

Alternative Approaches for Measuring Duration of Work Disability After Low Back Injury Based on Administrative Workers' Compensation Data

Niklas Krause, MD, PhD, MPH,^{1*} Lisa K. Dasinger, PhD,¹ Leo J. Deegan, PhD¹
Richard J. Brand, PhD² and Linda Rudolph, MD, MPH³

Background *Studies of low back pain (LBP) disability remain largely incomparable because of different outcome definitions. To date, systematic comparisons of alternative outcome measures have not been made.*

Methods *Duration of work disability was studied in a 3-year cohort of 850 workers' compensation LBP claimants. Eleven administrative outcome measures were compared using Kaplan-Meier estimates of the proportion of claimants still on disability benefits during 3.5 years of follow-up.*

Results *The estimated mean duration of work disability was 75 days for the first temporary disability (TD) episode, 108 days for cumulative time on TD, and 337 for total compensated days, which includes all types of wage replacement benefits during vocational rehabilitation, temporary and permanent disability.*

Conclusions *Commonly used administrative measures of lost workdays—time to first return to work and time on temporary disability—substantially underestimate the duration of work disability compared to measures based on all wage replacement benefits. Am. J. Ind. Med. 35:604-618, 1999. © 1999 Wiley-Liss, Inc.*

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INTRODUCTION

Return to work after occupational injuries in general and duration of work disability due to low back pain in particular have become a major concern in most industrialized countries. Low back pain (LBP) is currently the leading

cause of work disability. Work-related low back injuries represent about 20% of all workers' compensation claims and 33% of all workers' compensation costs in the United States [Andersson et al., 1991]. Disabling back injuries have been associated with decreased earning capacity and quality of life of injured workers [Peterson et al., 1997], an overburdening of health care systems [Leigh et al., 1997], and large scale losses of productivity [Yelin and Felts, 1990]. Temporary and permanent disability benefits comprise about two-thirds of total direct workers' compensation costs for LBP [Andersson et al., 1991]. A small proportion of workers with long-term disability accounts for the majority of workers' compensation costs [Abenhaim and Suissa, 1987; Franklin and Fulton-Kehoe, 1996; Hashemi et al., 1997; Leavitt et al., 1971; Snook, 1988; Spengler et al., 1986; Williams et al., 1998]. Moreover, with increasing duration of work disability, the probability of ever returning to work decreases [Krause and Ragland, 1994; Scheer et al., 1995; Snook and Webster, 1987].

¹Public Health Institute, Berkeley, California

²Department of Epidemiology and Biostatistics, School of Medicine, University of California, San Francisco

³Division of Workers' Compensation, State of California, San Francisco

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*Correspondence to: Niklas Krause, M.D., Ph.D., M.P.H., School of Public Health, Division of Epidemiology, 140 Warren Hall, University of California, Berkeley, CA 94720-7360. E-mail: nkrause@uclink4.berkeley.edu

Duration of disability has frequently been used as a measure of outcome in the evaluation of alternatives in the treatment and rehabilitation of LBP [Franklin and Fulton-Kehoe, 1996; Franklin et al., 1994; Scheer et al., 1995], in the evaluation of company-based return to work programs such as modified work or gradual return to work [Krause et al., 1998], as a proxy measure for severity of injury [Cairns et al., 1984; Oleinick et al., 1993], and in the classification of occupational disability due to back injuries [Krause and Ragland, 1994].

A recent trend has been the use of workers' compensation data to obtain estimates of workdays lost or time to return to work after occupational injuries [Cheadle et al., 1994; Hogg-Johnson et al., 1994; Oleinick et al., 1996a; Rossignol et al., 1992]. However, studies remain largely incomparable because of different operational definitions of disability length and return to work outcomes and a lack of systematic comparisons between alternative outcome measures. Only one study has systematically compared two methods for measuring duration of work disability and found large discrepancies. Oleinick and colleagues showed for the State of Michigan that the annual national employer survey of employer's OSHA 200 logs of occupational injuries and illnesses underestimates mean duration of disability by a factor of 3 to 9 when compared to measures based on workers' compensation benefit payment records [Oleinick et al., 1993]. Unfortunately, many workers' compensation systems do not directly measure or systematically record duration of work disability or return to work dates. Researchers, therefore, have to choose from several options of creating outcome measures which are determined by conceptual considerations, kind and availability of administrative data, and data management resources.

The main outcomes reported in the literature are calendar time to first return to work, cumulative time on temporary disability (TD) benefits, and one time measures (point prevalence) of work status during follow-up. First discontinuation of disability benefits is often used as a surrogate for measuring time to first return to work [Hogg-Johnson et al., 1994]. However, in a landmark study of 1,850 permanently disabled workers, Baldwin and coworkers showed that over 60% of workers had repeated injury-related disability episodes or withdrew from the labor force after an initial return to work [Baldwin et al., 1996]. About one third of those who returned to work at some point after their injury had made several unsuccessful attempts to work between a series of disability spells [Butler et al., 1995]. Thus the duration of the first disability episode appears to be a poor measure of work disability after occupational injury.

Total number of days on temporary disability benefits during multiple TD episodes has been used to measure the cumulative number of workdays lost [Rossignol et al.,

1992]. Others have used total amount of temporary disability payments as a proxy measure for time on disability [Cheadle et al., 1994]. Alternatively, Oleinick and coworkers estimated the cumulative number of compensated workdays using the number of days on TD plus the number of "equivalent workdays lost," the latter calculated from permanent partial or total disability as reflected in continuous or lump-sum permanent disability payments [Oleinick et al., 1993].

Point prevalence of work disability is often used in clinical studies [Franklin et al., 1996]. This method takes a snapshot approach to work disability, assessing it at a specific date, typically at 3, 6, 12, 18, or 24 months after the injury. Because of the on and off pattern of work disability, this method is bound to overestimate the return to work rate and will provide less accurate estimates of the total burden of work disability than do cumulative measures of disability days. However, point prevalence measures have the advantage of modest data requirements. Only one binary follow-up data point needs to be gathered — working at day X yes or no — which explains the wide use of this measure.

As the above discussion shows, outcome definitions have varied considerably across existing studies. To date, alternative measures of work disability using workers' compensation data have never been compared systematically within the same sample.

The objective of this study is to describe and compare several alternative measures of work disability derived from workers' compensation data. The study population consists of 850 California workers with temporary or permanent disability due to low back injuries who were followed up for 1 to 3.5 years after injury. This article compares a variety of administrative outcome measures that can be used as proxies for compensable lost workdays after low back injury. The research question is to what degree alternative operationalizations of outcomes change the estimate of disability duration associated with LBP. Specifically, three main approaches, time to first return to work (measured as the duration of the first TD episode), cumulative time on temporary disability (TD) benefits, and total number of compensated work days based on all wage replacement benefits including lump sum permanent disability payments will be evaluated. Within these three major conceptualizations, a total of eleven alternative operationalizations with different resource requirements will be compared. In a separate paper, we compare these administrative estimates with self-reported measures assessed by a follow-up telephone survey of this claimant cohort [Dasinger et al., 1999]. It is hoped that clarifying and quantifying the differences between alternative outcome measures will assist researchers and administrators in the choice and interpretation of disability measures for occupational back injuries.

METHODS

Workers' Compensation in the State of California

In California, temporary disability payments are made to work-injured employees after the third lost work day in order to compensate for lost wages due to an inability to return to full-time work. Temporary disability benefits continue until (1) the worker is officially released to return to work by the treating physician, or (2) the worker's condition is determined to be "permanent and stationary," meaning that no significant improvement or deterioration in the condition is expected. In both instances, the worker is considered able to work, although for permanently disabled workers this may be at some diminished capacity. Permanently disabled workers are eligible for permanent disability (PD) benefits, which are paid weekly for a pre-designated number of weeks, as a lump-sum, or by a combination of these two methods. Workers whose injuries preclude return to their pre-injury occupation may receive vocational rehabilitation maintenance allowance (VR) to replace lost wages during job retraining. The weekly dollar amounts of permanent disability and vocational rehabilitation are generally less than what would be received while on temporary disability.

