

Occupational Health and Safety Surveillance and Research Using Workers' Compensation Data

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Objective: Examine uses of US workers' compensation (WC) data for occupational safety and health purposes. **Methods:** This article is a summary of the proceedings from an invitational workshop held in September 2009 to discuss the use of WC data for occupational safety and health prevention purposes. **Results:** Workers' compensation data systems, although limited in many ways, contain information such as medical treatments, their costs and outcomes, and disability causes that are unavailable from national occupational surveillance sources. **Conclusions:** Despite their limitations, WC records are collected in a manner consistent with many occupational health and safety surveillance needs. Reports are available on the use of WC data for surveillance and research purposes such as estimating the frequency, magnitude, severity, and cost of compensated injuries. Inconsistencies in WC data can limit generalization of research results.

Occupational injuries, illnesses, and fatalities are a major public health issue. In 2008, the US Bureau of Labor Statistics (BLS) reported 5214 workplace fatalities and 3.7 million workplace injuries and illnesses with 1.1 million resulting in days-away-from-work.^{1,2} Surveillance of workplace injuries, illnesses, and fatalities is required to efficiently allocate occupational safety and health prevention resources. Several ongoing surveillance programs, some specific for occupational injuries and illnesses³ and others for the general US population,^{4,5} contain occupation and employment information that help identify hazards and intervention opportunities and track trends. Yet, gaps in knowledge exist which limit effective, structured approaches for analysis of the economic and human burden of such injuries and illnesses⁶ and their surveillance in the US. Analysis of Workers' Compensation (WC) claims information can be an effective and economical means to discover essential prevention information. Workers' compensation records are collected longitudinally in a manner consistent with occupational surveillance programs⁷ and complement information in other surveillance programs.⁸ However, combining data from multiple states can be problematic due to the differences in statutes, regulations, and case law and occupational diseases, particularly those with long latencies, are not adequately reported. A workshop to explore the use of WC data for prevention of occupational injury and illness was convened in September 2009; the workshop proceedings have been published.⁹

Workers' compensation insurance for US workers in 2007 cost employers \$85 billion and covered over 130 million employees.¹⁰

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Although WC costs are routinely tabulated, WC records systems include data that could be utilized further for prevention purposes including industry, occupation, nature of injury and cause, hospitalizations, medical treatments and costs, disability duration, and eventual recovery. This article identifies important opportunities for systematic use of WC data for occupational safety and health surveillance purposes in the United States, and describes their many limitations.

SURVEILLANCE WITH WC DATA

When available, WC data have been used in many countries for systematic occupational surveillance.¹¹⁻¹⁸ In the United States, WC data have been used to supplement national surveillance of occupational injuries, illnesses, and fatalities from BLS.¹⁹

Liberty Mutual Research Institute for Safety has utilized WC data extensively for occupational injury surveillance purposes.²⁰⁻²³ Liberty Mutual Research Institute for Safety produces the annual Liberty Mutual Workplace Safety Index, first published in 2000, which combines WC data from Liberty Mutual, the BLS and National Academy of Social Insurance to estimate the national direct cost burden of occupational injuries. The Index further reports the categorical burden for each of the top 10 disabling event categories that contribute to the overall burden.^{24,25}

State-level WC data have been used for surveillance purposes in the United States. The Safety and Health Assessment and Research for Prevention program in Washington State developed the Prevention Index using WC claims frequencies and rates to evaluate priorities for intervention and other resources.²⁶⁻²⁸ Washington State WC data have also been used for surveillance purposes to help identify occupational hazards in the automotive collision repair industry²⁹ and the need for more extensive patient lifting interventions in hospitals and nursing homes.³⁰

The California Department of Public Health has conducted sentinel event surveillance of occupational asthma since 1993. Workers' compensation claims are one source of information used in California to identify asthma cases and intervention needs. Similar surveillance records do not exist at the national level so state-based surveillance systems provide essential opportunities to reduce occupational injuries and illnesses through interventions.³¹

WORKERS' COMPENSATION DATA FOR OTHER OCCUPATIONAL SAFETY AND HEALTH RESEARCH

Many investigators with access to WC data have produced important research results. Workers' compensation first reports of injury, job history, and subsequent case information on costs and duration have been used for epidemiologic studies of chronic conditions later in life from exposures to asbestos,³² noise,³³ and repetitive motion.³⁴ Englehardt et al³⁵ used WC data to describe risks among solid waste workers. Rosenman et al³⁶ combined WC data with other records to identify work-related asthma risks associated with the use of cleaning agents.⁸

