Deriving Occupational Fatal Injury Costs: A State Pilot Study

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A pilot study tested an effort to develop accurate, timely, and readily available State-based estimates of the costs associated with fatal occupational injuries; it found that such estimates would benefit safety and health professionals and aid the overall education and prevention efforts aimed at eliminating workplace fatalities.

In 1970, the U.S. Congress passed the Occupational Safety and Health Act to assure "so far as possible every working man and woman in the Nation safe and healthful working conditions."[1] This landmark legislation created two new agencies to meet this ambitious goal. The act established the Occupational Safety and Health Administration (OSHA) to perform the enforcement function and the National Institute for Occupational Safety and Health (NIOSH) to perform the research function. In addition, the Bureau of Labor Statistics (BLS) was charged with developing and maintaining a comprehensive statistical system covering all work-related deaths, injuries, and illnesses.[2]

Occupational mortality statistics are used to quantify the extent of some public health problems, such as fatal occupational injury, and to determine the relative importance of various worker and case characteristics. Frequency counts and incidence rates for fatal occupational injuries in the United States are annually collected and presented.[3] Such relevant data provide a basis for setting priorities for research and prevention efforts. However, in addition to including the magnitude of the problem (frequency of injury and size of affected workforce) and the risk to workers (rates of injury), the criteria for setting priorities should include the amenability of fatal occupational injuries to prevention efforts, including the cost effectiveness of such efforts.[4] To date, few studies have provided national cost estimates suitable for evaluative tools such as cost-effectiveness, cost-benefit, and decision analysis to assist in allocating limited resources more effectively. This pilot study tested an effort to develop State-based cost estimates that are representative, timely, and readily available for use by safety and health professionals.

Methods To Calculate Economic Cost

There are two fundamental economic approaches used to assess the cost of an occupational fatality: *willingness to pay* (a utility measure) and *cost of illness* (a welfare measure). The results obtained may vary drastically, depending on the model and variables used to generate the estimates.

The willingness-to-pay (WTP) method assigns dollar values to the resources that individuals are willing and able to forego for a reduction in the probability of encountering a hazard that may result in their dying at work. WTP estimates are derived through either "stated-preference" or "revealed-preference" methods. The first method involves asking individuals directly how much money they would be willing to trade for a change in fatal health risk. The second method, "revealed-preference," observes the choices individuals make concerning health risks. Accepting a higher wage for jobs that have a higher risk of death, or purchasing a bicycle helmet to decrease the risk of fatal traumatic brain injury are examples of revealed preference. The value of a statistical life (VSL), a commonly used statistic, measures the monetary amount that an individual would trade to reduce mortality risk by a small increment. The sum of these individual monetary amounts provides a societal value of one unit of fatal risk reduction or one statistical life.

The cost-of-illness (COI) method, which was used in this model, estimates the cost of an occupational fatality by summing the value of two components: direct and indirect costs. Direct costs consist of the actual dollar expenditures associated with the fatality and include the value of all goods, services, and other resources that are consumed. They are the value of those resources that could have been used elsewhere if the fatality had not occurred. The most prominent direct costs are health care costs, which include physician’s fees, prescription medicines, ambulance service, and hospitalization fees.

Indirect costs in this model are measured using the human-capital method. This method values health according to the economic productivity of the worker. Calculating the full economic or productivity loss requires determining the sum of the discounted value of all lost present and future productivity of the worker, both market and nonmarket. Market loss is the value of the decedents' lost future earnings. Nonmarket loss represents the present and future value of goods and services they would have produced in the home.