Not all workers receive TD continuously. Some make one or more attempts to return to work, during which time TD is not collected [Butler et al., 1995; Rossignol et al., 1992]. If a worker is unable to work after an attempted return, TD benefits may resume. For this reason, there may be one or more TD "episodes" in the life of a workers' compensation claim, in which an episode is a period of contiguous days for which TD was paid. TD episodes are demarcated by "gaps" of a day or more in which the worker is deemed able to work by the treating physician and TD is not received. In our sample of 850 workers, 21% had more than one TD episode. The distribution of gap sizes between TD episodes was one to seven days (4%), one to four weeks (7%), one to three months (3%), three to six months (3%), and over six months (3%).

Study Population

A complete 3-year cohort of 850 low back injury cases was drawn from all workers' compensation claims administered at three district offices of a large workers' compensation insurance carrier in California. The insurer has a client base exceeding 230,000 employers, or about 45% of California's insured employers. The 850 cases were extracted by computer algorithms according to the case criteria (see below) using information contained in three relational

databases linked by case claim number: (1) a Master Claims file, containing information on age, sex, date of injury, nature of accident, nature of injury, and dollar amounts of benefits paid to date on each claim; (2) an externally reviewed Medical Payment file, containing individual records of all payments for medical services made on a claim, including date of service, physician diagnosis (ICD-9 or *International Classification of Diseases*, ninth revised clinical modification) codes (up to four per bill), and clinical procedure and treatment (CPT) codes; and (3) a Payment History file, containing individual records of all workers' compensation temporary disability, permanent disability, and vocational rehabilitation payments to the worker as well as medical and legal payments. A fourth database containing Employer Policy information was used to obtain information about employer size, which was not used in the selection of cases.

Case definition

Cases consisted of those matching the following administrative and diagnostic criteria: (1) A date of injury between 1/1/94 and 12/31/96; (2) At least one day of temporary disability (TD) within 14 days after the date of injury; (3) An ICD-9 code indicating a non-traumatic injury relating to the lumbar or sacral region of the spine, according to a list of codes developed by Cherkin et al. [1992]. This list contains codes indicative of both possible and definite spinal injuries in the low back area. While the former include unspecified sites of the spine and ambiguously defined sites (e.g., "lumbar or thoracic"), the latter codes pertain explicitly and exclusively to the lumbar or sacral region. ICD-9 codes were used over ANSI injury codes as it has been shown that the latter may result in misclassification in identifying low back injuries [Oleinick et al., 1996b]. Eligible cases had the following time- and diagnosis-dependent criteria: (1) an ICD-9 code indicative of a *definite* LBP diagnosis on any medical bill record of the first physician visit or on any bill record of a physician visit within 14 days after the date of injury; or (2) an ICD-9 code indicative of a *possible* LBP diagnosis on any medical bill record for the first physician visit or on any bill record of a physician visit within 14 days after the first physician visit, **and** a *definite* low back ICD-9 code on a bill of a physician visit within 90 days after the date of injury. For these purposes, a physician was defined as a medical doctor (MD), an osteopathic physician (DO), or a chiropractic doctor (DC).

Case exclusion criteria were: (1) an ICD-9 code indicating a vertebral fracture, neoplasm, infection, or inflammatory disease at any point in the life of the claim, and (2) a nature of accident or nature of injury code indicative of a burn, open wound, or fracture.

Case selection process

A complete 3-year set of claims files was available from two of the district offices, while for the third office, only the 1994 and 1995 files were available at the time of data collection. Case selection began with the Medical Payment files by extracting all claims that had at least one ICD-9 code indicative of a definite or possible low back diagnosis at any time in the life of the claim. The resulting claim numbers were then matched to claim numbers in the current Master Claims files at each of the three district offices. This resulted in 12,632 unique claim numbers. The order of application of inclusion and exclusion criteria to this set of 12,632 claims and the number of cases remaining after each step are as follows: (1) date of injury on or after 1/1/94: 6,828; (2) at least one day of TD within 14 days after date of injury: 3,166; (3) ICD-9 inclusion criteria: 1,076; (4) ICD-9 exclusions: 1,044; (5) nature of accident/injury exclusions: 850.

Outcome Variables

Eleven different outcome variables were constructed in order to address three main objectives of this study: (1) to compare different measures of duration of disability based on workers' compensation insurance data that have been previously described in the literature, within the same sample, (2) to compare new measures of duration of disability to those previously described in the literature, within the same sample, and (3) to evaluate the balance between accuracy and resources required for file abstraction and programming in using different operationalizations of the same measure.

Duration of workers' compensation benefits is a proxy measure for duration of work disability, the number of workdays lost, or actual work status: a worker who is receiving temporary disability benefits is assumed not to be working. The eleven outcome measures fall into three general categories: (1) **Calendar time to event** outcomes, which measure the amount of time (e.g., number of days) between a reference point representing the beginning of disability (e.g., date of injury) and an event which marks the end of disability (e.g., date of last TD)—without regard for any intervening work periods; (2) **Cumulative time** outcomes, which base duration of disability on the number of days the worker was paid benefits for wage loss (TD, PD, or VR), excluding calendar periods when no benefit payments were made; and (3) **Point prevalence** outcomes, which measure the proportion of claimants on disability benefits at specific points in time after date of injury (e.g., at 3, 6, 12, 18, or 24 months follow-up).

Outcomes were generated from information in one of two files—the Master Claims file or the Payment History file. While the former provides summary information of workers' compensation benefits paid to date on each claim,

the latter breaks this information down into individual disability benefit payment records for each claim. Each record in the Payment History file is categorized as to benefit type (TD, PD, VR, medical, etc.). Records of wage replacement benefit checks (TD, PD, VR) have information on the calendar period that they cover (a “from” and “to” date). This makes it possible to determine periods “on” and “off” wage replacement benefits. The Payment History file also serves as a balance sheet for all benefits paid, consisting of records of both negative and positive dollar amounts. Negative amounts indicate an adjustment (e.g., TD payments reallocated to PD payments, or TD paid at too high a rate). Positive amounts may represent regular payments or adjustments to regular payments (e.g., paid for too few days or at too low a rate). It is these kinds of intricacies in the Payment History file, and in other insurance databases as well [see Oleinick et al., 1993], that make the use of administrative databases for research purposes challenging. Some measures were created by computer algorithms alone; others involved manual review of pay records for a portion of cases that were identified by computer algorithms.

We define six calendar time to event outcomes, four cumulative time outcomes, and one point prevalence outcome in this paper. Table I provides a definition of each of the measures and technical issues involved in their calculation (e.g., complexity, advantages, possible shortcomings). Five of the calendar time to event outcomes are based on temporary disability benefits. Two limit disability to the first temporary disability episode [similar to Hogg-Johnson et al., 1994; Oleinick et al., 1996a], and three cover all temporary disability episodes [similar to Cheadle et al., 1994]. The sixth calendar time to event outcome is the most comprehensive, including not only all TD episodes but all types of wage replacement benefits (TD, PD, and VR). Three of the four cumulative event outcomes are based on the number of days on temporary disability benefits alone. The fourth cumulative event outcome is a measure of “total compensated days” and includes all forms of wage replacement benefits, even lump-sum distributions made for future anticipated work loss [similar to Oleinick et al., 1993].

Although point prevalence of disability does not constitute a measure of duration of disability, it can be used as a proxy for the proportion of claimants still disabled at a certain time after the date of injury. Our measure of point prevalence is based on the presence or absence of TD coverage at different monthly intervals after the date of injury.

