	46	**2%**	0.01
Chiropractor											
Past 1 year?	218	**12%**	66	**13%**	18	**11%**	66	**15%**	368	**12%**	0.15
Past 3 years?	367	**20%**	90	**18%**	34	**20%**	89	**20%**	580	**20%**	0.88
Past 5 years?	418	**23%**	106	**21%**	37	**22%**	101	**23%**	662	**22%**	0.81
Specialist											
Past 1 year?	23	**1%**	4	**1%**	5	**3%**	16	**4%**	48	**2%**	0.0004
Past 3 years?	52	**3%**	13	**3%**	9	**5%**	30	**7%**	104	**4%**	<0.0001
Past 5 years?	71	**4%**	16	**3%**	10	**6%**	36	**8%**	133	**4%**	0.0002

Note: Chi-square p-value tests location shifts or trends by categories of paid lost time (Row Mean Scores Differ)

Figure 14. Overlap in workers' compensation and Carpenter Trust payment care during the first year after the injury date

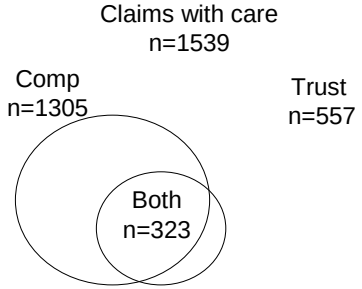
All claims

0 to 90 day interval



Overlap in care	n	%
Both systems	329	11%
Workers' Comp only	2559	88%
Carpenters Trust only	11	0.4%

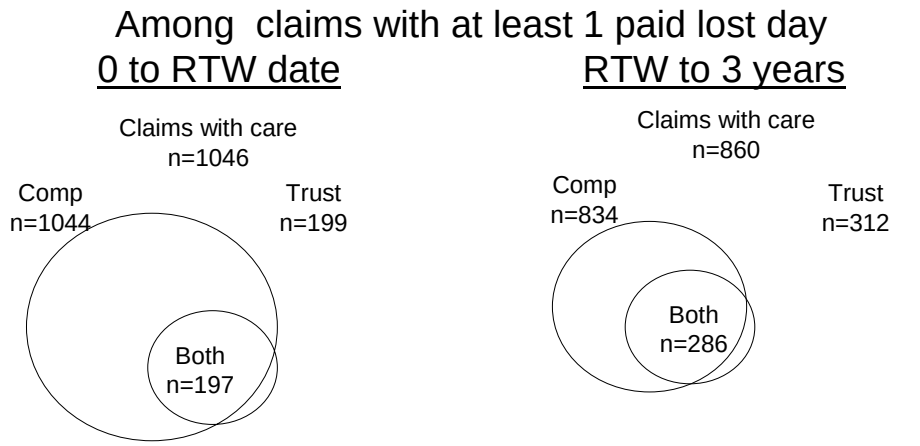
91 to 365 day interval



Overlap in care	n	%
Both systems	323	21%
Workers' Comp only	982	64%
Carpenters Trust only	234	15%

NOTE: Venn diagrams are not proportionally scaled.

Figure 15. Overlap in workers' compensation and Carpenter Trust payment care after return to work (RTW) among claims with at least one paid lost day from work.



Overlap in care	n	%
Both systems	197	19%
Workers' Comp only	847	81%
Carpenters Trust only	2	0.2%

Overlap in care	n	%
Both systems	286	33%
Workers' Comp only	548	64%
Carpenters Trust only	26	3%

NOTE: Venn diagrams are not proportionally scaled.

DISCUSSION

By combining data from multiple sources for this retrospective cohort we have learned a considerable amount about back injuries in these union carpenters. Back injuries accounted for an average of over six injuries per 100 fulltime carpenters over this 15 year period, and they were responsible for nearly one-fifth of workers' compensation claims filed by the cohort. Injury rates declined significantly over time consistent with the overall decline of injuries among this group and others that have been reported [Lipscomb et al., 2003a; Murphy and Volinn, 1999; NIOSH, 2004; US DOL, BLS, 2005, 2007; Center to Protect Workers Rights, 2002 and 2007], but at the same time their rates of utilization for musculoskeletal back injuries through their private health care trust increased.

The back injury rates we observed among this cohort of carpenters are considerably higher than those reported by the Bureau of Labor Statistics, providing additional evidence that the Bureau of Labor Statistics data under estimate work-related injury risk [Lipscomb et al., 1996; Glazner et al., 1998; Rosenman et al., 2006]. The BLS reported work-related injury or illness rates of 6.8 per 100 full-time construction workers in 2003 [US DOL, BLS, 2005]. Among this well-defined cohort we observed an injury rate of 3.8 per 100 full-time carpenters for back injuries alone in that year. In light of the insured private health care access among this cohort of union workers, the findings are even more compelling.

