A Glimpse at Economic Research Directions at NIOSH†

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Introduction

Occupational illness and injury create human suffering, a huge burden upon healthcare resources, and a tremendous drain on U.S. productivity. More than 150 million men and women in the United States are employed (U.S. Department of Labor, Bureau of Labor Statistics [BLS], 2006a) and

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each year over four million nonfatal illnesses and injuries and over five thousand fatalities (BLS, 2005b) occur that are associated with work. Individuals affected by these health problems often become unable to work or their ability to work is limited by physical impairment, or, more tragically, they die. Although many workers may never face more than minor adverse health effects from exposures at work, every industry grapples with hazards, many of them serious (National Institute for Occupational Safety and Health [NIOSH], 1996, p.1).

Even though the number of workers affected is a somewhat uncomplicated measure, the cost of worker illnesses and injuries is not straightforward and varies in method and scope. One particular method of measuring economic cost is the cost of illness method described in the technical appendix of this document. For example, in 2003, the Liberty Mutual Workplace Safety Index, which tracks work-related injury and disability, reported that serious workplace "injuries" cost $45 billion (Liberty Mutual, 2005).[1] These are nonfatal injuries that result in six or more lost workdays. Meanwhile, the 2004 estimate of all "unintentional injuries,"[2] a more comprehensive category that includes both fatal and nonfatal injuries by the National Safety Council (2006) was $142.2 billion. Wages and productivity losses explained about

[1] Liberty Mutual's top 10 workplace injuries include overexertion, falls on the same and to lower levels, bodily reaction, struck by or against an object, repetitive motion, highway incident, caught in or compressed by, and assaults and violent acts.

[2] The NSC defines unintentional injury as the preferred term for accidental injury in the public health community. It refers to the results of an accident that may include unintended injury, death, or property damage. Therefore, both fatal and nonfatal injuries are included. In 2004, 5,704 workers died from work-related injuries and 4,999 of these deaths were accidental according to the Bureau of Labor Statistics Census of Fatal Occupational Injuries. See http://www.nsc.org/library/report_injury_usa.htm

one-half ($73.3 billion) of the NSC's estimate. Employers' uninsured costs[3] represented five percent ($7.9 billion) of that total burden. The remaining costs of illness and injury, such as medical and administrative expenses ($57 billion), and capital and equipment losses ($4 billion from motor vehicle crashes and fire loss), also affect productivity in the workplace. In 1996, a NIOSH-supported study using 1992 data reported annual total costs of all occupational illness and injury (OI&I) in the United States to be $171 billion (Leigh et al., 1997). Accounting for general inflation, that amount would have been $238 billion in 2005.

The National Institute for Occupational Safety and Health, a principle component of the U.S.'s public health agency, the Center for Disease Control (CDC), was created by the Occupational Safety and Health (OSH) Act of 1970 (Public Law 91-596)[4] to conduct research and prevention efforts to "assure every working man and woman safe and healthful working conditions and preserve our human resources." Its staff of 1400 is the largest devoted to research and prevention efforts reducing the number and severity of workplace illness and injury in the United States. NIOSH is responsive to requests from employers, employees, and other governmental entities to assess the potential work-relatedness of health problems, and to recommend effective prevention and remedial strategies. NIOSH enumerates hazards present in the workplace, identifies the causes of work-related diseases and injuries, evaluates the hazards of new technologies and work practices, creates ways to control hazards, trains safety and health professionals, and recommends OSH standards. To summarize, much of NIOSH's research identifies and prioritizes problems, quantifies risk factors, identifies existing approaches or develops new strategies to prevent OI&I, helps implement the most effective control measures, and monitors intervention efforts (NIOSH, 1998a). Intramural research programs are targeted to investigate

[3] The NSC defines employers' uninsured costs as the money value of time lost by uninjured workers. It includes time spent investigating and reporting injuries, giving first aid, production slowdowns, training of replacement workers, and the extra time of overtime for uninjured workers. See http://www.nsc.org/lrs/statinfo/estcost.htm

[4] 29 U.S. Code (USC) 671.

potentially hazardous working conditions ranging from chemical exposures to slippery work surfaces and to understand the causes and effects of work-related diseases and injuries from physical to psychological health outcomes. After thorough scientific investigation, NIOSH translates the knowledge gained into products and services.