Analysis

Differences between duration of disability as measured by calendar and cumulative time outcomes were studied using the Kaplan-Meier (product-limit) non-parametric survival analysis method [Selvin, 1991]. In our study, the term

TABLE I. Summary of Outcome Measures for Duration of Disability*

Acronym	Definition	Technical comments
Calendar time to event outcomes		
Date of injury to end of first temporary disability episode		
1 FTD1	Time from date of injury to the end of the worker's first temporary disability episode, defined as the first period for which TD was paid continuously.	Requires advanced computer programming. Must determine end date of the first among (possible) multiple temporary disability episodes from a series of records on individual temporary disability payments in the Payment History file. The time interval for each payment is given by associated "to" and "from" dates. This interval may vary across payments and overlap in time with the interval for other temporary disability payments within the same case.
2 FTD2	Time from date of injury to the end of the worker's first temporary disability episode, defined as the first period for which TD was paid continuously or with gaps in payment of no more than seven days	Requires advanced computer programming, as above. This is an adaptation of the measure of disability duration described in Oleinick et al. [1996a], who used the first disability episode only and included gaps of seven days or less for which TD was not paid.
Date of injury to end of last temporary disability episode		
3 LTD1	Time from date of injury to end date of last temporary disability episode given in the Master Claims file	Simple calculation. The Master Claims file contains a single record for each claim with date of injury field and "TD thru" date field. In contrast to the previous two measures, includes all temporary disability episodes. May overestimate duration of disability because it includes "TD outliers" (see below).
4 LTD2	Time from date of injury to the end of the last TD episode given in the Payment History file, after removing TD outliers.	TD outliers are isolated TD payments of one to three days at the end of a claimant's TD payment history that are separated from earlier, much longer TD episodes. They most likely represent time missed from work due to medical appointments or court appearances, and as such, do not represent instances of continued work disability. In our sample, 37 claims (4%) had TD outliers. Outliers were removed by manual review of cases. Otherwise, this is a straightforward calculation.
5 LTD3	Time from date of injury to the end date of the last TD episode given in the Payment History file, after removing TD outliers and adjusting the date of last TD if benefits have been reallocated into or out of TD at the end of a claim's TD payment history.	See definition of TD outliers from previous outcome measure. TD benefit reallocations refer to positive or negative TD amounts at the end of a claim's TD payment history (designated by a transaction date) that do not have a check number or "to" and "from" dates. These TD amounts are converted into TD days by dividing by the TD rate of the previous TD payment. The date of last TD is adjusted accordingly either forward or backward. In our sample, 90 claims (11%) required this adjustment. Although claims with benefit reallocations are easily identified by computer algorithms, the adjustment to the last TD date is done manually and can be labor intensive depending on the number of claims requiring this adjustment.
Date of injury to end of all wage replacement benefits		
6 LSUP	Time from date of injury to date of last support, either TD, permanent disability (PD), or vocational rehabilitation (VR), whichever is latest, given in the Master Claims file	Simple calculation. Master Claims file has a "thru date" field for each type of wage replacement benefit.
Cumulative time outcomes		
7 CUMTD1	Cumulative days of TD paid, calculated from total TD amount paid-to-date and wage rate information in the Master Claims file	Simple calculation. The claimant's daily TD rate can easily be calculated from the wage rate. Assumes a constant TD rate over the entire course of a claim. In some cases, this may lead to an over- or underestimation of cumulative days on TD.
8 CUMTD2	Cumulative days of TD paid, calculated using "from" and "to" dates of each TD payment period in the Payment History file, and summing over all TD payment periods, after removing TD outliers	Requires advanced programming that deals with overlapping TD coverage dates of some TD payments. Unlike CUMTD1, takes into account changes in TD rate by counting the days for which TD was issued rather than dividing total TD dollars by a fixed TD rate.
9 CUMTD3	Cumulative days of TD paid, calculated as for CUMTD2, after removing TD outliers and adding or subtracting days if benefits have been reallocated into or out of TD in the Payment History file.	Requires advanced programming, as with CUMTD2 plus manual review of claims with TD benefit reallocations, as with LTD3.
10 TCOMPDIS	Total compensated days, created by summing the amount of benefits paid over all categories of wage replacement (TD, PD, VR) and dividing this sum by the daily TD rate, using the Master Claims file	Simple calculation. Assumes a constant TD rate, as with CUMTD1.
Point prevalence outcomes		
11 POINTPRV	Point prevalence of cases on TD at specific times after the date of injury, ascertained from Payment History file	Requires advanced programming to assess from individual pay records the proportion of claimants receiving disability benefits for each calendar day during follow-up

*TD = temporary disability; PD = permanent disability; VR = vocational rehabilitation maintenance allowance.

survival refers to “still receiving disability benefits.” Kaplan-Meier survival curves provide an estimate of the proportion of claimants still on disability benefits throughout the follow-up period while taking into account incomplete follow-up or “censored” data. In our sample, termination of disability benefits was not observed for all subjects because follow-up ended in June of 1997, when workers’ compensation payment data were downloaded from administrative databases. Observations were considered right-censored if termination of disability benefits had not occurred at least three months before the end of follow-up. If a claim had gaps in wage replacement benefits, the last termination date of benefit payments was used to determine if and when censoring occurred.

Kaplan-Meier curves were also used to estimate the total number of compensated disability days by multiplying the estimated mean number of disability days by sample size. For survival curves that have not reached zero, mean values are underestimated to some degree, as are the derived total number of disability days, but these biases appear to be very small for these data. Although the median is free from this bias, it does not provide an estimate of the *total* number of workdays lost. In low back pain claims, the total number of disability days is mostly influenced by subacute and chronic cases accumulating disability days a month after the date of injury, by which time the 50th percentile of workers has already reached the end of disability benefits.

Since all outcome measures come from a complete population of 850 claims administered by one insurance company, differences in duration of disability between outcome measures are not influenced by sampling variation and are not eligible for statistical testing. Because of missing data, some comparisons between different types of outcomes were performed across subsamples of 839 claimants with complete data. Strictly speaking, the unit of analysis was the claim; a negligible number (4 workers, or 0.5% of claims) in our sample had two back claims during the sampling period.

RESULTS

Characteristics of the Study Population

Table II describes the final cohort of 850 workers. Most claimants were male, between 20 and 50 years old, with an average of 2.6 years at the employer where the back injury occurred. Workers’ compensation administrative follow-up data were available for an average of 2.5 years (date of injury to date of file writing). Nearly half of the cases (47%) received temporary disability for more than 30 days, 30% received permanent disability, 13% had wage replacement while they participated in a vocational rehabilitation program, and 19% of the cases were litigated.

Table III gives information on injury characteristics. Nearly all injuries were caused by lifting (35.3%), an

unspecified movement (23.2%), or falling or slipping (17.4%) and resulted in strains or sprains (93.1%). Table III also shows the distribution of diagnostic subgroups comprising groups of ICD-9 codes indicative of low back injury [Cherkin et al., 1992]. Six hundred four (71%) claimants had more than one ICD-9 back code and 229 (27%) claimants had ICD-9 codes from more than one diagnostic subgroup (not shown in table). Claimants were classified by the most severe diagnosis they received. Decreasing severity was ranked in the order the diagnostic groups appear in Table III. Most cases were classified as least severe (74.9%). Surgery was performed in less than 2% of the cases.

Comparisons of Outcome Measures

Calendar time to event outcomes

Figure 1 shows the proportion of claimants remaining on disability benefits by calendar time elapsed since the date of injury, according to six alternative methods of determining the end of disability. The top curve depicts the proportion of workers still on disability as measured by time from date of injury to date of last indemnity support (the latest of either TD, VR, or PD benefits). The middle group of graphs is derived from measures of duration of disability based on time from date of injury to the end of the last TD episode date, with three alternative operational definitions. The two graphs at the bottom of Figure 1 are based on time from date of injury to the end of the first temporary disability episode, with two alternative operationalizations.