The COI approach was selected as the best approach for use in this model for the following reasons: First, because this method employs a societal perspective, many researchers in the field consider it to be the most appropriate method for a public health agency to select.[5] COI is a measure of the impact of a premature death on society,[6] rather than the measure of an individual's value of reducing the risk of fatal injury. Secondly, adopting this method is the most pragmatic in that data are reliable, easily acquired, and most often free of charge,[7] as is the case for data available from BLS. Furthermore, computations using the COI approach are relatively easy to perform and the results can be understood by noneconomists. In contrast, calculating national estimates using the willingness-to-pay approach is extremely labor intensive and requires expensive surveys which themselves demand significant developmental work prior to implementation. Finally, the WTP estimates are subject to great variability based on the respondent's economic status and their physical and mental condition at the time of the survey.

Cost Calculator

The National Institute for Occupational Safety and Health (NIOSH) developed a computerized cost calculator to estimate the monetary reduction in the U.S. Gross Domestic Product (GDP) associated with a fatal occupational injury.[8] The calculator computes comprehensive national estimates of the economic burden of occupational fatal injuries reported by the NIOSH National Traumatic Occupational Fatalities (NTOF) surveillance system. It estimates the value of an individual fatality based on the key characteristics of the fatally injured worker, and then sums the individual fatality costs to arrive at the national burden. It provides national and State estimates for the economic burden of occupational fatalities among various groups of workers, such as those in specific industries or occupation groups, minority workers, older workers, and teenage workers. The calculator supports yearly updates, scenario analysis, and the potential for linking to other fatal and nonfatal databases.

For this study, direct costs included only medical expenditures. The indirect cost estimates of occupational fatal injury ($PV_{fatality}$) are generated using the following algebraic expression:

$$PV_{fatality} = \Sigma P_{y,q,s}\,(y+1)[Y_{s,j}(n) + Y^{h}_{s}(n)]\,(1+g)^{n-y}/(1+r)^{n-y},$$

where

$P_{y,q,s}(y+1)$ = probability that a person of age y, race q, and sex s will survive to age y+1

y = age of the individual at death,

q = race of the individual,

s = sex of the individual,

j = occupation of individual at death,

n = age if the individual had survived,

$Y_{s,j}(n)$ = median annual earnings of an employed person of sex s, occupations j, and age n (includes benefits and life-cycle wage growth adjustment),

$Y^h{}_s(n)$ = mean annual imputed value of home production of a person of sex s and age n,

g = wage growth rate attributable to overall productivity, and

r = real discount rate (3 percent).

National cost estimates[9] represent income that was not received and medical expenses incurred because of fatal injuries, which affect the gross domestic product and other national economic measures. These estimates can be used to improve occupational injury prevention and control program planning, prioritizing research needs, policy analysis, evaluation of safety and health interventions, and advocacy efforts for safer working conditions. Although this calculator can produce cost estimates by State, the calculation currently uses national wage data from the BLS Current Population Survey (CPS). Because using State-specific wage data would improve the accuracy and credibility of these estimates for use in policy analysis for individual State programs, a pilot project was conceived to determine the feasibility of deriving such estimates.

State Pilot

The initial model developed to calculate the societal cost of fatal occupational injuries was modified by replacing the decedent characteristics from the NIOSH National Traumatic Occupational Fatalities (NTOF) surveillance system with data from the BLS Census of Fatal Occupational Injuries (CFOI). This change provided an opportunity to work directly with the participating CFOI State staff. In addition to being familiar with the CFOI program, the staff was instrumental in attempting to access necessary State-specific data (such as median annual wage by detailed occupation, and employee benefits) to improve the specificity of the model, and their comments on the utility of the estimates also were helpful.[10]

BLS and Texas agreed to collaborate with NIOSH to evaluate the cost calculating model. The cost calculator was customized by eliminating all but Texas fatality data for the years 1992 through 1999 and by maintaining national wage data for those same years. This "Texas model" was provided to the Health and Safety Division of the Texas Workers' Compensation Commission staff for initial evaluation. The evaluation focused on the overall usefulness of the cost estimates for making policy decisions, the ease of operation of the model, and the appropriateness of the variables included and excluded in the model.