Although nearly all research endeavors within NIOSH could benefit from economic examination (the study of how best to allocate limited or scarce resources among competing needs or uses), until 1996 economic research within NIOSH was virtually nonexistent. Studying the economic conditions that influence the incidence and severity of OI&I, as well as its economic consequences, provides guidance for the optimal allocation of resources in OSH from the societal, employer, and worker perspective. Estimating economic costs,[5] is important to NIOSH for many reasons. For example, they are a major factor in setting priorities and in generating improvements in workplace performance. Understanding the economic conditions and how best to allocate limited or scarce resources among competing needs or uses can influence the incidence and severity of OI&I, as well as the economic consequences of OI&I from the societal, employer, and worker perspective. Economic costs, unlike financial costs, include opportunity costs and expenditures to achieve risk reduction. This paper discusses the most dominant process for bringing economic focus to NIOSH research – the National Occupational Research Agenda (NORA).

National Occupational Research Agenda

Fiscal constraints are increasing, making collaboration between state and local health departments, community organizations, labor organizations, employers and employer groups, academia, professional groups, and federal agencies an imperative. Neither NIOSH nor any other single organization has the resources necessary to conduct OSH research to serve the needs of all workers and workplaces. As a result, in 1996, NIOSH and its public and

[5] Again, for a more detailed description of measuring economic costs using the cost-of-illness approach, please see Appendix I.

private partners developed the NORA process to provide a framework to guide OSH research into the following decade for NIOSH and the entire OSH community. The agenda was intended to target and leverage limited resources for research to address systematically those topics that are most pressing and most likely to yield gains to workers and the nation. The original NORA was a continual process where broad stakeholder input was collected, used to shape research efforts or modify current endeavors, and to create a national research focus. It became a model for other health organizations and led to an expansion of research priorities and goals. This original framework created 21 priority areas that were grouped into three broad categories: disease and injury, work environment and workforce, and research tools and approaches.[6] At the time of this first NORA, one of the designated priority areas (classified under research tools and approaches) was the Social and Economic Consequences of Workplace Illness and Injury (SEC), whose work will be described below. At that time, NIOSH and its partners had agreed that SEC research in the United States was limited and mostly focused on workers' compensation insurance and claims.

Over these first 10 years, NIOSH economists focused on developing an agenda and facilitating relationships and collaborations internal and external to NIOSH. The SEC team developed an agenda of research priorities that focused on ascertaining the burden of OI&I, identifying and understanding the complete costs of OI&I and other mechanisms for compensation and support for OI&I, comprehending coping strategies and behaviors of workers and their families to OI&I, standardizing methods to evaluate the economic consequences of OI&I, and the impact of OI&I on economic growth and competitiveness of employers. Much of this agenda was a result of the NORA process of collaboration described in the following paragraphs.

In terms of collaborative efforts, in 1999, the SEC team and the Health Services Research team began by holding a conference with leaders from

[6] A list of those priority areas can found at http://www2a.cdc.gov/nora

academia, industry, and government.[7] It focused on the status of the functional, economic, and social outcomes research and suggested areas for future research. As a result of the conference, several of the agenda areas that were identified above for further research emerged. These themes included (NIOSH, 2006, pp. 122-3):

- The measurement of the economic burden of OI&I on workers and the determination of the non-monetary costs of such burdens.
- The inclusion of research by psychologists, sociologists, anthropologists, and others on the social consequences of work injuries, including depression, a reduced ability to perform social and family roles, and difficulty maintaining family relationships.
- The examination of worker's compensation claims in employer costs, and the examination of less visible costs such as the hiring and training of replacements and the impact on productivity.
- The examination of ways to shorten the return-to-work period, and the quantification of the effects of return-to-work programs in the short run and long term.
- Research on factors that discourage workers from filing workers' compensation claims, resulting in the under-reporting of illnesses and injuries.
- Measuring gaps in workers' compensation benefits (i.e. the differences between lost earnings and medical costs).
- Examining the unrealized potential for using existing administrative and survey data to assess SEC.
- The need to develop new data using better measures of causal factors and outcomes.