Figure 1 shows that outcome measures based on the first TD episode alone underestimate the proportion of workers on TD when compared to measures that include all TD episodes, or all TD episodes and other types of wage replacement, i.e., PD or VR. Figure 1 also shows, for the most part, that different operationalizations of the same measure do not lead to substantially different estimates of the proportion of workers still on disability. The two measures based on the first TD episode alone yield virtually identical survival curves, as do two of the three measures of time to the end of the last temporary disability episode. Both of these operationalizations exclude TD outliers. On the other hand, including TD outliers appear to overestimate the proportion of workers still on disability.

Table IV shows the percentage of claimants still on disability benefits for a subset of the calendar time to event outcomes. At 12 months after date of injury, 4.0% of workers are still on disability as measured by time to end of the first temporary disability episode, a proxy measure for time to first return to work. This percentage is more than doubled (10.3%) if the end of disability is defined as the end of the last TD episode. If duration of disability is defined as time to the last payment date of any wage replacement benefit, 23% of workers are classified as disabled at 12

TABLE II. Socio-Demographic and Administrative Case Characteristics of the Study Population: 1994–1996 California Low Back Pain Claimant Cohort, N = 850

Variable	N	Percent or mean
Gender		
Male	630	74.1
Female	220	25.9
Age at date of injury (DOI)		
Mean (SD)		36.1 (10.4)
<20 yrs.	25	2.9
20–29	241	28.4
30–39	298	35.1
40–49	180	21.2
50–59	76	8.9
≥60	17	2.0
Unknown	13	1.5
Occupation ^a		
Professional, technical, managerial	113	13.3
Clerical and sales	82	9.7
Service	132	15.5
Agricultural, fishery, forestry, etc.	58	6.8
Processing	3	0.4
Machine trades	39	4.6
Benchwork	29	3.4
Structural work	214	25.2
Miscellaneous	149	17.5
Unknown	31	3.6
Employee county of residence		
Northern California	798	93.9
Southern California	40	4.7
Out-of-state	9	1.1
Unknown	3	0.4
Employer size (\$ payroll)		
≤\$50,000	113	13.3
>\$50,000 ≤ \$500,000	311	36.6
>\$500,000 ≤ \$5,000,000	326	38.4
>\$5,000,000	73	8.6
Unknown	27	3.2
Length of pre-injury employment (yrs.)		
Mean (SD)	829	2.6 (4.3)
Length of follow-up (DOI to file writing, yrs.)		
Mean (SD)	850	2.5 (0.6)
Length of disability		
<7 days temporary disability (TD)	178	20.9
7 to 30 days TD	273	32.1
>30 days TD	399	46.9
Received permanent disability	254	29.9
Received vocational rehabilitation maintenance allowance	106	12.5
Litigated case	161	18.9

^aCoded by occupational division as described in *Dictionary of Occupational Titles*, revised 4th ed., U.S. Department of Labor (1991).

TABLE III. Injury Characteristics of the Study Population: 1994–1996 California Low Back Pain Claimant Cohort, N = 850

Characteristic	N	Percent
Nature of accident ^a		
Lifting	300	35.3
Unspecified movement	197	23.2
Fall or slip	148	17.4
Pushing or pulling	56	6.6
Motor vehicle accident	46	5.4
Holding or carrying	29	3.4
Struck or injured by object	21	2.5
Reaching	16	1.9
Using tool or machine	14	1.6
Other	23	2.7
Nature of injury ^a		
Strain or sprain	791	93.1
Multiple injuries	52	6.1
Other	7	0.8
Medical diagnosis ^b		
Postlaminectomy syndrome	4	0.5
Spinal stenosis	19	2.2
Herniated lumbar disc with myelopathy	9	1.1
Herniated lumbar disc without myelopathy	115	13.5
Sciatica	28	3.3
Possible instability	5	0.6
Probably degenerative changes	33	3.9
Nonspecific backache	637	74.9
Surgery performed ^a	16	1.9

^aFrom Master Claims file.

^bBased on ICD-9 back codes developed by Cherkin et al. [1992] found in Medical Bill Review records and ranked in order of decreasing severity. Cases with more than one different ICD-9 back diagnosis were classified according to the most severe diagnosis received in the history of the claim.

months. This is a more than fivefold difference compared to estimates based on the first temporary disability episode alone.

Cumulative time outcomes

Figure 2 shows the proportion of claimants remaining on disability for the four methods of determining cumulative days on disability. The top curve gives the proportion of claimants who are still on disability when measured by total compensated days based on TD, VR, and PD benefits combined (TCOMPDYS). The lower group of curves depicts three different operationalizations of cumulative compensated days based on TD only. By definition, the measures that exclude TD outliers (CUMTD2 and CUMTD3) yield a lower percentage of workers on TD at any point when compared to CUMTD1. However, differences appear to be small. The two measures excluding TD outliers also lead to

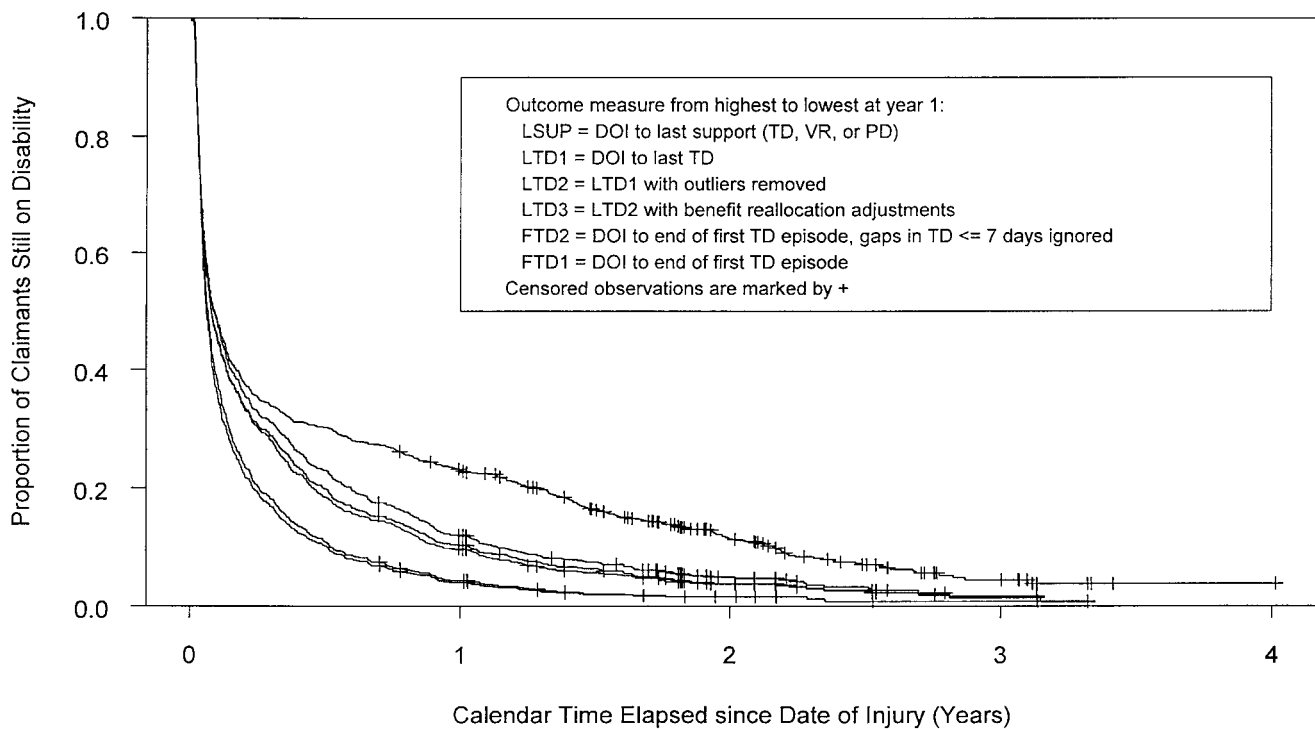


FIGURE 1. Proportion of claimants remaining on disability benefits by calendar time elapsed since date of injury. Kaplan-Meier product-limit estimates for six alternative methods of determining the end of disability benefits (see Table I for definitions). 1994–1996 California Low Back Pain Claimant Cohort, N = 839.