Although a number of the rate ratios are modest, they are based on internal comparisons of a population with high injury rates. It is of note that, consistently, the effect of age was diminished when adjusting for time in the union. From these data we cannot determine whether differences in risk by union tenure represent inexperience, different exposures based on seniority, or perhaps both. The decline in overexertion injury rates after four years in the union, or the end of the typical apprenticeship period, certainly raises suspicions that apprentices may be more heavily involved in manual materials handling.

During this period of time when work-related musculoskeletal back injuries among this cohort decreased steadily and dramatically [Lipscomb, 2008], their health care utilization rates through their private insurance followed a different pattern. Utilization rates ended in 2003 over twice as high as in 1989. This pattern of utilization raises concern that some work-related care for back disorders could have shifted to the carpenters' health care trust, particularly in later years. There was a marked increase in outpatient utilization rates through the trust for other diagnoses during this time period as well, but it followed a different pattern than those for back disorders.

Rates of utilization through the trust were increased in the first 3-5 years following a work-related back injury with slightly different patterns associated with a prior overexertion work injury compared to a prior back injury from acute trauma. The magnitude of the rate increase in the first year following a work injury is consistent with the report of increased health care utilization among health care workers who had experienced a musculoskeletal work injury in British Columbia [Koehorn et al., 2006]. Although we limited our before and after analyses to individuals with only one back injury, we saw a steady increase in utilization for back diagnoses through the trust as the number of work-related back injuries increased. This finding is

consistent with the chronic nature of some back problems even among the employed [Koehorn, 2006; Carey, 1999; Carey, 2000; Rosenman, 2006].

Time in union was associated with work injuries [Lipscomb, 2008] and utilization through the trust; those with less union experience were at greater risk of injuries and had higher health care utilization. Individuals who were affiliated with locals who did residential carpentry had higher rates of work-related injury and utilization through the trust, particularly. These findings suggest that work-related risk factors or exposures may be playing a role in health care utilization for musculoskeletal back problems through the trust as well as in their work-related injury experiences.

In any workforce including the construction trades, it cannot be assumed that all work-related illnesses, or even injuries, will be captured in workers' compensation data [Biddle, 1998; Shannon, 2002; Fan, 2006; Carey, 2000; Breslin, 2007; Blessman, 1991]. Even after a person chooses to seek medical care, there appear to be factors which influence whether an individual chooses to seek care through the compensation system. For example, Fingar [1992] reported that younger workers were more likely to seek emergency room care than older workers, but they were less likely to file a compensation claim [Fingar, 1992]. In contrast to some concerns of cost-shifting to compensation, these carpenters describe the ease of seeking care outside the compensation system for injuries that are not likely to keep them out of work. These jointly trusteed health care funds have traditionally had close alliances with the populations they serve; some report that seeking care through their private union-provided insurance is less trouble than dealing with workers' compensation.

It is important to recognize that we were studying health care utilization and reported work-related injuries. However, the data also provided information about trends in health care use among these construction workers over 15 years. We know that there was some misclassification in the identification of incident injuries based on lack of knowledge of work-related claims that occurred among cohort members prior to 1989 when we were able to first gain data access. Misclassification, if present, would likely have attenuated the differences in rates we observed before and after injury.

Relatively little is known about the delivery of health services to construction workers, and these analyses provide important information. Construction workers have one of the highest proportions of working individuals without private health insurance, and lack of coverage is more prevalent among non-union workers [CPWR, 2007]. Even among union construction workers, such as these, coverage may lapse during periods of unemployment. Eligibility for benefits is typically based on having worked a required number of hours, however workers are allowed to "bank" hours to cover eligibility requirements during periods of time when they are unable to work due to lack of available work, illness, or disability. We recognize that our findings are not generalizable to a workforce without health insurance coverage, but the payment for work-related conditions through other sources is not limited to privately insured workers. The recent report of Dong et. al., [2007] documented that less than half of total medical expenses for work-related injuries were paid by workers' compensation with greater disparities among

Hispanic construction worker [Dong, 2007]. Costs were not just borne by private insurance sources, but also through public mechanisms as well as by workers and their families.

These data also allowed us to describe payments for back disorders through the workers' compensation system and through the CTWW. Specifically, we were able to compare patterns of resource use over time and among different sub-groups of workers based on age, union tenure, and their predominant type of work, as well as for different mechanisms of injury.

The analyses confirm a significant, but decreasing, economic burden for back injuries reported through the workers' compensation system among these union carpenters for medical care and lost work time. The decline reflects both declining costs associated with acute back injuries over time as well as the previously described decrease in overexertion injury rates among this cohort between 1989 and 2003 [Lipscomb et al, 2008]. Acute back injuries were responsible for a disproportionate share of costs among these carpenters compared with overexertion injuries consistent with patterns seen in other industries as well as construction [Murphy and Courtney, 2000].