Liberty Mutual Research Institute for Safety used WC data to produce descriptive studies of musculoskeletal disorder (MSD) costs for low back and upper extremities.^{37,38} Additional research at Liberty Mutual Research Institute for Safety using WC records has targeted risk factors for MSD,³⁹⁻⁴³ slips, trips, and falls,^{20,44}

recurrence of low back pain,⁴⁵ and evaluation of diagnostic and treatment practices of MSD.^{46–48}

Workers' compensation data from Washington State was used in a descriptive epidemiologic study of health disparities among temporary agency employees and those with limited English proficiency.⁴⁹ The latter group of workers had greater time away from work, greater claims costs, greater utilization of physical therapy and vocational services, and less surgery when compared with workers who preferred English.⁵⁰ Temporary agency employees experienced elevated risk classifications in several industries and occupations.^{51,52} In Washington State, linkage of WC claims to employment data sets such as those from a state employment security agency allowed injury rate calculations based on employment information such as hours worked. The combined records also were used to calculate loss of earnings following surgical treatment for carpal tunnel syndrome in comparison with workers who were treated for upper extremity fractures.^{53,54}

Workers' compensation records were matched against a state trauma registry using both deterministic and probabilistic methods to supplement information available for workplace injuries in the Illinois construction sector. The combined data set was used to evaluate data accuracy in each set of files and to increase the overall case capture for specific injuries. The median cost of compensation for a range of injuries, treatments, and outcome characteristics were determined from the combined data.^{55,56} A similar approach was used with Washington State WC and trauma registry data.⁵⁷ One limitation identified in those data was that WC underestimated the injuries among the self-employed, federal, maritime, and tribal populations.

Workers' compensation data have supported the enactment of health and safety legislation and evaluation of its impact. For example, the Safe Patient Handling legislation in Washington State reduced manual handling in hospitals subject to the legislation but WC incidence rates in nursing homes in the same state not covered by the legislation had increasing WC incidence rates over the same time period.⁵⁸

Organizations that are self-insured for WC have published articles based on their claims information in combination with other records to track frequency and severity of occupational disorders and to evaluate occupational safety and health program effectiveness.^{59–61} Program attributes such as the number of ergonomic surveys at an establishment were compared with the number of upper extremity MSD diagnoses and the number of cases that required surgical intervention.⁶² Other research with WC data has covered topics such as wage replacement ratio,^{63–66} compensating wage,^{67,68} whether injured workers file claims,^{69–72} and the impact of state statutes and regulation changes.^{73–76}

Salient issues on WC data utilization have been investigated such as the accuracy of WC data^{77–79} and that of other injury and illness surveillance programs,^{80–82} patterns of use of WC benefits by different populations of workers,^{49,83,84} and evaluation of WC program economic drivers.^{24,77,85–88} Self-insured entities can use various data systems to directly evaluate intervention programs⁶² and modify the systems as needed to achieve program goals.⁸⁹

DISCUSSION

Occupational injuries and illnesses are an important public health issue in the United States and globally. Workers' compensation insurance expenses in the United States have exceeded \$85 billion in recent years.^{10,90} In addition to direct WC expenses, there are other social costs that are measured with proxies such as the temporary or permanent loss of worker production, worker replacement and training, and family-provided health care that are more difficult to track. The total cost of work-related injuries and illnesses has been estimated at more than twice the dollar value of WC claims expenses.^{79,91} Because of its extensive coverage, WC data could and should be further utilized in the United States as an information

source for public health purposes. Workers' compensation data on diagnosis, treatments and outcomes, costs, and exposures have augmented national surveillance systems information.⁸ Yet, WC data have intrinsic limitations and vary among the states due to statutes, regulations, and case law.⁷⁸

Workers' compensation data are systematically collected for use by employers, medical providers, and insurers and they have properties that are consistent with many occupational health and safety surveillance needs.^{7,92} Greater than 130 million US workers are covered by employer-provided WC insurance,¹⁰ yet a comprehensive national WC data system does not exist in the United States.

Prior work has demonstrated that research with WC data can support surveillance, risk factor identification, intervention development, control strategies, and prevention program evaluation.⁹³ Workers' compensation data also have been used for epidemiologic studies and the results have been applied to reduce workplace hazards for many decades.^{8,31,79}

Longitudinal WC data sets exist at state insurance agencies, insurance carriers including state funds, reinsurance companies, and employers. Workers' compensation record systems contain information that is unavailable from other sources on incidence and rates of occupational injuries—including data stratified by state, industry, establishment, and corporation. Information in WC systems may be used to track lost work-time, temporary/permanent and partial/full disabilities along with reported immediate causation, and the portions of total costs that are disbursed to claimants and health care providers. Medical treatments, their costs, and outcomes in WC data are associated with specific injuries and classes of injuries in the data sets. Disability cause, duration, and cost data are generally quite complete. The narrative text in WC claim files can be used to identify hazards and illustrate their essential factors.⁹⁴