TABLE IV. Percent of Claimants Remaining on Disability Benefits at Selected Calendar Times (months after injury)*

Outcome measure ^a	Number of calendar months								
	1	3	6	9	12	18	24	30	36
Date of injury to									
End of first TD episode (FTD1)	40.4	19.4	10.1	5.9	4.0	1.9	1.6	0.8	0.8
End of last TD episode (LTD2)	49.0	30.9	19.9	14.5	10.3	6.3	3.8	2.7	1.4
End of all disability episodes (LSUP)	51.2	35.5	30.3	26.8	23.0	16.3	11.3	6.9	4.3

*Kaplan-Meier estimates for three alternative methods of determining the end of disability benefits. 1994–1996 California Low Back Pain Claimant Cohort, N = 839.

^aFor full definitions of outcomes, see Table I.

virtually identical survival curves. The balance between accuracy and effort in calculating these two measures would, therefore, seem to be weighted in favor of the less resource intensive measure (CUMTD2).

Table V shows the proportion of claimants remaining on disability for different numbers of months, measured by cumulative days on temporary disability and cumulative days on all types of wage replacement benefits. The biggest difference between these measures is seen for workers

receiving at least 30 months of disability benefits. If duration of disability is based solely on cumulative TD benefit periods, then the proportion of claimants receiving 30 or more months of benefits is underestimated by a factor of 5.75 compared to total compensated days, which additionally includes equivalent lost workdays covered by PD and VR benefits.

Point prevalence outcomes

Figure 3 compares the proportion of workers still on TD based on point prevalence (bottom curve) with the proportion of workers still on TD based on their last TD payment record. Table VI shows these proportions for different time periods of follow-up after date of injury. The point prevalence method consistently underestimates the number of workers still receiving TD payments, from a factor of 1.13 at 1 month to 7.0 at 36 months after the injury date.

Comparisons across outcome types

Figure 4 shows representative survival curves of each type of outcome measure. Time to last indemnity support and cumulative time on all wage replacement benefits represent the most inclusive estimates of duration of disability and are shown by the top two curves. They are followed by measures based on all temporary disability episodes,

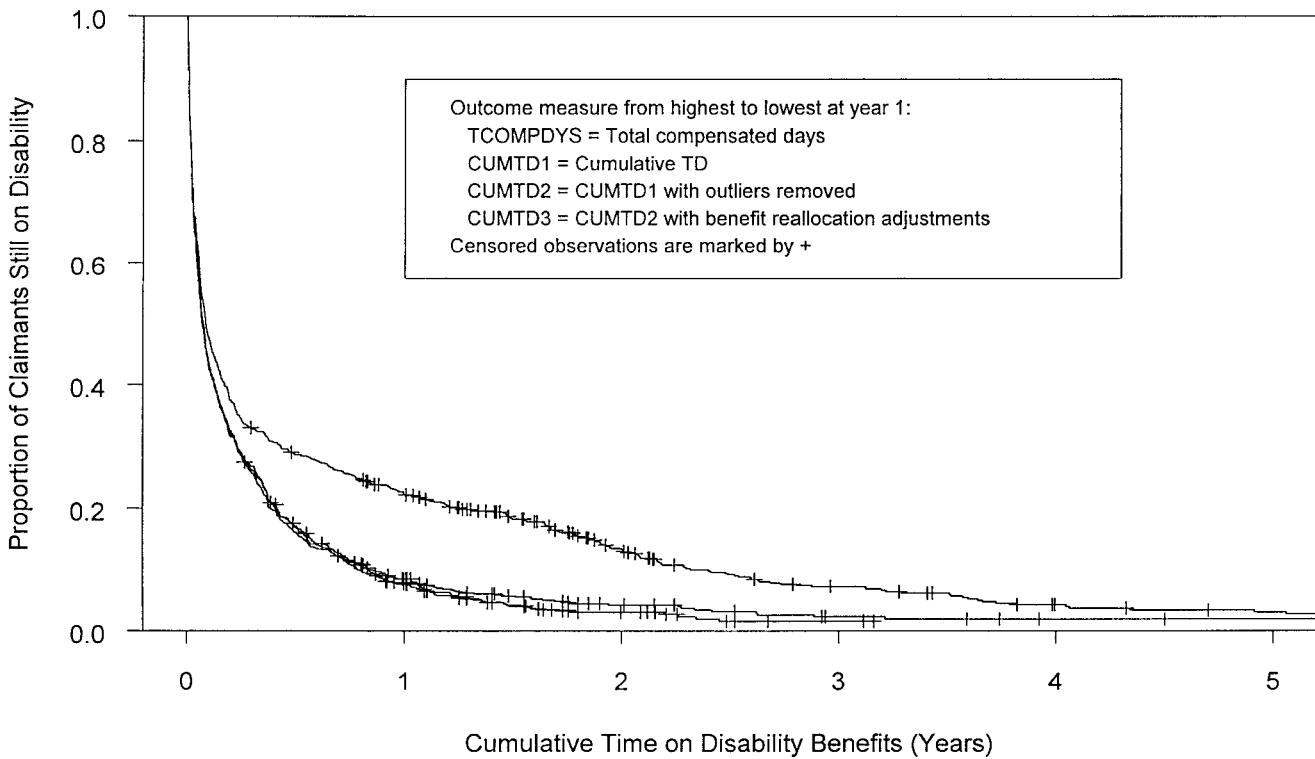


FIGURE 2. Proportion of claimants remaining on disability benefits by cumulative days of disability received. Kaplan-Meier product-limit estimates for four alternative methods of determining the end of disability benefits (see Table I for definitions). 1994–1996 California Low Back Pain Claimant Cohort, N = 839.

TABLE V. Percent of Claimants Remaining on Disability Benefits by Cumulative Months of Disability Benefits Received*

Outcome measure ^a	Number of cumulative months								
	1	3	6	9	12	18	24	30	36
Cumulative time on TD (CUMTD2)	47.0	29.0	16.9	11.3	7.9	4.2	3.0	1.6	1.6
Total compensated days (based on TD, VR, and PD) (TCOMP DYS)	51.0	34.3	28.7	25.5	22.3	18.3	13.2	9.2	7.2

*Kaplan-Meier estimates for two alternative methods of determining the end of disability benefits. 1994–1996 California Low Back Pain Claimant Cohort, N = 839.

^aFor full definitions of outcomes, see Table I.

measured in calendar time (LTD2), cumulative time (CUMTD2), and by point prevalence. The proportion of workers reaching the end of their first temporary disability episode is shown in the bottom curve. Table VII provides ratios of the proportions of the first five measures to the proportion of workers still disabled by the measure time to end of the first disability episode (FTD1), at selected monthly durations. These ratios differ not only between measurement method but also with length of follow-up. At

one month of disability, differences between the proportions of claimants still on disability assessed by different measures are modest (up to 27%). These differences then increase with time of follow-up, being most pronounced between 18 and 30 months, reaching a ratio of 11.5 for total compensated days at 30 months.