In 2004, the SEC and Intervention Effectiveness teams and the World Health Organization held a second conference on the economic evaluation

[7] Commissioned background papers were published in the *American Journal of Industrial Medicine*, 2001, 40(3).

of OSH interventions at the company level. It brought together six international developers of models for measuring employer costs, individuals, government representatives, academics, and large and small employers. This conference established a global network of researchers interested in encouraging the use of economic knowledge and tools to evaluate economic gains from occupational health and safety interventions at the company level. Discussions at this conference expanded the economic agenda to the development of training modules in prevention effectiveness methods relating to evaluation at the company level and an exploration of developing a universal economic evaluation tool for use by corporate enterprises, small and medium firms, developing and transitioning nations, and economic theorists. Model descriptions and specific projects that could be pursued to advance knowledge in this area were incorporated into a special issue of the NSC's *Journal of Safety Research*.[8]

Also in 2004, NIOSH sponsored a multi-disciplinary conference, "Steps to a Healthier US Workforce," which explored the relationship between occupational and non-occupational factors affecting health. One area explored was the economics of integrating illness and injury prevention and health promotion programs using a model where workers and employers can reduce the likelihood of future health concerns. The success of the conference spurred additional research in economics, and initiated arrangements for a second conference to convene in the very near future.

In 2005, NIOSH published "A Compendium of NIOSH Economic Research, 2002-2003," which describes intramural research projects and projects that are extramurally funded.[9] These economics-related projects supported by NIOSH include five extramural projects (i.e. cooperative agreements and grants) and 22 intramural projects having some economic components. Some projects focus on determinants and not consequences of OI&I, and other projects have a primary focus that is prevention and control of occupational injury and illness with a minor focus on economics.

[8] Papers were published in the *Journal of Safety Research*, 2005, 36(3).

[9] See http://www.cdc.gov/niosh/docs/2005-112/default.htm

This document was intended to serve as a baseline to measure the impact of NORA on NIOSH economics research. Preliminary discussions for updating the Compendium began in 2006.

Finally, in 2006, NIOSH published 10 fact sheets on the number, rates, and costs of fatal occupational injuries from 1992 to 2002 in different industries. These included the eight sectors (listed in Table 1) with the trade and services groups separated into their components. Cost estimates for fatalities were calculated using the cost-of-illness approach described in Appendix I (Biddle, 2004).[10]

To summarize, the first decade of NORA increased funding for SEC research, increased the visibility of SEC research, and increased NIOSH resources, showing a stronger commitment to this endeavor. Research focused on both workers and employers. Employer research explored costs of interventions and prevention measures and workers' compensation costs to employers. Research also examined the impacts of lost earnings, medical costs, and changed employment status on workers and their families and the value of avoiding OI&I. Much research, mostly extramural projects, looked at the determinants rather than the consequences of the OI&I and included work on the availability of prevention resources and the economic situation of employers and workers. Other work looked at the measurement of intervention effectiveness and the impact of risk factors on OI&I (NIOSH, 2006). Additionally, collaborations were begun with many organizations, including the American Society of Safety Engineers, National Safety Council, Georgetown University and Embry-Riddle Aeronautical University, and the University of Pennsylvania's Wharton School.

The Second Decade of NORA

In 2006, NIOSH reshaped their NORA efforts, based on the knowledge gained over the previous 10 years. A second plan was unveiled that will continue these collaborative efforts and continue anticipating and responding

[10] DHHS (NIOSH) Publication Nos. 2006-151 through 2006-160.

to needs of workers and workplaces. The second decade of NORA will use a sector-based approach to better guide research results to improved practice in workplaces. The following table lists the sector-based areas.

TABLE 1
NORA Sector-based Areas

NORA Sector Group	*NAICS Code(s)*
Agriculture, Forestry & Fishing	11
Mining	21
Construction	23
Manufacturing	31-33
Wholesale and Retail Trade	42 & 44-45
Transportation, Warehousing & Utilities	48-49 & 22
Services	51-56 , 61, 71-72, 81 & 92
Healthcare & Social Assistance	62

As before, strong involvement with partners and stakeholders throughout the research process is emphasized.

In addition to the eight NORA sector programs that represent industrial sectors, there are fifteen cross-sector programs organized around adverse health outcomes, statutory programs, and global efforts. And, there are seven coordinated emphasis areas that support the sector and cross-sector programs.[11] Economics is one of the coordinated emphasis areas and members are participating in research planning efforts in the sector-based areas.