Yet substantial barriers to utilization of WC data exist. States began enacting WC insurance programs in 1908 and the history of WC in the United States is such that 50 sets of state laws are established with differing requirements.⁷⁸ For example, states vary in the coverage of compensable occupational injuries and illnesses, levels of payments for partial and total disability, both temporary and permanent, and the minimum days away from work to qualify for wage replacement. In many states, employers with small numbers of employees and other groups, such as farm employers, are exempt from coverage requirements and many larger employers are self-insured.^{8,10,78} In Texas, employers have the option to not offer WC.⁹⁵

Legal and administrative conditional filters affect record contents and vary by jurisdiction. Content variability across the United States can affect the interpretation of data as well as inhibit combining and comparing data. Cross-state comparisons require knowledge of statutes, regulations, court interpretations, and agency operations. Some important differences among state WC programs are: (1) regulations for which employers are mandated to provide coverage; (2) occupational illnesses that are compensable; (3) severity of injuries that require reporting; (4) treatment of cumulative trauma injuries and mental disorders; and (5) coverage of undocumented workers. Examination of one type of disability requires knowledge of the remaining classes of disability.⁷⁸

The actual numbers of injuries and illnesses classified as work-related for public health purposes may differ from those in paid claims records due to the legal definitions and administrative rules for compensable injuries and illnesses within WC systems. A large portion of workers with work-related injuries requiring medical treatment do not obtain care that is paid by WC insurance.^{77,96–98} The decision of a worker to file a WC claim can be influenced by many factors.^{95,99,100} Many low-wage workers have been found to be unaware of WC benefits and to fear reprisal for filing a claim or for missing work due to injuries.⁹⁷ Contingent workers may not have access to functional worksite claims systems or may be considered independent contractors instead of employees.¹⁰⁰ Incentive programs

for low injury rates and counts may induce pressure, both direct and indirect, for filing WC claims.^{99,100}

Proprietary records, state laws and practices, and Federal and state privacy and confidentiality rules can inhibit data sharing and analysis.⁷⁸ Private carriers' data systems and their contents are proprietary and often subject to contractual obligations regarding privacy and confidentiality. Release of the records may impair their competitive position as well as increase exposure to litigation. Multiple parties are involved in the development of the data sets so that errors and inconsistencies are likely due to the way data are collected and stored. For example, WC data used for managing claims payments may be more complete and accurate than other data elements such as cause and nature of injury.

Some organizations, for example, National Council on Compensation Insurance,¹⁰¹ systematically collect WC data from multiple sources for rating purposes using standardized methods. The National Academy of Social Insurance produces an annual report¹⁰ that is based, in part, on WC data from states. But these WC data are not generally available to public health organizations or individual researchers and many large data collections are restricted by confidentiality agreements.⁸⁸ If available, some WC data sets developed by rating agencies are expensive to purchase.⁷⁹ Yet, some requests to state WC agencies have been fulfilled and some insurance carriers and other organizations have published useful data.⁷⁹

Medical treatment and disability costs and trends can be derived from WC data to serve many needs in business, labor, and government programs. For example, allocation of resources can be improved through the analysis of medical treatment and cost information for specific injuries and conditions across larger populations of workers. Financial incentives for workplace safety may be compared through analysis of the relationship between the type of insurance, for example, retrospective rating program, and its effects on claims experience. Carriers and companies may use consolidated WC data for benchmarking.^{94,102}

Additional strategies for collaborations could expand capacity and capabilities to utilize WC data for public health purposes. Analyses of the frequency of events within industries or by region could ensure more effective prevention resource allocation and initiate prevention efforts. Analyses of injury or illness rates or their severities among employee groups might trigger identification of new hazards or conditions. Analysis of incidence, cost, and lost time data can be used to create business cases for prevention programs and provide employers with additional incentives to reduce claims through interventions. Cost-benefit evaluations for interventions would be more informative through the examination of financial, medical, and disability data available from WC records.⁹⁴

Workers' compensation data, where available, could be combined with other sources to provide vital public health information such as evidence for prevention needs based on the magnitude and cost of occupational illnesses and injuries. More complete estimates for the actual count of work-related injuries and illnesses may be developed through linking WC, BLS, and state registries, despite limitations in individual data sets. The total real cost of occupational injuries and illnesses could be estimated more accurately by linking data from WC, BLS, unemployment insurance, and Social Security Disability Insurance. Medical treatment effectiveness can be evaluated through combinations of data from WC, disability systems, and medical data systems. Cooperation among the Occupational Safety and Health Administration, Mine Safety and Health Administration and state Occupational Safety and Health Administration programs could allow determination of the effectiveness of regulatory requirements through evaluation of the WC data. An example is the impact of safe patient handling legislation in Washington State (with legislation) and Idaho (without legislation), or in Washington between hospitals covered by the legislation and nursing homes not covered by it.⁵⁸ Review of mandated employer reports and disability data

that are collected by WC, private and public disability insurance, and the Social Security Administration could lead to better public health intervention strategies. If a national disability database were established, WC data could be used to examine the contributions from occupational disorders.⁹⁴

Finally, WC data collection varies substantially between states. For example, data for acute injuries are far more complete and representative of population risks than are occupational illness data, particularly those with long latencies. However, surveillance with secondary data sources such as WC need not be complete to be informative.