Some of the adjusted cost ratios we report contrast with earlier described patterns of injury risk among this cohort. For example, younger carpenters and those with less union tenure have higher rates of back injuries [Lipscomb et al., 2008], while payment rates are higher among injured older carpenters.

It is fairly well recognized that age is associated with delayed return to work following injury and this cohort is no exception. Older workers may not be more at risk of injury, but when they do experience injuries, the consequences are more severe. For example, workers over 45 years of age who sustain a work-related back injury requiring time away from work are less likely to return to work than younger workers [Dasinger et al., 1999; Gluck and Oleinick, 1998; McIntosh et al., 2000; Oleinick, Gluck, and Guire,1996]. It is of note that among these carpenters, indemnity payment rates increased with increasing age as did medical payment rates, providing some indication that the injuries of older workers may be more severe and that older workers may be more difficult, or less likely, to be accommodated in this heavy industry.

Return to work may mark the end of the first episode of work disability [Baldwin, Johnson, and Butler, 1996], but many people with back problems continue to have problems which require modification of activities [Carey,1995; Pransky et al., 2000; Von Korff, 1994]. Among this cohort we saw increasing costs associated with second and third back injury claims, particularly if they were of a musculoskeletal nature as well as very high costs among the small group of carpenters who experienced multiple back injuries. Prevention of additional injuries via accommodation may be important to prevent subsequent more expensive injuries.

These findings are consistent with the disproportionate burden of costs from recurrent back pain related to care seeking and work disability among workers in multiple industries in New Hampshire reported by Wasiak, Kim and Pransky [2006]. While secondary prevention may be warranted, among these workers we have been unable to identify factors that are strongly associated with recurrent back injuries other than prolonged work disability with the initial injury

[Lipscomb et al, 2009]. With only 5% of these injured carpenters experiencing a month or more of time away from work with their first injury, targeted secondary prevention that will have substantive impact on costs among this population is difficult to operationalize.

Among this cohort of union carpenters with private health insurance coverage, medical care for musculoskeletal back disorders was responsible for $69 in outpatient costs for every year of insurance eligibility between 1989 and 2003. There was a steady increase in costs for back diagnoses through their health and welfare fund as the number of work-related back injuries increased. The health insurance cost of outpatient care for musculoskeletal back disorders increased by 30% a year in their health and welfare fund a year after a work-related back injury; this may correspond to formal closure of workers' compensation claims allowing coverage for care through that system. These findings are also consistent with the chronic nature of some musculoskeletal problems even among the employed [Carey 1999 and 200; Koehorn, 2006: Welch, 1999].

During a period of time when work-related musculoskeletal back injuries among this cohort decreased steadily and dramatically [Lipscomb et al; 2008], health insurance payment rates followed a different pattern. These rates were 16% lower in 2003 than in 1989, a period when outpatient costs for all conditions increased. Payment rates for back disorders had dropped 38% in 1995 and have increased since that time. This increase in payment rates is not as dramatic as the increase in outpatient health care utilization rates for musculoskeletal back disorders which ended in 2003 over twice as high as in 1989 [Lipscomb et al., 2009], but the charge rates are very similar.

Even though carpenters with less union experience were at greater risk of work-related injuries [Lipscomb et al., 2008] and used more outpatient health care [Lipscomb; 2009], their payment rates for care in these analyses were not higher than those of workers with more union tenure. These findings suggest that there could be differences in severity of musculoskeletal back disorders among those with more union tenure and/or differences in their patterns of care-seeking for musculoskeletal back problems.

Jointly trusteed health and welfare funds, such as the one we studied, have traditionally had close alliances with the populations they serve. Some carpenters report that seeking care through their private union-provided insurance is less difficult than dealing with workers' compensation. Since workers in the construction industry are less likely than workers in other industries to have private health insurance, and since lack of coverage is more prevalent among non-union workers (CPWR, 2007), our findings may not be generalizable to a workforce without health insurance coverage. However, the recent report of Dong et. al., [2007] documented that less than half of total medical expenses for work-related injuries were paid by workers' compensation. These costs were not borne just by private insurance, but also by public programs, such as Medicaid, as well as by workers and their families.

We also know that there was some misclassification in the identification of incident injuries based on lack of knowledge of work-related claims that occurred among cohort members prior to 1989, the pint at which we were first able to gain data access. Misclassification, if present,

would likely have attenuated the differences in payment rates we observed before and after injury.

Second reported work-related back injuries occurred at a rate 80% higher than initial events. Although the mean difference in lost time from work was modestly higher for second injuries than for the first, the distributions of the first and second back injuries were remarkably similar in terms of mechanism and nature of injury, as well as medical diagnoses received for treatment. These findings are consistent with injuries from like work exposures over time among members of the cohort.