Through partnerships, building of capacity, and evaluation of efforts, NIOSH's economic team is developing a program of economic research that focuses on "human capital." The research in economics specifically supports the NIOSH goals of conducting research to reduce work-related

[11] See http://www.cdc.gov/niosh/programs

illnesses and injuries; promoting safe and healthy workplaces through interventions, recommendations, and capacity building; taking a leadership role in developing a global network of occupational health centers; and addressing the economic issues in occupational safety and health. Some of the long-standing issues that were of concern during the first era of NORA will continue to be important and some new areas have been added. Of continual concern are the following areas (NIOSH, 2006):

- Measurement of employer costs and consequences.
- Development of tools to assist employers in evaluating the economic value of prevention.
- The standardization and application of economic methods for evaluating workplace issues related to OI&I and its consequences for workers, employers, and ultimately, society.
- The evaluation of compensation and support systems for injured workers in terms of adequacy, equity, cost, and effectiveness.
- Increased documentation of how workers and their families cope with a disabling work injury and the economic impact of altered activity and work patterns, relationships, and psychological impacts resulting from OI&I.
- The study of the long-term effects of OI&I on workers and employers due to chronic or recurring health problems, job changes, or workforce withdrawal; and of the factors determining ultimate success of workers in returning to work as the nature and degree of the injury or illness, the work environment, the state of the labor market, and employer and workers' compensation policies.
- Assessment of the economic impact of OI&I on national resources as gross domestic product, tax revenues, growth, competition, and income distribution.
- Generally, to increase understanding of how the burden of OI&I is shared by workers, family members, employers, the wider community, and the government so that incentives for greater prevention measures can be developed.

- The examination of the economic consequences of OI&I by specific conditions, injury types, and hazards;
- The degree to which and how certain worker groups are more vulnerable, and generally to assist in ascertaining research and prevention priorities.

In the latter part of 2006, strategic goals for NIOSH's research in economics were simplified into four all-encompassing areas. These include:

- Increase the knowledge base on the value of preventing OI&I.
- Increase the knowledge base on how employment relationships, worker characteristics, work organization, and technology affect OSH.
- Enhance the capacity to make use of available knowledge on the economics of OSH.
- Develop strategic partnerships among researchers in the fields of economics and OSH and between researchers and practitioners to improve the relevance, quality, and impact of NIOSH and other research.

Concluding remarks

Both of these NORA frameworks have provided new and on-going opportunities for research partnerships, allowing NIOSH and the OSH community to not only advance research, but to translate this research into prevention programs and practice. These programs can affect the productivity of the individual worker and the employer. NIOSH's economic efforts are designed to reduce injury, illness, and fatality, and their economic costs, and indirectly to increase productivity.

Throughout this paper we have discussed the means and methods of NIOSH's economic research in a number of areas. Every study and each collaborative effort at NIOSH (with or without an economic component) is designed specifically to improve working conditions for the American

worker. By improving the work environment and reducing the incidence and risk of illness, injury, or death (the mission of NIOSH), productivity will increase. By studying economic costs directly, contributory factors to losses can be identified and ways to increase productivity and reduce economic costs can be explored.

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APPENDIX I

Technical Appendix on the Cost of Illness

When economists establish the social and economic impacts of adverse human health outcomes, they convert costs into monetary measures using, most often, the cost-of-illness (COI) method (Cooper & Rice, 1976; Rice, 1966; Rice et al., 1985). This cost methodology was reviewed by a task force of the U.S. Public Health Service, convened in 1978-79, whose mission was to reduce methodological differences between COI studies (Hodgson & Meiners, 1979, 1982). COI estimates provide an indicator or accounting of the economic changes that result from avoiding adverse health events and are often used to measure the dollar value of benefits from a government program that might improve health outcomes such as saving human lives or preventing diseases. They are unlike financial costs that just account for money used in healthcare such as insurance payments or hospital charges. Economic costs additionally account for the resources that could be used elsewhere and that may not have a monetary value, though these are often difficult to capture.[1,2]

There is no standard formula to estimate COI dollars. However, COI studies include direct and indirect cost components associated with incurring an illness and/or premature death.

There is general agreement on COI's two major components: medical costs and productivity losses. Sometimes these are the only two concepts that allow implementation of this approach. Both components are referred to by economists as "opportunity costs." If illness occurs, healthcare services are used and

[1] Note that in benefit-cost analysis, the concept measured is the difference between benefits and costs, an incremental picture of the value of an intervention or program. It is usually applied to an intervention. The COI method just portrays a part of the benefit-cost picture (Blanciforti & Luster, 2006).

[2] The willingness-to-pay method, which values goods based upon their worth to individuals, is sometimes used as an alternative to the COI method (Mishan, 1971). It is seldom used by NIOSH since it is a more individual approach than a social approach. It will not be discussed here but there are many good resources (Freeman III, 2003; Kenkel, 1994; Kenkel et al., 1994) that explain this method.

productivity is lost. The opportunity cost is the illness cost that could have been used elsewhere. If the illness had not occurred, healthcare services would not have been used and productivity would not have been lost.