FURTHER STEPS

A number of activities could help ensure greater utilization of WC data as a surveillance tool.⁹⁴ Pilot efforts in a few states could determine what data are most useful for surveillance purposes at the employer, carrier, and public health levels as a prelude to coordinating and standardizing methods. Capacity in state health and labor departments could be increased to support the use of WC data systems for evaluating workplace injuries and illnesses and to provide feedback to employers, carriers, and public health departments. Benchmarking could be provided by trade associations or others that use combined data sets to allow employers and carriers to compare their programs to others in similar industries.

Those who work with WC data should agree on a standard set of data coding systems. Some standardized data coding systems that are available include those from National Council on Compensation Insurance, the Occupational Injury and Illness Classification System, and the North American Industry Classification System. The International Association of Industrial Accident Boards and Commissions has developed standardized data forms used in many states. A joint venture of International Association of Industrial Accident Boards and Commissions and BLS could work on additional standardized reporting. Also, existing surveillance data systems could be expanded to include more information on cases. For example, BLS Survey of Occupational Injuries and Illnesses could capture whether a particular injury or illness case involved a hospitalization or emergency department visit.⁹⁴

Inclusion of historical occupation and industry into individual electronic medical records would allow better tracking of the full consequences of occupational injuries and illnesses when combined with WC and other existing medical data. This important change would better capture the full burden of occupational illness and injury and allow for the evaluation of the long-term consequences of work-related injuries, for example, the odds of osteoarthritis due to a work-related fracture of the hip may be greater than the odds of osteoarthritis for those without a history of work-related hip fracture.⁹⁴

CONCLUSION

Workers' compensation coverage of the US workforce extends to over 130 million US workers. Workers' compensation data systems contain claim information not available from national surveillance sources such as medical treatments, their costs and outcomes, specific injuries, classes of injuries, and some illnesses. Disability cause, duration, and cost data are generally quite complete. In addition, narrative text in WC claim files can be used to identify hazards and their determinants to specify interventions. Even though the recorded information varies among the states and multiple parties are involved in the completion of WC forms, the data have been shown to be adequate for etiologic research and occupational safety and health surveillance.⁹⁴ Numerous reports are available on the use of WC data for surveillance purposes such as estimating the frequency, magnitude, severity, and cost of compensated injuries and examining trends over time.

Yet, combining WC injury and illness data from many sources for occupational safety and health surveillance is a major challenge.

A variety of approaches should be tested. Development of surveillance systems with WC records from a single state would reduce the number of challenges; however, those estimates would not be nationally representative. Exclusive WC funds in North Dakota, Ohio, Washington, and Wyoming may be the most comprehensive data sources but every state has one or more agencies that prospectively compile WC records for administrative purposes. Some very large data sets in the insurance industry are routinely collected in standardized forms but their contracts restrict data analysis and require the protection of the proprietary interests of data contributors.⁹⁴

To increase the utilization of WC data for public health purposes, interested parties should identify effective approaches that encourage WC data owners to collaborate with public health researchers, for example, use of de-identified data sources. Health scientists, economists, and others could use the data sets for informative analyses of incidence and costs, identification of health hazards associated with new technologies, evaluation of injury and illness prevention program effectiveness, and to provide employers with information needed to protect a most valuable asset—their workforce.