Total number of days on disability

All of the above comparisons focused on outcomes expressed as the proportion of workers remaining on disability at specified points in time. The Kaplan-Meier curves can also be used to estimate the total number of workdays lost across all cases for each alternative outcome definition. Table VIII shows the estimated mean number of workdays lost until the last payment date for each selected outcome measure. In addition, Table VIII gives the total number of disability days, calculated by multiplying the mean number of workdays lost by the population size. For example, based on cumulative days on any disability benefit type (TCOMP DYS), the mean duration of disability is 337 days. This mean multiplied by 850 yields a total of 286,450 disability days. If duration of disability is measured by the first TD episode alone, the mean and total number of disability days are 75 and 63,750, respectively. This measure, used as a proxy for first return to work, underestimates the total

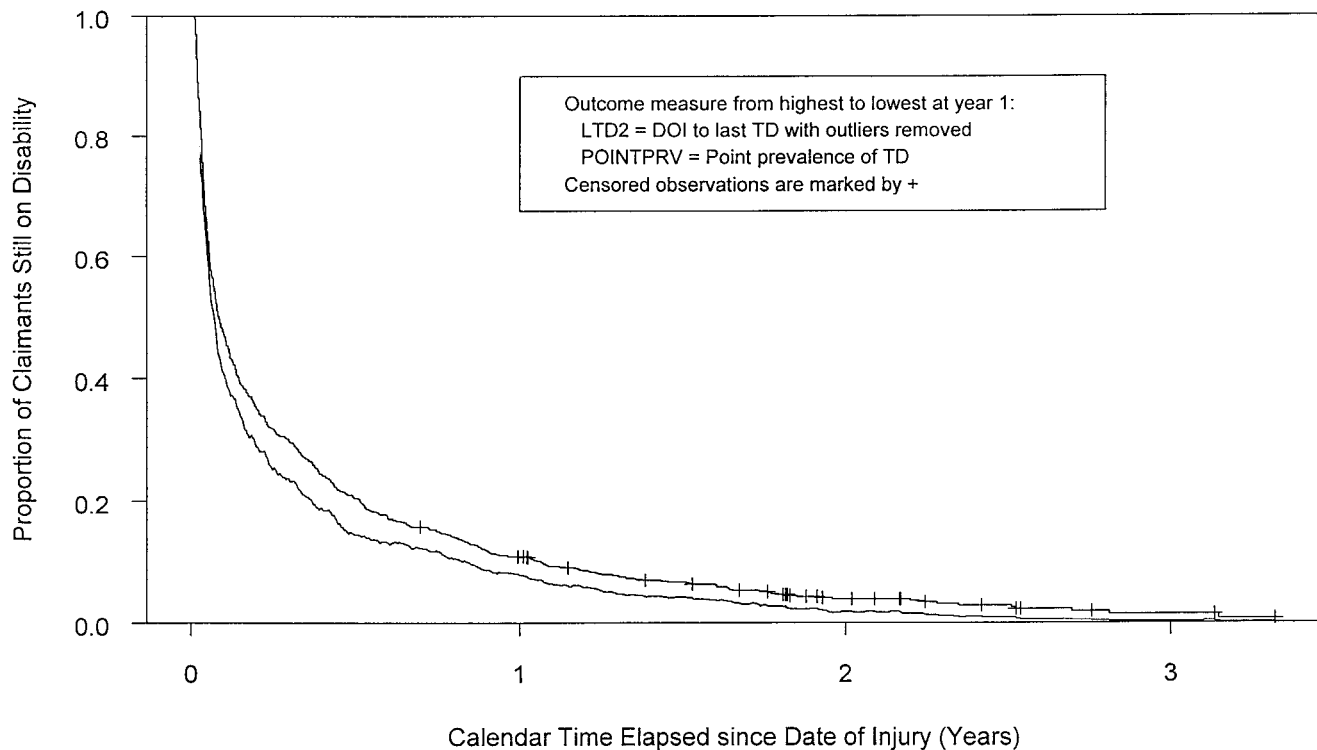


FIGURE 3. Proportion of claimants remaining on disability benefits by calendar time elapsed since date of injury. Kaplan-Meier product-limit estimate for one alternative measure of time to last TD and point prevalence of work disability (see Table I for definitions). 1994–1996 California Low Back Pain Claimant Cohort, N = 850.

TABLE VI. Percent of Claimants Remaining on Disability Benefits at Selected Months of Calendar Times (months after injury)*

Outcome measure ^a	Number of months								
	1	3	6	9	12	18	24	30	36
Time to end of last TD episode (LTD2)	49.6	31.5	20.5	15.1	10.9	6.7	3.9	2.9	1.4
Point prevalence of cases on TD (POINTPRV)	43.8	25.5	14.5	11.6	7.8	4.2	1.9	0.9	0.2
Ratio: LTD2/POINTPRV	1.13	1.24	1.41	1.30	1.40	1.60	2.05	3.22	7.00

*Kaplan-Meier estimate and point prevalence for two alternative methods of determining disability status. 1994–1996 California Low Back Pain Claimant Cohort, N = 850.

^aFor full definitions of outcomes, see Table I.

number of disability days by 222,700 days in our population, i.e., by an average of 262 days per person or a factor of 4.5.

Finally, Table VIII shows the number of disability days when 25, 50, 75, 90, 95, and 99% of workers have reached

the end of disability benefits. The median number of disability days (i.e., when 50% of workers reached the end of benefits) is 22 for the first temporary disability episode (FTD1) and 31 when cumulative days on all disability types are considered (TCOMPDYS). In both cases, the median is less than a tenth of the mean, indicating that a large proportion of disability days is accrued by subacute and chronic LBP cases. It took 844 compensated days of disability (TCOMPDYS) until 90% of the workers reached their end of disability benefit coverage.

DISCUSSION

This study compared eleven alternative measures of duration of work disability after occupational low back pain based on administrative workers' compensation data. Using wage replacement benefits as a proxy for disability duration or lost work time, outcome measures were classified according to three main types: point prevalence measures, calendar time to event outcomes, and cumulative time outcomes. The results showed substantial differences in the estimated mean number of disability days depending on the outcome measure used, ranging from 75 to 337 days. These differences increased with time of follow-up. The proportion of workers still on disability measured by the total number of compen-