Carpenters between 30 and 40 years of age were at greatest risk of back injuries, after adjusting for gender, time in the union, and predominant type of work. The fact that we observed individuals with the greatest union tenure carrying the lowest risk likely reflects a healthy worker effect or changes in direct physical exposure that occur with more seniority in the trade. Consistent with other reports [Lipscomb, 2000], carpenters involved in drywall work were at relatively high risk of back injury compared to their union colleagues in other forms of work; residential carpenters were at higher risk of initial injury but not for a second event (based on a small number of observations).

The risk ratios for a subsequent musculoskeletal injury based on the different mechanisms and nature of injury were quite similar, consistent with our hypothesis that the ANSI codes assigned to the initial injury would not be sensitive enough to identify individuals at greater risk of a second injury. We observed no differences in risk of a second injury between those who had first aid only compared to outpatient medical care for their first injury. Individuals with longest period of work disability with the first back injury were at particularly high risk (2.3x greater than risk for first event) consistent with fairly recent report of Wasiak et al. [2004] based on analyses of compensation data.

Carpenters whose medical diagnoses reflected a degenerative condition or multiple diagnoses were at greater risk of a second injury as were those who required hospitalization or were out of work for a month or greater; all likely reflect more severe initial injuries or pathology at the time of injury. However, multiple diagnoses are more likely to be assigned to individuals with more medical encounters and may reflect evolving clinical impressions sometimes accompanied by more testing among individuals with delayed recovery. Consistent with Waller's findings [1989/1990], it was rare for a carpenter to require hospitalization for a back injury, even among those who never returned to carpentry work.

The risk of a back injury of a musculoskeletal nature peaked at 1500 hours of time after return to work from a previous injury, and gradually decreased with increasing time back at work. This time represents close to a year of full-time work for many of these union carpenters. We have no data on accommodation or restricted work after injury. It is possible that these carpenters did receive less taxing duties upon return from an earlier injury or they may look for ways to limit stressful exposures on their own when first coming back to the job. However, the overall nature of construction work makes light duty assignments unlikely, particularly for extended periods of time.

Consistent with our findings, among Canadian workers who had lost-time back compensation cases, the risk of recurrence was greater in the first year after injury and especially for those with longer periods of absence from work. Of note, recurrence was not defined by filing another injury report as we did, but by exacerbation of symptoms and work absence after return. There was also a gradual increase in the duration of absence with each recurrence [Rossignol, 1992], potentially representing worsening symptoms or pathology, or, perhaps, the tendency of care givers to recommend longer absence from work with recurrent episodes.

In case-control analyses we observed associations with delayed return to work for increasing age, years of experience, and acute injury events. These findings are consistent with previous occupational studies that reported delayed return to work among workers of older age [Cheadle, et al. 1994, Oleinick, et al. 1996] and for falls [Hogg-Johnson, et al. 1994]. In a previous study, shorter employment duration was associated with delayed return to work [Infante-Rivard and Lortie 1996]. In this study we used time in the trade which does not equate to employment duration (e.g. carpenters generally work for multiple employers/contractors for different periods of time throughout their career). Washington State Union carpenters have clearly defined apprentice and journeyman experience levels. Our study considered less than 4 years whereas the study conducted in a rehab clinic by Infante-Rivard and colleagues included workers of different industries and defined employment duration as <2 years.

Though carpenters of younger age and inexperience are at increased risk for a paid lost time back injury claim [Lipscomb, et al. 2008], older carpenters and more experienced workers, once injured, were more likely to have delayed return to work. This finding provides some evidence for a cumulative trauma effect or the inability to adapt in older age and our data for increasing experience supports this. Journeymen (76% vs. 66%) were more frequently cases and more frequently had previous paid time off back injury claims (90% vs. 68%).

Like age and experience, the observed associations for previous claim history and ICD-9 degenerative diagnosis also support a possible cumulative trauma effect. We observed some heterogeneity of the association between previous claim history and delayed return to work by injury mechanism. Among the overexertion and bodily reaction mechanism claims, the presence of a previous paid time off claim was associated with delayed return to work (OR 2.5, 95% CI: 1.7-3.6). We observed the opposite association for claim history among other injury mechanisms (OR 0.8, 95% CI: 0.4-1.6). Explanations for this finding include increased susceptibility to an overexertion or bodily reaction injury via incomplete treatment or rehabilitation after a previous paid time off claim and the natural history of back disorders.

Among these Washington State union carpenters, females and workers with a 30 or more day delay to medical care were a small proportion of the over all back injury claims, but were at the highest increased risk for delayed return to work. This association remained after adjustment for age and experience. With only 37 female carpenters in this study, we were unable to examine potential differences by type of work or other variables. An association for increasing time from injury and rehabilitative treatment is supported in previous rehabilitation clinic studies [Infante-Rivard and Lortie 1996, McIntosh, et al. 2000]. We used delay to any medical care in this analysis, and we could not determine from our data the myriad of potential reasons behind such

delays to medical care for these cases and controls: exacerbation of issue or complaint, reluctance to get care, seeking care through private insurance, issues with workers' comp system and/or reimbursement, or job overlap.