Direct costs are the expenditures on healthcare goods and services, or the medical costs. This is the value of resources used in supplying healthcare that would be spent elsewhere in the absence of the illness. They include, for example, expenditures on healthcare professionals, hospitalizations, emergency room visits, drugs and medical tests, as well as other costs such as insurance and overhead related to that care.

The second component, indirect costs, is equated with lost productivity and is more likely a consequence of the illness or injury. These costs account for the value of resources lost as a result of time absent from work or from other usual daily activity due to an illness or premature death. Indirect costs include lost earnings, lost fringe benefits, and lost household production such as the loss of household services and the value of a caregiver's time that is taken away from household work or other outside employment to care for the ill person. It also includes retraining and recruiting costs for businesses. Generally, these indirect costs reflect the cost of lost output to the economy since the social perspective is used, while direct costs reflect changes in consumption of healthcare and its related goods and services. Indirect cost estimates are complicated by the fact that if one had not become sick or died, they would have continued to be productive. So, indirect costs include lost potential productivity or future earnings. Indirect costs are usually calculated by the "human capital" approach (Freeman III, 2003; Mitchell and Carson, 1989; Tolley et al., 1994).[3] A focus on the human capital approach improves the understanding of how investing in "assets," such as worker knowledge, skills, and health and safety, influences outcomes such as productivity, earnings, and the overall welfare of workers, organizations, nations, and the world.

[3] The human capital approach is best understood if an individual is thought to be like a capital good and, thus, investments that improve their health will have future returns, similar to that of an investment in a piece of equipment and what it does for a producer.

To estimate indirect costs, national data on population estimates (USCB, 2000), life expectancy (Arias, 2004), and labor participation rates and earnings (USDOL, 2005) are considered. Lost productivity is measured using lost earnings as a surrogate for the monetary value of lost labor, or an average market wage rate multiplied by a labor participation amount. The value of lost wages is estimated over the future and discounted to a present value based on the mortality or morbidity of the population being examined. For example, when comparing the cost of different diseases, the base or reference year, the discount rate (the rate used to value money's worth today compared to money's future value) and the inflation rate should be similar for each disease. For the most part, indirect costs derived from mortality data far outweigh those from morbidity, since they cover the entire productive life of individuals. Since these amounts depend on the resulting number of deaths or disabilities, indirect costs usually exceed direct costs. Co-morbidities are usually not included since they are difficult to capture. However, both the severity and the possibility of recurrence of illness and injury should be considered as these will significantly affect the cost.

Although the COI method provides a magnitude or indicator to which costs may be compared, some differences occur because data are unavailable, underreported, or overestimated. The COI approach has been criticized for excluding the value of pain and suffering and lowered quality of life resulting from any recurrence of an illness or injury. Controversy also arises over whether an individual's productivity is truly measured by their earnings. Because the COI method uses earnings to measure productivity, these losses may vary depending upon education, sex, age, race, job skills, and other socioeconomic characteristics in the population. Although such variations could be accounted for, they are typically ignored in COI estimates. Some imputations can be done for caregivers who do not typically work outside the home. For example, the value of lost household services (Hartunian et al., 981; Peskin, 1984) might be imputed on the basis of expected earnings of workers providing similar services as cleaners, cooks, babysitters, nurses, or maids.

Consistent estimating procedures are important, especially when comparing economic costs. Healthcare costs do not have an official market price. They are often measured by hospital charges, which may be over-inflated to meet insurance payouts and may not reflect the costs of the actual goods and services used. For many diseases, for example, there are differences in available data depending

on the specific infectious agent, disease severity, or whether the disease is acute or chronic. Usually, primary diagnoses are used for specific illnesses, so that associated conditions or multiple diagnoses are ignored. This might be reflected in overstated direct costs and even overestimated productivity losses of a disease when economic costs are measured separately.

Estimating productivity losses also may be problematic. Wage data may include pension plans, health insurance, and flexible hours. It is also not clear whether a work-loss day, the usual value used to represent absenteeism, is always associated with illness. Collectors of surveillance data may differ in their definition of medical services. There is also a large amount of underreporting for many illnesses and injuries, particularly common for infectious diseases such as influenza where only about 20 percent of the illnesses are reported (NRC, 1983). This is because the recording of influenza is dependent on whether the individual self-medicates or consults a doctor, if the physician recognizes the illness as viral, if blood is drawn and sent to a lab for testing, and if the lab recognizes the viral pathogen is influenza and reports the case to the CDC. Some of these issues are not uncommon to other OI&Is as well.

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Contents

(continued on back cover)