REFERENCES

- Bureau of Labor Statistics, TABLE A-1. Fatal occupational injuries by industry and event or exposure, All United States, 2008. Available at: <http://www.bls.gov/iif/oshwc/foi/cftb0232.pdf>. Accessed February 23, 2011.
- Bureau of Labor Statistics, BLS News Release: Workplace Injuries and Illnesses—2008. Available at: <http://www.bls.gov/iif/oshwc/osh/os/osnr0032.pdf>. Accessed February 23, 2011.
- Bureau of Labor Statistics. BLS Handbook of Methods, Chapter 9. Occupational Safety and Health Statistics. Available at: <http://www.bls.gov/pub/hom/homch9.htm>. Accessed February 22, 2011.
- Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey (NHANES), 2009. Available at: http://www.cdc.gov/nchs/data/nhanes/nhanes_09_10/ocq_f.pdf. Accessed February 22, 2011.
- Centers for Disease Control and Prevention. 2009 National Health Information Survey. Public Use Data Release. Available at: ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2009/srvydesc.pdf. Accessed February 22, 2011.
- Leamon TB. Reducing occupational injury—the value and the challenge of determining the burden. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings from September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:11–13. NIOSH Publication No. 2010-152.
- Stanbury M, Anderson H, Rogers P, et al. *Guidelines for Minimum and Comprehensive State-Based Public Health Activities in Occupational Safety and Health*. Cincinnati, OH: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2008. NIOSH Publication No. 2008-148.
- Dembe AE. The contribution of workers' compensation research to public health. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings from September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:19–21. NIOSH Publication No. 2010-152.
- Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Prevention of Occupational Injuries and Illnesses: Proceedings from September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010. NIOSH Publication No. 2010-152.
- Sengupta I, Reno V, Burton JF. *Workers' Compensation: Benefits, Coverage, and Costs, 2007*. Washington DC: National Academy of Social Insurance; 2009.
- Rognstad K. Costs of occupational accidents and diseases in Norway. *Eur J Oper Res*. 1994;75:553–566.
- Conti DJ, Burton WN. The economic impact of depression in a workplace. *J Occup Environ Med*. 1994;36:983–988.
- Fisman DN, Mittleman MA, Sorock GS, Harris AD. Willingness to pay to avoid sharps-related injuries: a study in injured health care workers. *Am J Infect Control*. 2002;30:283–287.
- Fayad R, Nuwayhid I, Tamin H, Kassak K, Khogali M. Cost of work-related injuries in insured workplaces in Lebanon. *Bull World Health Organ*. 2003;81:509–516.
- Liang YX, Wong O, Fu H, Hu TX, Xue SZ. The economic burden of pneumoconiosis in China. *J Occup Environ Med*. 2003;60:383–384.
- Mannetje A, Pearce N. Quantitative estimates of work-related death, disease and injury in New Zealand. *Scand J Work Environ Health*. 2005;31:266–276.
- Hartley D, Biddle EA, Jenkins EL. Societal cost of workplace homicides in the United States, 1992–2001. *Am J Ind Med*. 2005;47:518–527.
- Leigh JP, Waehrer G, Miller TR, Keenan C. Costs of occupational injury and illness across industries. *Scand J Work Environ Health*. 2004;30:199–205.
- Wolf MH. 2010. Claims characteristics of workers aged 65 and older, NCCI Research Brief. Available at: <https://www.ncci.com/documents/Claims-65andOlder.pdf>. Accessed February 22, 2011.
- Leamon TB, Murphy PL. Occupational slips and falls: more than a trivial problem. *Ergonomics*. 1995;38:487–498.
- Courtney TK, Matz S, Webster BS. Disabling occupational injury in the U.S. construction industry. *J Occup Environ Med*. 2002;44:1161–1168.
- Smith GS, Timmons RA, Lombardi DA, et al. Work-related ladder fall fractures: identification and diagnosis validation using narrative text. *Accid Anal Prev*. 2006;38:973–980.
- Verma SK, Sorock GS, Pransky GS, Courtney TK, Smith GS. Occupational physical demands and same-level falls resulting in fracture in female workers: an analysis of workers' compensation claims. *Inj Prev*. 2007;13:32–36.
- Marucci-Wellman H. Methodological challenges in the liberty mutual workplace safety index: working towards a future model. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:29–36. NIOSH Publication No. 2010-152.
- Courtney TK. Workers' compensation data utilization in injury prevention research at the liberty mutual research institute for safety. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:49–53. NIOSH Publication No. 2010-152.
- Silverstein B, Viikari-Juntura E, Kalat J. Use of a prevention index to identify industries at high risk for work-related musculoskeletal disorders of the neck, back, and upper extremity in Washington state, 1990–1998. *Am J Ind Med*. 2002;41:149–169.
- Bonauto D, Silverstein B, Adams D, Foley M. Prioritizing industries for occupational injury and illness prevention and research, Washington State Workers' compensation claims, 1999–2003. *J Occup Environ Med*. 2006;48:840–851.
- Silverstein BA. Safety & health assessment and research for prevention (SHARP) program. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:5–10. NIOSH Publication No. 2010-152.
- Bonauto DK, Sumner AD, Curwick CC, Whittaker SG, Lofgren DJ. Work-related asthma in the spray-on truck bed lining industry. *J Occup Environ Med*. 2005;47:514–517.
- Silverstein BA, Howard N, Lee D, Goggins R. Lifting Patients/Residents/Clients in Health Care Washington State 2005: Report to the Washington State Legislature House Commerce and Labor Committee, 2006. Available at: <http://www.lni.wa.gov/Safety/Research/Files/HealthCareExecSumm.pdf>. Accessed February 23, 2011.
- Harrison R, Flattery J. State-based occupational injury and disease surveillance. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:73–82. NIOSH Publication No. 2010-152.
- Calhoun C, Hiller H. Coping with insidious injuries: the case of Johns-Manville Corporation and asbestos exposure. *Soc Probl* 1988;35:162–181.
- Johnson ED. Sounds of silence for the walkman generation: rock concerts and noise-induced hearing loss. *Indiana Law J*. 1993;68:1011.
- Dembe AE. *Occupation and Disease*. New Haven, CT: Yale University Press; 1996.
- Englehardt JD, Fleming LE, Bean JA, et al. *Solid Waste Management Health and Safety Risks*. Gainesville, FL: Florida Center for Solid and Hazardous Waste Management; 2000. Available at: <http://www.floridacenter.org/publications/englereport.pdf>. Accessed August 30, 2009.
- Rosenman KD, Reilly M J, Schill DP, et al. Cleaning products and work-related asthma. *J Occup Environ Med*. 2003;45:556–563.
- Webster BS, Snook SH. The cost of compensable upper extremity cumulative trauma disorders. *J Occup Environ Med*. 1994;36:713–717.