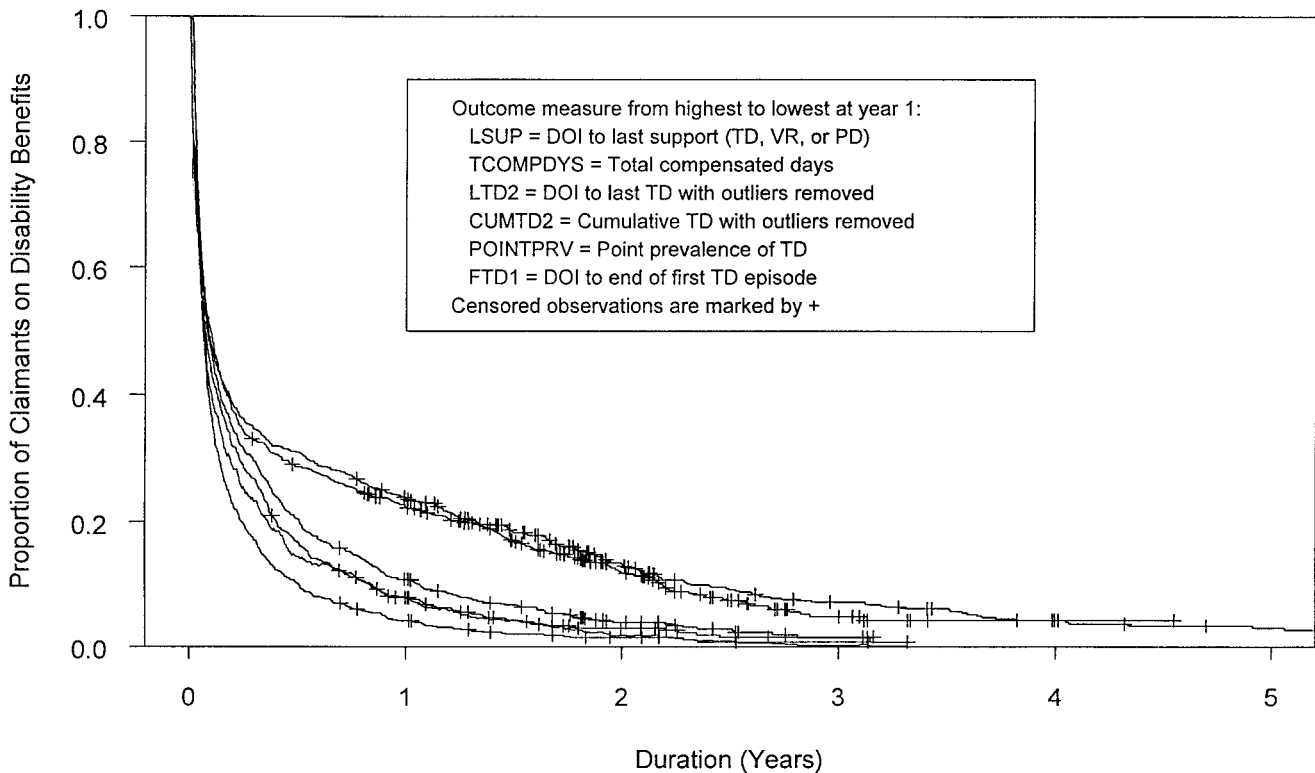


FIGURE 4. Proportion of claimants remaining on disability benefits by calendar time elapsed since date of injury or cumulative time on disability benefits. Kaplan-Meier product-limit estimates for selected methods of determining duration of disability benefits and point prevalence of disability (see Table I for definitions). 1994–1996 California Low Back Pain Claimant Cohort, N = 839.

TABLE VII. Ratios Between Alternative Measures of the Proportion of Claimants Remaining on Disability Benefits to FTD1, by Duration of Disability (months)*

Outcome measure ^a	Number of months								
	1	3	6	9	12	18	24	30	36
Time to end of first TD episode (FTD1)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Cumulative time on TD (CUMTD2)	1.15	1.46	1.65	1.82	1.88	2.10	2.00	2.00	2.00
Time to end of last TD episode (LTD2)	1.22	1.60	2.00	2.44	2.60	3.40	2.67	3.63	1.88
Time to end of all disability episodes (LSUP)	1.27	1.83	3.02	4.42	5.64	8.45	7.93	9.38	6.00
Total compensated days (based on TD, VR, and PD) (TCOMPDIS)	1.25	1.73	2.80	4.11	5.29	9.15	8.93	11.50	9.00

*Kaplan-Meier estimates for five selected methods of determining duration of disability benefits. 1994–1996 California Low Back Pain Claimant Cohort, N = 839.

^aFor full definitions of outcomes, see Table I.

sated days is 25% greater than that measured by time to the end of the first TD episode at 1 month, 73% greater at 3 months, 529% greater at 12 months, and 1,150% greater at 30 months of follow-up (calculated from figures in Table VII).

Point Prevalence Measures of Disability Status

Point prevalence measures of disability are not designed to measure duration of disability; rather, they measure the

TABLE VIII. Mean Disability Days, Total Disability Days, and Number of Disability Days for the 25th to 99th Percentiles of Claimants Who Have Reached the End of Disability Benefits, by Five Selected Outcome Measures: 1994–1996 California Low Back Pain Claimant Cohort, N = 850

Outcome measure ^a	Estimated mean days ^b	Estimated total days ^c	Estimated percentiles						
			25	50	75	90	95	98	99
Time to end of first TD episode (FTD1)	75	63,750	12	22	67	185	330	531	856
Cumulative time on TD (CUMTD2)	108	91,800	8	26	121	303	493	854	— ^d
Time to end of last TD episode (LTD2)	131	111,350	13	30	140	387	642	981	1,146
Time to end of all disability episodes (LSUP)	243	206,550	13	35	329	792	1,044	— ^d	— ^d
Total compensated days (based on TD, VR, and PD) (TCOMPDYS)	337	286,450	8	31	282	844	1,326	2,368	3,407

^aFor full definitions of outcomes, see Table I.

^bCalculated as area under Kaplan-Meier curves.

^cBased on N = 850 claimants.

^dPercentile was not observed due to censoring.

percentage of individuals that are disabled at specific points in time after injury or illness onset. Compared to estimates of disability duration based on the last TD payment, point prevalence measures consistently underestimate the percentage of claimants on TD by 1.2 to 6 percentage points (calculated from Table VI). The ratio of the proportion of claimants still on disability measured by these two outcomes (point prevalence/time to last TD) increases from 1.13 at one month to 7 at 3 years of follow-up, indicating an increasing bias with time of follow-up. More than 20% of claimants in our sample population experienced gaps in TD payments. Point prevalence outcomes are, therefore, of limited value in assessing the absolute burden of work disability. However, they are easily obtained and are useful and economic measures of the relative effectiveness of clinical interventions if the research question is limited to whether injured workers are working at a certain date. If the research question is about the economic efficiency of an intervention or how long injured workers have been off work, it is necessary to employ alternative outcome measures, as discussed below.

Time to First Return to Work and Other Calendar Time to Event Outcomes

We found that the duration of the first TD episode, a proxy measure for time to first return to work, seriously underestimates the total duration of work disability when compared to alternative outcome measures. Redefining the first TD episode to include gaps of seven days or less between TD payments does little to reduce the magnitude of this underestimation [Oleinick et al., 1996a]. More than 20% of LBP claimants in our population experienced multiple TD episodes during the 1 to 3.5 years of follow-up. This is consistent with the observation of other researchers that

workers with low back injuries experience recurring disabling symptoms and often make several attempts to return to work [Baldwin et al., 1996; Butler et al., 1995; Rossignol et al., 1992]. For these reasons, time to first return to work does not adequately reflect work disability associated with occupational low back injuries.

Based on clinical experience, both unduly delayed and premature return to work may result in an aggravation of the underlying condition, a delay in recovery, and/or recurrent work disability. Studies of the determinants of the duration of LBP disability and evaluations of disability management and early return to work programs should, therefore, not rely solely on time to first return to work as the outcome measure, but should take into account disability spells that occur after an initial return to work. Because of the chronic nature of some occupational LBP cases (over 10% of workers are still on TD at one year after the injury), and the positively skewed distribution of work disability days, follow-up periods of at least several years are necessary to capture the majority of subacute and chronic forms of LBP disability. Surveys with limited follow-up, for example, the Bureau of Labor Statistics Annual Survey of Occupational Injuries and Illnesses, with a 12-month follow-up period, substantially underestimate the burden of work disability, as noted by others [Hashemi et al., 1997; Murphy et al., 1996].

A more complete measure of time on TD benefits is time from date of injury to the end of the last TD episode. Different operationalizations of this measure adjust for outliers and reallocations of payments in the course of the claim. It seems appropriate to exclude short-term TD episodes of one or two days at the very end of a claim's history if they occur after a long period without any TD. These outliers probably reflect medical examinations or court appearances during the final adjudication or claim

settlement process. Taking administrative reallocations of TD payments into account added little to the precision of this measure and at the high cost of manually checking the payment history balance sheets.

Duration of TD benefits, however, provides only a lower bound for an estimate of the total number of compensated workdays lost. TD benefits may be replaced by other wage replacement benefits, i.e., permanent disability (PD) and/or vocational rehabilitation maintenance allowance (VR), if the condition fails to improve and/or precludes return to the pre-injury occupation. A sizable portion (about 30%) of claimants in our study population received such additional benefits. If duration of disability is measured as time from date of injury to date of the last wage replacement benefit of any type, the proportion of claimants still on disability is up to 3.6 times greater than that measured by time to the last TD episode, and up to 9.4 times greater than that measured by time to the end of the first TD episode (Table VII). The estimated mean number of days on disability is 75 for time to first return to work, 131 for time to the last TD episode, and 243 for time to last support. These examples illustrate that measures of time on TD substantially underestimate the time injured workers remain on some form of wage replacement benefits.