While ANSI codes represent the body part injured in the first report of injury claim event, ICD-9 codes reflect treatment for a back injury by a provider. The inconsistent associations observed for ANSI coded "dislocations" or herniated discs (OR=6.2) and ICD-9 coded "dislocations" (OR=0.5) support these as different injuries.

We observed strong associations between delayed return to work and ICD-9 symptom descriptor (OR=6.3) and mixed diagnoses (OR=5.9). ICD-9 coded symptom descriptor injuries (n=65) were predominantly due to overexertion (42%) or falls (32%) and almost all involved ANSI body parts other than the back or neck/back (95%). ICD-9 codes for treatment of a back claim caught these claims. Involvement of other parts implies that the coder identified the primary injury at exam as a part other than back, however the worker tends to be out a long time. This could signal delayed return to work due to multiple injuries (carpenter had more than just a back injury) or treatment for a chronic back problem in addition to a new injury or inadequate rehabilitation of a prior back injury. Injuries coded mixed diagnosis by ICD-9 (n=594) were predominantly due to overexertion (64%), bodily reaction (9%), and falls from height (9%) and most involved the back or neck/back (87%). These mixed diagnoses likely represent the evolution of back diagnoses of benign or non-specific categories that develop into other more specific diagnoses.

We used conservative case and control definitions (>90 days versus 0 to 30 days) aiming to separate these groups more clearly. These groups corresponded with the phases of disability described in previous studies: acute phase or 1st 30 days, subacute phase or 30 to 90 days, and chronic phase or >90 days [Cheadle, et al. 1994, Dasinger, et al. 1999, Krause, et al. 2001, Oleinick, et al. 1996]. In a study of industry insurance back sprain claims, Violinn et al. compared 90 or more days to <=14 days and found similar associations with increasing age [Volinn, et al. 1991]. Dichotomizing case and control definitions at 90 days (>90 versus <=90 days), we found similar associations for our main variables except for experience and delayed care which were attenuated.

In looking at medical care for these back injuries it is clear that while overexertion back injuries are common among these carpenters, the majority of these work-related back injury claims resulted in no paid lost days. Those with >90 days of paid lost days were more likely to have seen a private health care provider within 30 days of their claim (consistent with the notion that many back disorders are chronic in nature [Carey, 1999]. Additionally, this could indicate some overlap in care among the two systems.

Care from chiropractors and general practitioners were most common for both workers' compensation and private health care. Overall, chiropractic care, whether workers' compensation or private, was frequent among this group of workers which is consistent with a previous study that found skilled laborers were more likely to see chiropractors compared to service workers [Cote, 2005]. Specialist encounters comprised 9% of workers' compensation

encounters and 8% of private health care encounters and were more likely as the number of paid lost days increased. Observed differences in provider care patterns by number of paid lost days is consistent with previous research where referral to specialist was associated with delayed return to work [Kominski et al., 2008].

Of the injured carpenters who sought workers' compensation care for their claim, the majority (82%) sought care within 7 days, 95% within 30 days. However, for the 5% who first sought care beyond 30 days from the claim, the proportion of claims with paid lost days increased. Kominski et al. in a survey of workers' compensation injured workers reported 12% waited >3 days to seek treatment and found increased associations with delayed RTW for those with 1 to 3 and 4 or more days between care and date of the claim [Kominski et al., 2008]. Previous analyses of back injury claims in these carpenters indicated a strong association for >30 delay to care and delayed return to work [Kucera et al.,]. For the first 30 days after the claim, the mean number of encounters to specialist, general practitioner, and physical therapy increased with paid lost days. This suggests increased utilization in the first month after an injury for those out longest. Whether this is related to severity of injury or complexity of the diagnosis, we do not know.

Mean and median days to physical therapy increased as did the proportion of claims with delays to therapy with increasing paid lost days. Of particular note, are the 38% of 31 to 90 paid lost day claims and 27% of >90 paid lost day claims that never received physical therapy. Ehrman-Feldman, et al in their study of compensated low back pain reported that physical therapy within 30 days had a protective effect on RTW within 60 days [Ehrmann-Feldman et al., 1996]. Patients referred earlier tended to return to work sooner indicating that timing of physical therapy was important. Delays increased among those with longer absence from work and authors postulated this could be due to physicians referring to physical therapy only after lengthy absences [Ehrmann-Feldman et al., 1996]. Infante-Rivard, et al also reported that >30 delay to therapy was associated with delayed return to work [Infante-Rivard and Lortie 1996]. Furthermore, injuries due to effort or movement were less likely to return to work compared with traumatic injuries.

The increasing prevalence of physical therapy visits with delayed return to work is not surprising and may reflect more care with failure to improve. However, it is interesting that among those who utilized physical therapy early, the mean number of encounters in the first 30 days after injury was higher among those with delayed return to work. This seems to indicate something different about these injuries, or carpenters, that was obvious in that first month.