38. Webster BS, Snook SH. The cost of compensable low back pain. *J Occup Environ Med.* 1990;32:13–15.
39. Brogmus GE, Sorock GS, Webster BS. Recent trends in work-related cumulative trauma disorders of the upper extremities in the United States: an evaluation of possible reasons. *J Occup Environ Med.* 1996;38:401–411.
40. Hashemi L, Webster BS, Clancy EA, Courtney TK. Length of disability and cost of Work-Related musculoskeletal disorders of the upper extremity. *J Occup Environ Med.* 1998;40:261–269.
41. Hashemi L, Webster BS, Clancy EA, Volinn E. Length of disability and cost of Workers' compensation low back pain claims. *J Occup Environ Med.* 1997;39:937–945.
42. Murphy PL, Volinn E. Is occupational low back pain on the rise? *Spine (Philadelphia PA 1976).* 1999;24:691–697.
43. Murphy PL, Courtney TK. Low back pain disability: relative costs by antecedent and industry group. *Am J Ind Med.* 2000;37:558–571.
44. Courtney TK, Sorock GS, Manning DP, Collins JW, Holbein-Jenny MA. Occupational slip, trip, and fall-related injuries – can the contribution of slipperiness be isolated? *Ergonomics.* 2001;44:1118–1137.
45. MacDonald MJ, Sorock GS, Volinn E, Hashemi L, Clancy EA, Webster B. A descriptive study of recurrent low back pain claims. *J Occup Environ Med.* 1997;39:35–43.
46. Tacci JA, Webster BS, Hashemi L, Christinani DC. Clinical practices in the management of New-Onset, uncomplicated, low back workers' compensation disability claims. *J Occup Environ Med.* 1999;41:397–404.
47. Tacci JA, Webster BS, Hashemi L, Christinani DC. Healthcare utilization and referral patterns in the initial management of New-Onset, uncomplicated, low back Workers' compensation disability claims. *J Occup Environ Med.* 1998;40:958–963.
48. Mahmud MA, Webster BS, Courtney TK, Matz S, Tacci JA, Christiani DC. Clinical management and the duration of disability for work-related low back Pain. *J Occup Environ Med.* 2000;42:1178–1187.
49. Bonauto DK. Identifying vulnerable populations in workers' compensation data: limited English proficiency workers and temporary agency workers. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop.* Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:125–129. NIOSH Publication No. 2010-152.
50. Bonauto DK, Smith CK, Adams DA, Fan ZJ, Silverstein BA, Foley MP. Language preference and non-traumatic low back disorders in Washington state workers' compensation [published online ahead of print]. *Am J Ind Med.* 2010;53:204–215.
51. Foley MP. Flexible work, hazardous work: the impact of temporary work arrangements on occupational safety and health in Washington State, 1991–1996. *Res Hum Cap Dev.* 1998;12:123–147.
52. Smith CK, Silverstein BA, Bonauto DK, Adams D, Fan ZJ. Temporary workers in Washington State [published online ahead of print]. *Am J Ind Med.* 2010;53:135–145.
53. Foley MP, Silverstein B, Polissar N. The economic burden of carpal tunnel syndrome: long-term earnings of CTS claimants in Washington State. *Am J Ind Med.* 2007;50:155–172.
54. Foley MP. Linking workers' compensation and employment security data for occupational health and safety surveillance. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop.* Cincinnati OH: National Institute for Occupational Safety and Health; 2010:145–148. NIOSH Publication No. 2010-152.
55. Friedman L, Forst L. Occupational injury surveillance of traumatic injuries in Illinois using the Illinois trauma registry, 1995–2003. *J Occup Environ Med.* 2007;49:401–410.
56. Forst L, Friedman L. Data linkages for prevention: traumatic injuries in construction. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop.* Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:159–161. NIOSH Publication No. 2010-152.
57. Sears JM, Bowman SM, Adams D, Silverstein B. Occupational injury surveillance using the Washington state trauma registry identification of work-related injuries in the Washington state trauma registry. *J Occup Environ Med.* In press.
58. Silverstein B, Howard N, Adams D. Implementation of safe patient handling in Washington State Hospitals, report to the Washington State Legislature 2010. Available at: <http://washingtontsafepatienthandling.org>. Accessed July 5, 2011.