While wage replacement with TD and VR benefits can be assumed to preclude gainful employment, this assumption cannot always be made for PD benefits. Time to the last coverage date of any wage replacement support may overestimate the total duration of work disability for claimants who work while receiving PD. On the other hand, the duration of work disability for claimants who receive their final PD payment in the form of a lump-sum distribution is likely to be underestimated. Such lump-sum distributions are meant to cover anticipated earnings loss caused by future work disability, where the length of any future disability is essentially unknown. We were unable to analyze the net effect of these two opposing trends in estimating duration of disability for PD recipients. Because of this uncertainty in our estimation procedures, and because calendar time to event outcomes do not take gaps in work disability into account, we do not recommend the use of time to last indemnity support, as long as a better cumulative time outcome measure is available.

Cumulative Time Outcomes and the Total Number of Compensated Lost Work Days

In contrast to point prevalence and calendar time to event outcomes, cumulative time outcomes take into account gaps in disability benefit payments, which are a common feature in LBP claims. They are, therefore, conceptually more valid measures of total number of days on disability. Two subgroups of cumulative measures were created, three based on cumulative days on TD alone

(CUMTD measures) and one based on cumulative days on any type of wage replacement (TCOMPDYS). The three cumulative TD outcome measures did not differ substantially and can therefore be used interchangeably. However, two of the cumulative TD measures required access to individual payment records and extensive programming and hardware resources in order to identify and exclude gaps in benefit payments.

As with calendar time to event measures of days on TD benefits, cumulative time on TD benefits provides only a lower bound for an estimate of the total number of compensated workdays lost. In subacute and chronic low back pain cases, a major portion of work disability is compensated by PD and/or VR benefits. The cumulative measure “total compensated days” (TCOMPDYS) includes all three forms of wage replacement benefits and gives an estimate of the total number of lost workdays effectively compensated during the entire life of a workers’ compensation claim. In terms of feasibility and completeness, the total number of compensated lost workdays is the (cumulative) outcome measure of choice: (1) it requires information readily available in a single electronic file (Master Claims), TD rate information, and the sum total of TD, VR, and PD benefits; (2) it includes all disability episodes; (3) it utilizes all types of wage replacement benefits; (4) it takes into account gaps in benefit coverage; and (5) it automatically includes benefit reallocations made in the course of a claim.

Conceptually, however, the link between payment amount and duration of disability is less straightforward for PD than for TD payments. First, in contrast to TD and VR, the payment of PD does not preclude gainful employment. Second, PD payments are based on a formula that includes a highly variable construct of a medically derived impairment rating and an administratively and/or legally negotiated prediction about future disability and loss of future earnings capacity. Third, PD benefits are often paid as lump sums and in these instances it is not known how PD benefits relate to actual past and future work loss. Because of these issues and because of missing information on impairment and disability ratings in the electronic files, we were unable to create a daily PD rate similar to the TD rate.

Since the measure total compensated days is defined as the sum of all wage replacement benefits (TD+VR+PD) divided by the daily TD amount, it is not a measure of the number of days on TD, PD, or VR benefits. It is, in effect, a proxy measure of the number of disability days fully compensated, or, “equivalent” workdays lost. Applying the TD rate to PD and VR amounts produces an underestimate of days on PD and VR, since these benefits are generally paid at a lesser rate than TD. The daily TD rate is used as the unit for measuring effectively compensated workdays because it best reflects the implicit value the workers’ compensation system attaches to a full lost workday. The number of total compensated days is comparable to Oleinick and

coworkers' measure of the total number of workdays lost [Oleinick et al., 1993], which also includes lump-sum PD payments (VR benefits are not provided in the workers compensation system they studied). These authors report separately on the number of "equivalent workdays lost," which were calculated from PD lump-sum payments [Oleinick et al., 1993].

The inclusion of compensated future workdays lost, as reflected in PD lump-sum distributions, may lead to an under- or overestimation of total disability days. However, there is evidence from historical data as well as our own ongoing investigations that future work loss is underestimated by PD lump sum distributions. A historical New York study at the beginning of this century found that workers regularly suffer more work loss than is typically compensated for in lump-sum settlements [Larson, 1991]. This finding resulted in New York legislators banning such settlements altogether. Data from our own cohort of claimants suggest that the total number of compensated days considerably underestimates the number of workdays lost due to low back injuries when compared to self-reported data with one to four years of follow-up [Dasinger et al., 1999].

As our comparative data show, not including PD or VR benefits would bias the proportion of claimants still receiving benefits by a factor of up to 5.75 when compared to cumulative time on TD alone (calculated from figures in Table VII). Total compensated days is also a very economic outcome measure in terms of resource requirements for its assessment. In the context of this study, all its components are readily available from currently updated summary data in single file. As it appears to be the best administrative estimate of the total number of compensated workdays, we recommend it as the primary administrative outcome measure of work disability after low back injuries. Furthermore, its use by other researchers would facilitate the comparisons of results across studies.

Mean Vs. Median Number of Disability Days

The median number (50th percentile) of disability days ranges from 22 to 35 across outcomes, and the mean number ranges from 75 to 337, indicating a positively skewed distribution of disability days. This distribution is not due to an exceptional study population. Several other studies have consistently shown that the majority of workers' compensation costs (which are driven by indemnity payments) is caused by a relatively small proportion of workers with subacute or chronic disability [Abenhaim and Suissa, 1987; Franklin and Fulton-Kehoe, 1996; Hashemi et al., 1997; Leavitt et al., 1971; Snook, 1988; Spengler et al., 1986; Williams et al., 1998]. In our sample, the 5% of claims with the longest duration of disability account for more than 50%

(149,099 out of 286,450) of the total number of disability days accumulated in all claims. The upper 25% account for 91% (260,111 out of 286,450 days). Clearly, these segments of the distribution cannot be conceptualized as "outliers"; rather, they constitute the centerpiece of the disability problem, and need to be reflected in any summary statistics. The median values, however, reflect only the "high" end of those 50% of claims with the shortest durations of disability. These claims account for only 2% of the total number of disability days (4,928 out of 286,450). If one is interested in capturing a meaningful proportion of the total burden of disability and monitoring any changes in work disability, the median is not an appropriate summary measure of disability days. Whenever estimates of the mean or the total number of compensated disability days can be made, we recommend their routine use for conditions that show such a highly skewed distribution of lost workdays. It should be acknowledged that, although the estimated mean increases with duration of follow-up, it always underestimates the true mean in the absence of complete follow-up.

Conclusions

This study demonstrates that administratively based estimates of the duration of work disability after occupational low back injury vary widely depending on the outcome measure used and the duration of follow-up. This finding has serious implications for the adequacy and comparability of results from studies using different types of outcome. Outcomes based on temporary disability benefits, whether measured by point prevalence, calendar time, or cumulative time on TD benefits, provide only a lower bound for the duration of work disability after low back injury. All TD-based measures substantially underestimate the total duration of work disability, because they fail to take into account work loss during vocational rehabilitation and due to permanent disability. Time to the end of the first temporary disability episode, a commonly used proxy for time to first return to work, is the weakest among these measures because it also ignores multiple spells of TD disability episodes, a common feature of LBP claims. Cumulative time on TD benefits, however, may provide a reasonable measure of disability duration for cases that have not exceeded the administratively, medically, or legally determined maximum period of TD.

The total duration of work disability is best reflected by the total number of days effectively compensated by all forms of wage replacement benefits, i.e., temporary disability, permanent disability, and vocational rehabilitation maintenance allowance. This measure translates all indemnity amounts into a uniformly measured number of disability days using the value of a lost workday—the claimant's daily

TD rate—assigned by the workers' compensation system. We recommend this measure for routine use in determining the total duration of work disability due to occupational low back injuries.

All administrative measures of duration of work disability share the limitation that periods of injury-related work disability that have not been reported and/or compensated are not included. Therefore, these administrative outcomes probably represent conservative measures of the total burden of work disability associated with low back injuries.

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