Reasons for delays to care and/or to physical therapy for these carpenters are unknown. With this administrative data source we do not know whether delays were due to late provider referral or deferred action by the claimant resulting from personal factors such as difficulty getting an appointment, not making the appointment in a timely manner, or failing to recognize need for immediate treatment, to name a few possibilities. We know of no reason administrative reporting differences are responsible for the observed association with delay to care. This administrative data source represents a population of workers and encompasses a large number of health care providers. We feel the results presented here are robust assuming higher

variability among this group of providers when compared to smaller, and less varied, clinic-based studies and data sources.

Roughly a third of claimants had a history of previous care for back injury in the workers' compensation (28%) or Carpenter Trust payment (36%) systems. Prior physical therapy and specialist care were more likely as paid lost days increased, but prior chiropractic care was not.

To date there are no comparative studies of care patterns for overexertion/bodily reaction injuries in construction or carpenters. The closest study was a cross sectional analysis of workers' compensation care for low back pain among 5 employers in 37 states and one group consisted of skilled/semi-skilled laborers [Cote et al., 2005]. Return to work would ideally be sooner for those injured workers in less physically stressful occupations, consequently treatment and referral patterns would likely be different.

We do not attribute direction or causality to the associations reported in this analysis. Administrative data sources such as the one available for these analyses were designed for purposes other than research. Therefore, we do not know if the event or delayed return to work determines receipt and type of care, or if receipt and type of care defines the event or influences delayed return to work. These results may represent the health care experiences of injured carpenters who don't get better, and therefore, see multiple providers and receive different diagnoses. Specific to physical therapy, injured workers may be referred to physical therapy only after prolonged absence from work. This illustrates the complex nature of provider care for work-related back injury.

CONCLUSIONS

It is not surprising that overexertion injuries from manual materials handling activities are responsible for the largest burden of back injuries among these union carpenters. Despite their substantial decline, continued efforts are needed to clearly define tasks or activities that place them at risk of injury and to identify methods to alleviate relevant exposures. This is particularly relevant given the contrasting pattern of care seen through the union-provided health insurance of these carpenters. At the same time, we should not fail to recognize the substantial contribution made by acute traumatic events to the burden of back injury.

Based on these findings, residential and drywall carpenters should be particular targets of prevention activities. Focused efforts are needed to identify ways to reduce risk of back injury among these small, and often dispersed, work groups. We acknowledge that in this particular cohort residential carpenters make a very small contribution to the overall injury burden. However, their risk is likely representative of other carpenters involved in the homebuilding industry – a group for which there is limited surveillance data [Dement and Lipscomb, 1999; Lipscomb et al., 2003b]. Beyond these two groups, these union carpenters perform a wide variety of construction work. The fact that they are not typical 'hammer and nail carpenters' should be kept in mind in generalizing their experiences to other groups.

After having an injury, these carpenters remain at greater risk of a second event of a musculoskeletal nature for a considerable period of time (3+ years). In large part, the ANSI coded compensation data reflecting nature and mechanism of injury are not particularly helpful in identifying individuals who are at greater risk of a recurrent back injury. We did find some indication that more severe initial injuries put individuals at risk of a second event. In this industry where there are considerable challenges to workplace accommodation because of the heavy nature of the work, individuals who are out of work over a month, especially over 3 months, warrant accommodation and, perhaps better rehabilitation efforts/attention to avoid re-injury. However, this is in fact more challenging than it might first appear.

While there is some evidence that even individuals with severe and chronic pain following work-related back injuries can reduce their risk of recurrent problems, including new work-related claims [Garcy 1996], there are also reports that patterns of recurrence following functional restoration efforts are consistent with the episodic nature of low back pain [Gross, 2005]. In addition, techniques such as functional capacity testing often fail to accurately identify when individuals are ready to safely return to work following injury [Gross and Battie, 2005]. Considering these issues in light of the lack of any particularly strong predictors of recurrence strongly speaks to the need for primary prevention of back injuries among these workers involved in strenuous tasks.

Our findings also clearly demonstrate the complexity of health care use for musculoskeletal back problems among this large construction cohort with non work-related insurance coverage. We observed evidence of changing patterns of utilization for musculoskeletal back problems in the carpenters' health care trust in concert with changes in their reported workers' compensation injury experience. However, even with the comprehensive nature of these data, these issues are

difficult to clearly understand, and we cannot say one caused the other. We cannot determine whether the undefined factors contributing to overall increased health care utilization were responsible for the increase in care for back diagnoses among this large cohort of construction workers or whether it might have been related to less use of the WC system. It is noteworthy that the trajectory of increased utilization differed for musculoskeletal back diagnoses and all other outpatient claims. In any event, these findings are interesting and raise questions about whether the overall health of the population in regard to back disorders is improving or not.