59. Bernacki EJ, Guidera JA. The effect of managed care on surgical rates among individuals filing for workers' compensation. *J Occup Environ Med.* 1998;40:623–631.
60. Bernacki EJ, Guidera JA, Schaefer JA, Lavin RA, Tsai SP. An ergonomics program designed to reduce the incidence of upper extremity work related musculoskeletal disorders. *J Occup Environ Med.* 1999;41:1032–1041.
61. Bernacki EJ, Tsai SP. Ten years' experience using an integrated workers' compensation management system to control workers' compensation costs. *J Occup Environ Med.* 2003;45:508–516.
62. Bernacki EJ. The use of workers' compensation data to identify and track workplace risk and the effectiveness of preventative measures. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop.* Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:155–157. NIOSH Publication No. 2010-152.
63. Loeser JD, Henderlite SE, Conrad DA. Incentive effects of workers compensation benefits: a literature synthesis. *Med Care Res Rev.* 1995;52:34–59.
64. Butler RJ, Worrall JD. Workers compensation—benefit and injury claims rates in the seventies. *Rev Econ Statist.* 1983;65:580–589.
65. Boden LI. Workers' compensation in the United States: high costs, low benefits. *Ann Rev Public Health.* 1995;16:189–218.
66. Boden LI, Reville RT, Biddle J. The adequacy of workers compensation cash benefits. In: Roberts K, Burton JF, Bodah MM, eds. *Workplace Injuries and Diseases, Prevention and Compensation: Essays in Honor of Terry Thomason.* Kalamazoo, MI: WE Upjohn Institute for Employment Research; 2005:37–38.
67. Leigh JP, Miller TR. Ranking occupations based upon the costs of job-related injuries and diseases. *J Occup Environ Med.* 1997;39:1170–1182.
68. Leigh JP, Robbins JA. Occupational disease and workers' compensation: coverage, costs, and consequences. *Milbank Q.* 2004;82:689–721.
69. Biddle J, Roberts K, Rosenman KD, Welch EM. What percentage of workers with work-related illnesses receive workers' compensation benefits? *J Occup Environ Med.* 1998;40:325–331.
70. Leigh JP. Expanding research on the economics of occupational health. *Scand J Work Environ Health.* 2006;32:1–4.
71. Lakdawalla D, Reville RT, Seabury S. *How Does Health Insurance Affect Workers' Compensation Filing?* Santa Monica, CA: RAND Institute for Civil Justice; 2005. Working Paper No. WR-205-1-ICJ.
72. Gilmore Research Group. Survey of Injured Workers: Claim Suppression and Direction of Care. Prepared for State of Washington. Seattle, WA: Department of Labor and Industries; 2007. Available at: <http://www.lni.wa.gov/ClaimsIns/Files/DataStatistics/DataAnalysis/SurveyInjuredWrks.pdf>. Accessed February 24, 2011.
73. Leigh JP, McCurdy SA. Differences in workers' compensation disability and impairment ratings under old and new California law. *J Occup Environ Med.* 2006;48:419–425.
74. Brigham CR. *Permanent Impairment—Disability Rating Study: Impact of the AMA Guides to the Evaluation of Permanent Impairment. Fifth Edition on Permanent Disability Ratings in the State of California* [Exhibit 2 in July 1, 2005, WCIRB Regulatory Filing as Amended May 19, 2005. Workers Compensation Insurance Rating Bureau]. Portland, ME: Brigham & Associates, Inc; 2005.
75. California Commission on Health and Safety and Workers' Compensation (CHSWC). Available at: http://www.dir.ca.gov/chswc/Reports/memounewratings_through_june_30_07_revised_aug_9.pdf. Accessed July 27, 2009.
76. Amick BC, Hogg-Johnson S. Managing prevention with leading and lagging indicators in the workers' compensation system. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop.* Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:83–87. NIOSH Publication No. 2010-152.
77. Azaroff LS. Narrative to accompany “barriers to reporting,” In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop.* Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:135–139. NIOSH Publication No. 2010-152.
78. Bateman K. Differences among state workers' compensation laws and regulations. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop.* Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:105–108. NIOSH Publication No. 2010-152.
79. Leigh JP. Past, present and future uses of some workers' compensation data. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September*