Following an initial review of the cost calculating model, NIOSH requested State wage data from Texas to quantify the merit of having State-specific wage data used to calculate the cost estimations. At that time, Texas provided 2002 wage data, the most current estimates available, to replace the national wage data in the cost calculating model. However, these wages could not be used because 2002 CFOI fatality data were not used in the pilot cost calculator and were not available from CFOI at the time this work was being conducted. Additionally, Texas wage data for 2002 and years prior were coded using the Standard Occupational Classification (SOC) structure, while CFOI data were coded using the Bureau of the Census (BOC) coding structure. A direct conversion between the two systems suitable for analytical purposes does not exist; therefore, these two systems are incompatible for use in the cost estimation model.

Discussion

Prior to this study, the cost calculator had been reviewed for theoretical appropriateness, but not for the practical operational issues. As stated earlier, this review would focus on the ease of operation and the appropriateness of the variables included, as well as the overall usefulness of the estimates in policy planning and decision making.

The subsequent review by the Texas Workers' Compensation Commission provided valuable operational recommendations that could be applied not only to a State-specific model but also to the national model. Table 1 summarizes the comments and suggestions made by the commission. In addition to this initial review, NIOSH requested that the commission provide Texas wage data by occupation for 1 year to determine the value of having State-specific wage data used in the cost estimations. Although Texas provided the requested wage data, they could not be used for this study (for the reasons explained in the previous section). Despite these limitations, NIOSH researchers developed an alternative approach to demonstrate the impact of wages on cost estimates.

First, State median wages were compared with national median wages for one occupation, truck drivers, using 1999 data from the BLS Occupational Employment Statistics (OES) program. NIOSH focused on this occupation because Texas had a sufficient number of fatalities in that occupation to generate yearly cost estimates when constrained to a single age. Texas OES wages for truck drivers were approximately 14 percent lower than the OES national median wage for that occupation. Second, Texas-specific wage data for this occupation were estimated by reducing CPS national wage data for truck drivers by 14 percent. Finally, for demonstration purposes, all other variables were held constant and national cost estimates were generated using CPS national wage data for truck drivers (BOC category 804), and Texas cost estimates were generated using Texas-specific wage estimates for that occupation. These estimates are presented in table 2. Texas cost estimates were between 10 and 11 percent lower than national estimates.

Conclusions And Future Directions

The computerized cost calculator was successfully modified to use CFOI decedent data and further subset to include only those decedents where Texas was the "State of Injury" reported. With one exception, recommendations from the Worker Health and Safety Division of the Texas Workers’ Compensation Commission (TWCC) were incorporated. Hispanic estimates could not be provided because the national wage data used in these calculations included race but not ethnicity classifications.

Despite not using Texas-specific wages, the TWCC derived estimates of the economic impact on the State economy resulting from occupational fatalities occurring in that State. These estimates quantified the benefits accrued from prevention efforts aimed at reducing the number of occupational fatalities. The participation of Texas in this pilot project was advantageous because it provided insight into potential expansion of that State’s CFOI analysis function by providing cost estimates that could be used in cost-effectiveness and cost-benefit studies.

This pilot study suggests that benefits could be gained by exploring methods to modify the national model to include State-based wage data for estimation. State-specific wage data will be available when the new Standard Occupational Classification (SOC) system is adopted by both the wage and fatality programs. Beginning with data for 2003, CFOI and the BLS OES wage program will use the same occupational classification structure. Therefore, the changes to the model can be made for 2003 CFOI data.

With such enhancements, the cost calculator would be capable of deriving estimates for each participating CFOI State as well as deriving more accurate national estimates. In summary, estimates of the costs associated with fatal occupational injuries and illnesses can improve prevention efforts and facilitate program planning, policy analysis, evaluation of safety and health interventions, and advocacy for a safer work environment.[11] The resulting dollar values provide policy makers the ability to systematically examine current and potential research and prevention impacts using standard economic measures.