These analyses provide clear evidence of interplay across two health care delivery systems for a working population. The findings add to the growing literature and demonstrate the need to look broadly at sources of healthcare coverage to better understand the health of working populations. Assuming the systems function independently would be naive.

Workers' compensation costs for back injuries have decreased substantively among this cohort of union carpenters over 15 years due in large part to declining injury rates. The changes observed in the costs of caring for and accommodating the carpenters with back injuries may be more significant than they first appear given that spine-related health care expenditures in the U.S. have increased substantially during this time period [Martin et al, 2008]. Older workers, whose injuries are responsible for higher costs, face challenges in returning to work following back injuries that can result in long-term activity limitations. Such concerns have been raised regarding our aging workforce in general, but among these construction workers costs began increasing among those in their 30's and continued to increase steadily with increasing age. This likely also reflects the generally heavy nature of their work in rather than simply the effects of biological aging. While musculoskeletal back problems remain a common, and consequently costly, source of injury among these carpenters that needs to be addressed through engineering modifications, there is also a need for measures to prevent the often more costly back injuries associated with acute trauma.

Although we expected private health insurance payments to mirror fairly closely the patterns of use of health care services, costs did not go up as much as utilization during this 15-year period. The pattern could reflect a more substantial shift of medical care for less severe back disorders from WC to health insurance consistent with concerns others have raised regarding possible cost-shifting [Biddle, 1998; Rosenman, 2000; Ducatman; 1996; Zwerling, 1991; Butler 1997; Ramsey 1994]. This would be consistent with the marked decline in work-related injury rates for overexertion-related back disorders we previously reported [Lipscomb et al, 2008]. However, it is of note that the pattern for charges, rather than payments, more closely approximates the one observed for utilization. Over time a smaller proportion of deductible charges were paid by the trust, thus shifting unpaid costs to the worker.

Health insurance payment rates for back pain declined between 1989 and 2003, but have been steadily increasing since 1995. Growth in these rates bears monitoring particularly in light of indications that medical treatment for back disorders may be shifting from WC to health insurance. In the United States, health care delivery for working individuals is covered by two independent insurance systems – health insurance and workers' compensation (WC). Among union carpenters in Washington State with health insurance coverage, medical costs for

musculoskeletal back disorders do not appear to be independent of their work-related injury experiences.

Individuals with multiple injuries often from acute traumatic injury and those with a previous back injury claim, especially if out a long time, were at increased risk of delayed return to work. The increased association we observed among females and those with delays to medical care is difficult to interpret with administrative data without substantive information from qualitative interviews. This information may reveal differences in work task distribution by gender and care seeking or reporting behavior. Whether delays in medical care are related to other issues such as time constraints, pressure from employers and fellow workers, hassles with workers' compensation process, etc., we need more information in order to make appropriate recommendations. We know from site visits and qualitative research conducted with residential St. Louis carpenters that workers are influenced by the attitudes of co-workers and supervisors and the safety climate on their worksites [Lipscomb et al., 2003].

Though carpenters of younger age and inexperience were at increased risk for a paid lost time back injury claim [Lipscomb, et al. 2008], older carpenters and more experienced workers, once injured, were more likely to have delayed return to work as were those who experienced acute events such as falls, being struck by objects or persons, and MVAs. Primary prevention of these work-related events is vital for occupations where the availability of modified work is limited if nonexistent. However, more than addressing manual materials handling is needed. There are work situations that cause acute traumas resulting in multiple injuries and it is important to address and prevent these events. Secondary prevention measures based on these findings would include prompt treatment for back injuries and development of modified work for injured carpenters who are not ready for full return to work.

The majority of individuals with these work-related musculoskeletal back injury claims received medical care within 30 days. Delays to any care, specifically physical therapy care, were associated with delayed return to work indicating that early treatment and referral are important for timely return to work. Chiropractors and general practitioners were the most common providers seen first after an injury, however many claimants saw a combination of providers. Carpenters Trust payment care only and care from both systems was more prevalent after the first 90 days following the injury overall, and likewise, after return to work for those with at least one paid lost work day. The overlap in care for back injury in both systems in this study provides another illustration of the importance of examining both workers' compensation and private health care systems in order to obtain a more complete picture of the care for back injuries among these construction workers.

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APPENDIX 1

Process used to assign ICD9 code groupings

CLASSIFICATION OF CASES USING ICD9 CODES

Process: Each workers' compensation claim was assigned one diagnosis based on a combination of ICD9 diagnosis codes and ANSI body part codes. The body part is used with the ICD9 code when necessary to define a body region. When the ICD9 code is specific for a body region this takes precedence over the body part code. To be assigned to any categorization the individual can only have ICD9 codes from that specific grouping, with the exception of additional symptom descriptor codes. If additional codes are assigned with symptom descriptor codes, the more specific code(s) were used Only ICD9 codes which reflected a spinal condition were considered in the classification schemes. This ignored non-musculoskeletal codes and non-sensical codes which would prevent a person from being classified. Individuals who have ICD9 codes coming from more than one category were assigned the label 'mixed diagnosis'. Cases were not classified by ICD9 codes if they were from self-insured employers.