- 2009 Workshop. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:97–104. NIOSH Publication No. 2010-152.
80. Nestoriak N, Pierce B, Ruser J. Reconciling workplace injury and illness data sources. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:23–27. NIOSH Publication No. 2010-152.
 81. Nestoriak N, Pierce B. Comparing Workers' Compensation claims with establishments' responses to the SOII. *Monthly Labor Rev*. 2009;132:57–64.
 82. Oleinick A, Zaidman B. Harmonizing existing databases counting workplace injuries and illnesses. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:37–41. NIOSH Publication No. 2010-152.
 83. Seidner A. Overview of an insurance carrier's service sector data. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:43–48. NIOSH Publication No. 2010-152.
 84. Schmid FA. Learning from Workers' Compensation Claims Triangles. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings from September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:115–118.
 85. Burton JF Jr. A brief history of economists' research on the effect of workers' compensation on safety and health. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:15–18. NIOSH Publication No. 2010-152.
 86. Burton JF Jr. National averages of employee benefits and employer costs for workers' compensation. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:109–114. NIOSH Publication No. 2010-152.
 87. Shuford H, Restrepo T, Beaven N, Leigh JP. Trends in components of medical spending within workers compensation: results from 37 states combined. *J Occup Environ Med*. 2009;51:232–238.
 88. Shuford H. Identifying and tracking trends in workplace injuries and illnesses—opportunities and challenges in using workers' compensation rating bureau data. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:119–123. NIOSH Publication No. 2010-152.
 89. Carson S. Using workers' compensation data: the move from lagging to leading indicators. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:95–96. NIOSH Publication No. 2010-152.
 90. Sengupta I, Reno V. Workers' compensation coverage by state. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:165–172. NIOSH Publication No. 2010-152.
 91. Huang YH, Leamon TB, Courtney TK, Chen PY, DeArmond S. Corporate financial decision-makers' perceptions of workplace safety. *Acc Anal Prev*. 2007;39:767–775.
 92. Baker EL, Matte TO. Surveillance of occupational illness and injury. In: Halperin W, Baker EL, Monson RR, eds. *Public Health Surveillance*. New York, NY: Van Nostrand Reinhold; 1992.
 93. Smith GS. Public health approaches to occupational injury prevention: do they work? *Inj Prev*. 2001;7:i3–i10.
 94. Silverstein BA, Spieler E, Utterback DF, Schnorr TM, Leamon TB, David L. Summary of workshop discussion: occupational health and safety surveillance using workers' compensation data. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:173–175. NIOSH Publication No. 2010-152.
 95. Brewer S, Tullar JM, Amick BC. Using employer records—pitfalls and opportunities. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:55–62. NIOSH Publication No. 2010-152.
 96. Fan ZJ, Bonauto DK, Foley MP, Silverstein BA. Underreporting of work-related injury or illness to workers' compensation: individual and industry factors. *J Occup Environ Med*. 2006;48:914–922.
 97. Bernhardt A, Milkman R, Theodore N, et al. Broken laws, unprotected workers: violations of employment and labor law in America's cities [Center for Urban Economic Development, National Employment Law Project, UCLA Institute for Research on Labor and Employment]. Available at: http://nelp.3cdn.net/319982941a5496c741_9qm6b92kg.pdf. Accessed February 23, 2011.
 98. Centers for Disease Control and Prevention. Proportion of workers who were work-injured and payment by workers' compensation systems—10 states, 2007. *MMWR Morb Mortal Wkly Rep*. 2010;59:897–900.
 99. Lashuay N, Harrison R. *Barriers to Occupational Health Services for Low-Wage Workers in California, San Francisco*. San Francisco, CA: University of California; 2006.
 100. Scherzer T, Rugulies R, Krause N. Work-Related pain and injury and barriers to workers' compensation among Las Vegas hotel room cleaners. *Am J Public Health*. 2005;95:483–488.
 101. National Council on Compensation Insurance, Inc. Detailed Claim Information Data Reporting Tools and Services Guide. Available at: <https://www.ncci.com/documents/Guide-DCI-ToolsSvc-2010.pdf>. Accessed February 22, 2011.
 102. Stewart M. Benchmarking and performance measurement for governments. In: Utterback DF, Schnorr TM, eds. *Use of Workers' Compensation Data for Occupational Injury and Illness Prevention: Proceedings From September 2009 Workshop*. Cincinnati, OH: National Institute for Occupational Safety and Health; 2010:89–92. NIOSH Publication No. 2010-152.