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Notes

1 William-Steiger Occupational Safety and Health Act of 1970, P.L. 91-596.

2 While the focus of this article is work-related deaths, BLS also provides extensive data on nonfatal incidents through its annual Survey of Occupational Injuries and Illnesses.

3 NIOSH conducted the National Traumatic Occupational Fatalities surveillance system from 1980 to 2002. In 1991, the BLS Census of Fatal Occupational Injuries was implemented in 32 States and New York City. Since 1992 the program has collected work-related fatal injury data from all 50 States and the District of Columbia.

4 See *Traumatic Occupational Injury Research Needs and Priorities: A Report by the NORA Traumatic Injury Team*, Publication 98-134 (U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 1998).

5 See D. P. Rice, *Economic Costs of Cardiovascular Diseases and Cancer: 1962*, DHEW Health Economic Series Publication 947-5 (U.S. Department of Health, Education, and Welfare, 1965); and A. C. Haddix, S. M. Teutsch, P. S. Shaffer, and D. O. Dunet, *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation* (New York, Oxford University Press, 1996).

6 See F. Kuchler and E.Golan, *Assigning Values to Life: Comparing Methods for Valuing Health Risks.* (Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 784. Washington, D.C., 1999).

7 See D. P. Rice and E. J. MacKenzie and Associates, *Cost of Injury in the United States: A Report to Congress* (San Francisco, Institute for Health and Aging, University of California; and Injury Prevention Center, Johns Hopkins University, 1989).

8 See Elyce Biddle, "Cost of Fatal Occupational Injuries in the United States, 1980-97," *Contemporary Economic Policy*, July 2004, pp. 370-81.

9 A complete description of the methods and data sources can be found in Biddle, "Cost of Fatal Occupational Injuries in the United States."

10 The only Texas-specific data available were for wages by occupation; data on benefits were not available.

11 See T. R. Miller, N. M. Pindus, J. B. Douglass, and S. B. Rossman, *Databook on Nonfatal Injury: Incidence, Costs and Consequences* (Washington, DC, Urban Institute Press, 1995).

Table 1. Summary of Comments and Suggestions Made by the Texas Workers' Compensation Commission

Comments/Suggestions	Resolutions
Texas and NIOSH cost calculator fatality counts do not agree.	Texas counts were confirmed by BLS. The NIOSH model was using the State of death, while Texas was using the State in which the fatal injury occurred. This situation was corrected.
Cost estimation tables should include the query parameters that were selected to create the tables on the same page.	Because the query parameters selected could be extensive, a list cannot always be included on the same page as the cost estimation tables. However, when possible, a one page presentation is provided.
Include the occupation, industry, and case characteristic(ANSI Z-16.2) code numbers along with the classification titles.	Added code numbers for each of the variables at the greatest level of detail; 2-, 3-digit levels as well as 4-digit levels when applicable.

Comments/Suggestions	Resolutions
Calculate and display the total number of fatalities on estimation tables.	Developed the capability to generate standard frequency tables using the same selection criteria as the cost estimation tables.
Increase the number of individual variables that can be selected for each cost estimation.	The model was modified to have no limit on the number of individual variables that could be selected for cost estimations.
Add Hispanic ethnicity as a variable	Because Hispanic is not a category in the wage data, this suggestion could not be implemented.

Table 2. Total Cost Estimates for Texas Truck Driver Fatalities with Selected Characteristics, 1993–96

Year of Death	Decedent Characteristics				Number of Texas Fatalities	Total Costs	
	Occupation	Age	Sex	Race		National Wages	Texas Wages(1)
1993	Truck Driver	47	M	W	11	$9,080,634	$8,125,135
1994	Truck Driver	28	M	W	19	17,916,553	16,124,158
1995	Truck Driver	44	M	W	23	21,057,147	18,818,577
1996	Truck Driver	35	M	W	15	14,369,218	12,896,477

Footnotes:
(1) For this example, it was assumed that all decedents were earning State-specific (Texas) wages at the time of death.

Note: These estimates were generated using national and Texas estimated wages.