APPENDIX 1

Case definitions based on ICD9 codes supplemented with ANSI body part code

- Spinal low back fractures

805 vertebral fracture w/o cord injury
805.8 ", unspecified closed
805.9* ", unspecified open
806 vertebral fracture with cord injury + body part code=BACK (420)
806.8 ", unspecified closed
806.9 ", unspecified open

805.4 vertebral fracture w/o cord injury, lumbar closed
805.5* " , lumbar open
805.6 " , sacrum and coccyx closed
805.7 " , sacrum and coccyx open
806.4 vertebral fracture with cord injury, lumbar closed
806.5* " , lumbar open
806.6 " , sacrum and coccyx closed
806.7* , sacrum and coccyx open

839.2 dislocation Th and lumbar , closed
839.20 " , lumbar closed
839.3 " , th and lumbar open
839.41 " , coccyx closed
839.42 " , sacrum closed
839.51 " , coccyx open
839.52 " , sacrum open

839 dislocation and other ill-defined
839.4 dislocation other vertebrae, closed
839.40 " , unsp closed
839.49 dislocation other, closed + body part code=BACK
839.5 " , open
839.59 dislocation other, open
839.8 dislocation multiple, ill defined, closed

[If dislocation is labeled 'open' and treated in the hospital assumed to be fracture]
[839.3, 839.30, 839.51, 839.5 +BPCD, 839.9 +body part code]

- Spinal cord injury w/o fracture

952 spinal cord injury w/o bone
952.9 spinal cord injury w/o bone, unspecified site + body part code= BACK
952.8 * injury to nerves and cod, multiple sites

952.2 spinal cord injury w/o bone, lumbar
952.3* " , sacral
952.4* " , cauda equina

- Nerve injury

953 injury to nerve roots and spinal plexus
953.8 ", multiple sites
953.9 " , unspecified site
954 injury to nerves of trunk + body part code=BACK
954.8 " , unspecified site
954.9 " , unspecified nerve of trunk
953.2 injury to lumbar root
953.3 injury to sacral root
953.5 injury to LS plexus
956.0 injury to sciatic nerve

- Contusion of trunk

922 contusion of trunk
922.9 contusion trunk, unspecified + body part code=BACK

922,922.9 contusion of trunk
+
922.3 contusion of back
or
922.3 contusion of back

- Spine dislocation, not fracture

839 other multiple ill-defined dislocation
839.4 dislocation other vertebrae, closed
839.40 dislocation vertebrae unspecified site + body part code=BACK
839.49 dislocation other vertebrae, closed
839.8 dislocation multiple illdefined, closed

839.2 dislocation th or lumbar, closed
839.20 " lumbar, closed
839.41 dislocation coccyx, closed or any of these specific codes
839.42 dislocation sacrum, closed with 839

- Low back spr/strain

846 spr/str SI region
846.x any of 846 codes

847 Spr/str unspecified part of back
847.9 unspecified back spr/str + body part code=BACK

847.2 spr/str lumbar
847.3 spr/str sacrum
847.4 spr/str coccyx

847 or 847.x + 846

- Degenerative low spine pain (disc disorders)

721 spondylosis and allied disorders
721.8 allied disorders of spine
721.9 spondylosis unspecified site
722 intervertebral disc disorders + body part code=BACK
722.2 displacement disc sit unspecified
722.70 disc disorder w myelopathy unspecified region
722.80 postaminectomy syndrome, unspecified region
722.9 other unspecified disc disorder
724 other and unspecified disorder of back
724.00 spinal stenosis, unspecifed region

721.3 LS spondylosis w/o myelopathy
721.4 th or lumbar spondylosis w myelopathy
722.1x Th or lumbar disc w/o myelopathy
722.32 Schmorl's node lumbar
722.5x degeneration th or l disc
722.83 postlaminectomy lumbar
722.93 other lumbar disc disorder
724.02 spinal stenosis lumbar

- LS root lesion

353 nerve root and plexus disorders + body part code=BACK
353.1 LS plexus lesions
353.4 LS root lesion, NEC
355.0 lesion of sciatic nerve

-Symptom descriptor ICD9 codes for back

724.2 Lumbago
724.3 Sciatica
724.4 Radiculitis or neuritis, thoracic or lumbar
724.5 Backache
724.8 Other symptoms referable to the back

739.3 Non-allopathic lesion lumbar region (segmental or somatic dysfunction)
739.4 Non-allopathic lesion sacral region "

Mixed Diagnoses, not elsewhere classified (NEC)